Proceedings of the British Equine Veterinary Association Congress
BEVA

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Next Congress:

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Welcome from the President

Please let me extend a really warm welcome to the vibrant City of Liverpool and the Arena and Convention Centre (ACC) Liverpool, situated on the World Heritage Mersey waterfront. Our first Congress here was in 2008, the year that this fabulous facility was opened. As a Liverpool graduate I feel extremely fortunate to be returning to a city with which I have such a warm affinity and fond memories.

The City of Liverpool sports two Premiership football clubs. Matches between the two sides are dubbed the ‘friendly derby’, in spite of this fixture having recorded more sending-offs than any other equivalent clash. Everton FC have an outlet close to the ACC Liverpool in the shopping area known as Liverpool 1. With typical satirical scouse humour, the shop bears the name Everton 2, giving it the postal address - Everton 2, Liverpool 1! This city is also famous for another sport, which strikes a chord with many of us and is the theme of this year’s Congress logo, viz. the Aintree Grand National, the most renowned jump race in world. In keeping with this theme, we are hosting a ‘Space-Hopper Grand National’, during the President’s Reception. I have little doubt that the event will attract numerous Steward’s enquiries for various infringements.

Since my first BEVA Congress in Warwick in 1989, which doesn’t seem that long ago, the event has grown to a size where there are only a handful of venues in the UK that can accommodate us. BEVA Congress is the second largest event of its kind in the world and we expect to welcome some 1200 attendees per day from across the globe.

During the formal opening of Congress the John Hickman Memorial Plenary Lecture, ‘Equine anaesthesia: illness, pain, broken legs and death’, will be delivered by Eddie Clutton, Professor of Anaesthesia at the Royal (Dick) School of Veterinary Studies. This will be immediately followed by the Prize Giving. I am delighted that Sue, widow of the late Professor Barrie Edwards, will be presenting the awards. Having Sue there reflects the affection and respect my colleagues and hosts the customary Happy Hours at the Registration desk. It is here that I will be handing over to next year’s President, Mark Bowen, who I wish the very best for what is likely to be a hectic but rewarding 12 months. If you haven’t booked your place yet, you still can by visiting the main Congress website.

During this year’s programme we are also engaging with the Musculoskeletal Allied Professionals, with all of Saturday in Hall 1c dedicated to the Vet/Physiotherapy Interface. This is the perfect opportunity to see things from ‘the other side’ and might enable you to engage more effectively in the future.

Back by popular demand are the Moral Maze debates: on Thursday afternoon the topic is, ‘Is Equine Sports Medicine Ethical?’ and on Saturday afternoon, ‘Does Equine Practice Need to Change to be More Compatible with Family Life?’ – two very different but equally controversial themes.

As mentioned earlier, throughout Congress there is a Practical Demonstration Area in the Exhibition Hall where Neil Townsend, Chris Pearce and Henry Bilson will be demonstrating dental ‘things’ during the coffee, lunch and tea breaks. You will also be able to sign up for small group sessions which we are extremely grateful, is an essential element of the Scientific Programme. There is also a full day session dedicated to making Congress what it is. The Commercial Exhibition is also the perfect opportunity to socialise with friends and colleagues and hosts the customary Happy Hours at the end of the lectures on Thursday and Friday afternoons.

One of the highlights of Congress will be Friday night’s black-tie Dinner at St George’s Hall, close to the city centre. It is here that I will be handing over to next year’s President, Mark Bowen, who I wish the very best for what is likely to be a hectic but rewarding 12 months. If you haven’t booked your place yet, you still can by visiting the main Congress registration desk. Table planning is arranged through the Registration desk.

Please make the most of Congress and don’t ‘write yourself off’ on the first night as has been known to happen in the past... maybe I shouldn’t judge you all by my standards.

With warmest regards

Andrew Harrison
BEVA President 2015
The British Equine Veterinary Association gratefully acknowledges the support of all companies who are taking part in the Commercial Exhibition, which not only provides considerable financial input to Congress but also enables delegates to see the vast range of products of specific interest to the equine veterinary profession.

In addition we are very much indebted to the following companies and organisations for their specific sponsorship.

**Agfa HealthCare**
Sponsors of the: Imaging Quiz Prizes.

**Bayer**
Sponsors of the: Trauma and Wound Panel Session (Thurs Hall 1b Session 3).

**Boehringer Ingelheim**
Sponsors of the: Respiratory Medicine Case Based Panel Session (Sat Hall 1a Session 2) and Advertising Sponsors.

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Sponsors of the: Proximal Suspensory Desmitis Session (Fri Hall 1a Session 1); The Stifle Session (Fri Hall 1a Session 2); The Mare and Stallion Session (Fri Hall 3b Session 1); Urology Session (Sat Hall 1a Session 3).

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**HBLB**
Sponsors of: The John Hickman Memorial Plenary Lecture Anaesthesia in Horses: Illness, Pain, Broken Legs and Death (Thurs Hall 1a Session 2); Refining Lameness Assessment Session (Thurs Hall 1a Session 3); Advances in Orthopaedics Session (Thurs Hall 1a Session 4); Regenerative Medicine in Orthopaedics Session (Fri Hall 1a Session 4); Foals and Youngstock Session (Fri Hall 3b Session 3); Upper Respiratory Tract Session (Sat Hall 1b Session 3); Clinical Research Sessions (Thurs Hall 12 Sessions 1, 3 and 4; Fri Hall 12 Sessions 1 and 2; Sat Hall 12 Sessions 1, 2, 3 and 4) and Free Access to all the HBLB Sponsored Sessions Online (after Congress).

**Manx Telecom**
Sponsors of the: Congress App.

**Merial Equine Health**
Sponsors of the: Equine Practice Management Session (Fri Hall 12 Session 2); Challenges in Equine Practice Management Session (Fri Hall 12 Session 4) and the Student Steward T-shirts.

**MSD Animal Health**
Sponsors of the: Infectious Disease Session and Workshop (Thurs Hall 1c Sessions 3 and 4); the Handbook; Pocketbook; Registration Pack and Lanyard.

**Rainbow Equine Hospital**
Sponsors of the: Hospitalised Horse Sessions (Sat Hall 3b Sessions 1, 2, 3 and 4).

**Rossdales LLP**
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**The Horse Trust**
Sponsors of the: Parasitology Session (Thurs Hall 1c Session 1); Equine Dentistry in Ambulatory Practice Session (Thurs Hall 3b Session 3); Diagnosis and Treatment of Colic Session (Fri Hall 1b Session 1); Respiratory Medicine Session (Sat Hall 1a Session 1); Award Lunch and Staff T-shirts.

**University of Liverpool**
Sponsors of the: Colic: What is the Evidence? Session (Fri Hall 1b Session 2); Techniques in Abdominal Surgery Session (Fri Hall 1b Session 3); Challenges in Colic Diagnosis and Post-Operative Care Session (Fri Hall 1b Session 4); Enterohepatic Disease Session (Fri Hall 1c Session 1); Anaesthesia Session (Sat Hall 1b Session 1); Anaesthesia for Dummies (Sat Hall 1b Session 2); Veterinary/Physiotherapy Interface: Physiotherapy Assessment (Sat Hall 1c Session 3); Veterinary/Physiotherapy Interface: Practical Treatment (Sat Hall 1c Session 4).

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Sponsors of the: Encore Room.
BEVA Rewards Excellence
Each year BEVA presents awards to the brightest and best in equine veterinary medicine to honour their outstanding contributions in the field.

The BEVA Equine Welfare Award, sponsored by the Blue Cross
The winner of this year’s prestigious BEVA Equine Welfare Award, sponsored by the Blue Cross, is Miss Johanna Vardon MBE, founder and owner of The National Foaling Bank in Shropshire. The National Foaling Bank provides a nationwide service for horse breeders to pair foster mares with orphaned foals and to provide guidance through the adoption process. Johanna has documented involvement in over 20,000 cases of fostering.

Always happy to pass on her knowledge, Johanna is an unsung hero of the equine industry. There is no doubt that the sort of cases she is involved with, e.g. death of the dam at foaling, rejection of the foal by the dam, and other foaling/dystocia problems, would compromise welfare significantly without the practical support and advice provided by Johanna and her team.

The BEVA Richard Hartley Clinical Award
The winner of this year’s award is Professor Paddy Dixon for ‘A long-term study on the clinical effects of mechanical widening of cheek teeth diastemata for treatment of periodontitis in 202 horses (2008-2011)’ by P.M. Dixon, S. Ceen, T. Barnett, J.M. O’Leary, T. Parkin and S. Barakzai. The article was first published online in June 2013 and then in January 2014, Volume 46 of Equine Veterinary Journal.

The award is given in memory of Richard Hartley, a founder member of BEVA and President from 1974 to 1975. It is awarded to the senior author of the best paper published in Equine Veterinary Journal or Equine Veterinary Education with direct clinical application. The prize is intended to support travel of the senior author and/or co-authors.

The BEVA Trust Peter Rossdale EVJ Open Award
The winner of this year’s award is Dr Andrew van Eps for the paper ‘Continuous digital hypothermia initiated after the onset of lameness prevents lamellar failure in the oligofructose laminitis model’ by A.W. van Eps, C.C. Pollitt, C. Underwood, C.E. Medina-Torres, W.A. Goodwin and J.K. Belknap. The article was first published online in November 2013 and then in September 2014, Volume 46 of Equine Veterinary Journal.

This award is given for the paper that best achieves EVJ’s mission to publish articles which influence and improve clinical practice and/or add significantly to the scientific knowledge that underpins and supports veterinary medicine in relation to the horse. The award is made by the BEVA Trust in recognition of Peter Rossdale’s immense contribution to BEVA and EVJ.

The Voorjaarsdagen and BEVA Awards
In 2005 the Voorjaarsdagen and BEVA Awards were introduced to mark the close relationship between the two Associations. The award is selected and presented biannually, once at the Voorjaarsdagen Congress and once at BEVA Congress, and is open to all those presenting a Clinical Research paper.

This year’s BEVA Award winner is Dr Mathijs Theelen, DVM DipI ECEI for his paper on ‘Ethmoidal infection with Aspergillus spp in 3 horses: successful treatment by transendoscopic removal of mycotic plaques alone or in combination with systemic itraconazole’. Dr Theelen’s presentation won the award at the Voorjaarsdagen Congress in April 2015; he will present it again during the Clinical Research Sessions at BEVA Congress.

The reciprocal Voorjaarsdagen Award winner will be selected from those presenting Clinical Research papers at this year’s BEVA Congress. Their prize will be free registration to Voorjaarsdagen Congress 2016 where they will have the opportunity to present their paper again.

The Sam Hignett Award
All Clinical Research presentations from general equine practice are eligible for the Sam Hignett Award. A continuous process of assessment will take place throughout the Clinical Research Sessions and the winner of the award will be announced after Congress through the BEVA website and newsletter.
Many diagnostic tests used during the clinical examination of a lame horse are known to produce both false positive and false negative results (e.g., application of the hoof tester, the distal interphalangeal extension test; flexion tests, and pressure applied to the proximal aspect of the suspensory ligament). Diagnostic intrasynovial and regional analgesia is, therefore, an important component of lameness examination if the site of pain causing lameness remains uncertain after the horse undergoes a thorough clinical examination. The results of diagnostic analgesia are usually evaluated subjectively, sometimes with difficulty, and errors in subjective evaluation lead to errors in diagnosis and, therefore, in prognosis and treatment. To evaluate the results of diagnostic analgesia accurately, the clinician should have a thorough knowledge of the nuances of interpretation. Although interpreting the results of diagnostic analgesia is usually straightforward, the clinician should be aware of the many ways in which diagnostic analgesia can be misinterpreted.

For subjective evaluation of a horse’s gait, the horse should be consistently and sufficiently visibly lame before diagnostic analgesia is performed, so that any improvement in gait can be detected and attributed to the diagnostic, analgesic injection. The clinician should be aware that lameness of some horses improves or resolves during exercise, and so, for these horses, a false positive response to diagnostic analgesia can occur if the horse has not been exercised sufficiently to attain a consistent state of lameness. Results of diagnostic analgesia can be misinterpreted if the incorrect limb is chosen for evaluation. Lameness of a single limb can cause alterations in gait symmetry that make the horse appear lame on other limbs, causing the wrong limb to be chosen for evaluation [1]. A clinician bias affecting evaluation of diagnostic analgesia, may reveal itself in a positive or a negative way, and a clinician may be inclined to see an improvement in a horse’s lameness where there is none or fail to see the improvement that is present [2].

A change in gait of a sedated horse can be erroneously attributed to the effects of diagnostic analgesia rather than to the effects of sedation if the gait was not evaluated after the horse was sedated but before diagnostic analgesia was administered.

Xylazine (0.2 mg/kg bwt, i.v.), detomidine (10 µg/kg bwt, i.v.), or acepromazine (0.01-0.02 mg/kg bwt) administered in the course of a lameness examination usually do not interfere substantially with assessment of gait [3]. After a regional nerve block, skin can be tested for loss of sensation at a specific site on the limb for each nerve, but this method of testing may yield erroneous information [4]. Misinterpretation of the results of regional analgesia may occur when the local anaesthetic solution is inadvertently administered outside the perineural fascia [5] or into a blood vessel or synovial structure [5].

When assessing the effects of anaesthesia of nerves in the distal portion of the limb, the clinician should be aware that, after injection, anaesthetic solution might migrate proximally along the neurovascular bundle to anaesthetise more proximal structures, thus confusing the results of the examination [5,6]. Results of intrasynovial analgesia can be misinterpreted if anaesthetic solution leaks or diffuses from a synovial structure to desensitise a nerve. The most widely recognised example of this situation is the desensitisation of nearly the entire foot after local anaesthetic solution is injected into the distal interphalangeal joint [7].

Results of diagnostic analgesia can also be misinterpreted if the horse’s gait is assessed before the onset of relief of pain. Relief of pain and resolution of lameness after local anaesthetic solution is administered near a nerve in the distal portion of the limb usually occurs within 5 minutes, but anaesthesia of larger nerves in the proximal portion of the limb may take 20 to 40 minutes [8].

Misinterpretation of regional analgesia can arise if clinicians do not realise that a diagnostic block may desensitise more than the target region or that the diagnostic block may not completely desensitise the target region [9]. A negative response to intra-articular analgesia does not always exclude joint pain as a cause of lameness. Intrasynovial analgesia may not resolve lameness if disease of subchondral bone contributes to joint pain because subchondral bone is innervated by branches of nerves that enter the bone through its nutrient foramen [10,11].

Aberrant nerve branches may be responsible for ineffective desensitisation of the foot after a palmar digital nerve block, leading to misinterpretation of the block, especially when the skin at the coronary band is no longer sensitive. When aberrant nerve routes are suspected, ring blocks may be a useful adjunct to perineural analgesia [8].

Because of all the pitfalls related to the interpretation of the results of regional or intrasynovial analgesia, results of diagnostic analgesia should be regarded with some degree of skepticism.

References


The role of scintigraphy in poor performance evaluation

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Scintigraphy is an important ancillary imaging modality; it should not be viewed as an ‘answer machine’. Often clients expect a straightforward answer to a complex, multifaceted performance problem with a single pass of the gamma camera. Scintigraphy cannot give an answer to every lameness problem but provides useful and interesting clinical information. Negative scintigraphic examination can in itself provide a clinical direction by ruling out active bony remodelling. A dressage horse has a chronic obscure performance problem and a negative whole body bone scan would ensure a training intensity change could be done without exacerbating an existing bony lesion.

Most false negative scans result from problems with limb or camera positioning, body part-to-camera distance, shielding by overlying soft tissues or bone, background (bladder) and physisal activity. Careful interpretation of caudal views of the stifle helps diagnose osseous cyst-like lesions. Authentic negatives are useful in horses in which an increase in exercise is planned, but care must be taken in racehorses. Negative delayed-phase supports pain is likely originating from soft tissues. In horses with hindlimb lameness, negative scan findings often lead me to suspect the stifle because delayed images lack sensitivity. Findings in horses with chronic proximal suspensory desmitis (PSD) also are often negative. Remember it is called a bone scan for a reason; sensitivity for soft tissue injury, particular chronic problems such as PSD is poor. DO NOT expect the bone scan to be positive in a horse with PSD.

Case selection

Racehorses are ideal since they undergo high-impact exercise and are prone to stress-related cortical or subchondral trauma. Older SHs, particularly Warmbloods are much less than ideal. Low-impact exercise coupled with advanced age decrease the possibility of an answer. Scintigraphic examination may provide disappointing information regarding chronic osteoarthritis, particularly of the fetlock joint. In racehorses increasing radiopharmaceutical uptake (IRU) of the palmar/plantar aspect of the fetlock joint (Mc/MtIII most common) is often pronounced, whereas in sport horses focal, mild IRU, most often seen associated with the dorsomedial aspect of the joint can be subtle, and is often under-appreciated or interpreted incorrectly. It is sometimes difficult to find correlation between scintigraphic and radiological changes in the distal hock joint. In racehorses increased radioactivity (IRU) of the distal part of the metatarsus/metatarsus, stifle, and the back. But, two important factors determining the usefulness of the bone scan include, the horse is clinically lame at the time of the scan and lameness has been localised. Scintigraphy provides a ‘functional evaluation’ of osteoelastic activity (modelling) at the time of the scan. If a horse with chronic lameness is rested for several months before evaluation, the chances of seeing IRU are greatly diminished. In a known area of clinical lameness, diagnostic accuracy can be increased, since a differentiation can be made between soft tissue and bony problems, and radiographs can be more carefully evaluated in light of scintigraphic findings. Scintigraphy is least likely to yield a diagnosis in SHs with nebulous histories of gait abnormalities and poor performance and with problems that can be perceived only by the rider. These horses usually are not lame, may have equivocal or negative manipulative test results, and may be difficult individuals with which to work. Diagnostic analgesia may be difficult to perform or interpret but selective analgesic techniques may improve the feel of the horse. Blocking one limb in a horse suspected of having bilateral nearly symmetric pain may produce obvious contralateral signs.

Scintigraphic examination has been used as part of a comprehensive purchase examination, but results must be carefully interpreted and clinical relevance established. Although unusual, this adjunct imaging procedure usually is requested in high-profile, expensive, upper-level sport horses and results can often be confusing. Finding an upper-level horse of any type without any scintigraphic changes would be unusual, mirroring radiological findings in these horses. Scintigraphy was useful in establishing clinical relevance of mineralisation of the cartilages of the foot and when present, intense IRU was associated with radiological changes that could be differentiated (wider and more irregular) from unimportant areas of mineralisation or separate centres of ossification [1–3]. A possible benefit to clinicians performing examinations before purchase was proposed [1].

Focal or diffuse areas of IRU are found in the thoracolumbar dorsal spinous processes and may account for clinical signs of back pain, poor performance, or gait restriction but occur only in horses that are ridden. A wide spectrum of scintigraphic and radiological changes in the thoracolumbar spine in horses without back pain led to the conclusion that IRU of the dorsal spinous processes should be interpreted carefully and in light of other clinical signs; only 7 of 33 horses without back pain had no radiographic or scintigraphic abnormalities and in some horses IRU was pronounced [4]. We have not identified areas of IRU in the thoracolumbar spine in the Standardbred racehorse, but these are common in young Thoroughbred in race training and in most are incidental scintigraphic findings. However in SHs scintigraphy may be helpful in the assessment of the clinical significance of radiological evidence of osteoarthritis of the thoracolumbar facet joints [5] or spondylolisthesis [6]. Blocking is the single most important procedure in horses suspected of having back pain, such as those that develop nappy behaviour, resistance and signs such as bucking. Resistance to saddling or poor performance could be explained by fracture, anomaly or injury of ribs [7].

References


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The equine neck: diagnostic and treatment strategies

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Introduction
While not an infrequent complaint related to athletic performance of the sport horse, the diagnosis of neck pain can be elusive and complex. Poor performance is a hallmark of neck discomfort and such discomfort can dramatically affect the horse’s way of going. Many symptoms may arise as simultaneous issues to other lameness problems, and the difficulty is determining the origin of the problem. Neck pain may be related to a ‘forced’ head position in training, injury from an accident or fall, muscle soreness, nuchal ligament injury, nuchal bursitis, previously undiagnosed fracture of cervical vertebrae or osteoarthritis of synovial facet joints [1].

Diagnosis
A thorough physical examination is essential in assessing if, in fact, the neck is the source of the current performance issue. This will include not only an examination at rest but also movement in hand, on the lunge line and under tack. Flexion and extension tests as well as response to certain exercises may give significant clues as to the origin of discomfort. Distal limb nerve blocks may be appropriate to further identify other sources of discomfort. Some neck issues may be the source of forelimb lameness unresponsive to distal limb nerve blocks. The well-known ‘carrot stretch’ exercise [2] is a good test for range of motion and possible discomfort, but stiffness alone does not confirm pain although it certainly can imply dysfunction. Imaging is critical to an accurate diagnosis. Today’s digital radiography systems coupled with high frequency portable x-ray generators make field radiography of the cervical region possible with excellent quality results. Diagnostic ultrasound is very sensitive to subtle changes of the cervical articular facets and visualisation of synovial effusion and capsular thickening is relatively simple [3]. More advanced imaging techniques such as nuclear scintigraphy and computed tomography (CT) may contribute to a more complete assessment of pathology in the clinically subtle case. Such imaging may also be used for confirmation of suspected lesions identified with other modalities.

Treatment
Treatment of neck pain can be accomplished through a variety of modalities. Nonsteroidal anti-inflammatory drugs (NSAIDs) may provide immediate relief that may be complete in the case of simple acute ligamentous or muscular strain or very mild arthritis (Prevail [flunixin meglumine]®: Newer NSAIDs such as firocoxib (Equioxx®), which works through COX2 enzyme inhibition, may be safer for long term use in horses with a history of gastric or colonic ulcers or in horses requiring extended therapy. Muscle relaxants such as metocarbamol (Metohcarbamol tablets, USP, 750 mg)® may provide additional relief in acute onset pain where there may be muscle splinting. Acute onset pain with a ‘stuck neck’ and possible neurological signs may respond best to a combination of flunixin meglumine (1 mg/kg bwt), dexamethasone (20-40 mg) (Dexamethasone sodium phosphate aqueous, 4 mg/ml)®, i.v. DMSO (1 g/kg bwt) (Dimethyl sulfoxide 99%)® in 5 litres of polyionic fluids (Plasma-Lyte A®), and muscle relaxants and/or tranquillisers.

In the case of nuchal bursitis, conservative management with injection of corticosteroids may be successful once infection has been ruled out through centesis and culture; however, those that do not respond to conservative management can be treated with bursoscopy and debridement [4]. Extracorporeal shockwave therapy is effective in calming the soreness associated with nuchal ligament enthesopathy at the occiput.

In the case of synovial facet arthritis, intra-articular injection with corticosteroids and other preparations such as autologous conditioned tissue (Arthrex® IRAP™ II System)® can be very effective in improving mobility and relieving signs that are secondary to osteoarthritis. Ultrasound guided techniques provide for accurate placement of intra-articular medications. Mesotherapy has further reduced local discomfort and improved range of motion in many cases of chronic neck pain. This technique involves the intra-dermal injection of a soluble corticosteroid such as dexamethasone sodium phosphate solution and local anaesthetic (Lidocaine HCL 2%)® that effectively break the local pain reflex arc and reduce muscle spasm and local discomfort. Three to four parallel rows of treatment are performed along either lateral surface of the neck. The effect may last for several weeks. Acupuncture, especially electro-acupuncture, has been of significant benefit in the author’s opinion as adjuvant therapy for neck pain. Ultrasound therapy may prove very useful for the treatment of neck soreness, improving comfort and range of motion. Therapeutic massage and careful manipulation of the neck may be of some benefit; however, this author is opposed to exaggerated adjustments of the neck. Exercises, such as the stretching exercises outlined by Stubbs and Clayton [2] have been very helpful for long-term management.

Conclusion
The neck is frequently the source of performance problems for the sport horse. Problems may range from acute trauma to chronic osteoarthritis. A thorough physical examination and careful observation of the horse in motion along with various imaging modalities can enable the practitioner to accurately assess the horse and address the problems in an effective manner.

References

Manufacturers’ addresses
* Bimeda, Cambridge, Ontario, Canada
* Merial Limited, Duluth, Georgia, USA
* Qualitest Pharmaceuticals, Huntsville, Alabama, USA
* Neogen-Life Sciences Division, Lexington, Kentucky, USA
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i.v. DMSO (1 g/kg bwt) (Dimethyl sulfoxide 99%)® in 5 litres of polyionic fluids (Plasma-Lyte A®), and muscle relaxants and/or tranquillisers.
Is it lame or neurological? The role of transcranial magnetic stimulation examination
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Introduction
The poor-performing horse is a diagnostic challenge for every veterinarian. Normal performance and locomotion is dependent of normal function of the neurological, the cardiorespiratory as well as the musculoskeletal system. Examining the poor performing horse consists of a thorough examination of all those systems. The neurological examination includes the clinical neurological examination, the transcranial magnetic stimulation (TMS) and diagnostic imaging.

Clinical neurological examination
The focus of this presentation is limited to the pathology of spinal ataxia. Basic clinical tests in a physical examination include: flexion of head and neck, evaluation of symmetry of neck, trunk and pelvis, the postures adopted at rest, evaluation of the gait at walk, trot and canter, evaluation of transitions walk-trot-canter-trot-walk, evaluating the horse whilst turning at stance and when the horse is maneuvered rapidly and stopped abruptly. In the horses that are examined for poor performance, signs will mostly be subtle. With mild cervical spinal cord lesions, signs of ataxia and weakness may be evident in the pelvic limbs only. We will look for degrees of weakness and ataxia: easily stumbling, horses will show buckling on a limb when turning, they will circumscribe a limb when turning, horses will be more easily pulled to the side by the tail while standing still and whilst moving, dragging of a toe and a low foot flight and awkward placement of a limb when the horse is stopped abruptly. Still, in the most subtle cases, it remains difficult to make an accurate objective diagnosis and other diagnostic tests are necessary. Transcranial magnetic stimulation is performed to identify the presence of a functional descending spinal cord lesion and make a localisation of the lesions, i.e. cervical spinal cord or caudal of the second thoracic vertebra.

Transcranial magnetic stimulation (TMS)
Transcranial magnetic stimulation is a noninvasive, objective, painless and sensitive neurological test that is performed on the standing, sedated horse. TMS in the horse is used for objective assessment of motor function, i.e. assessment of the motor tracts in the spinal cord. Both in humans and animals with spinal cord lesions, magnetic stimulation of the brain is proven to be a valuable diagnostic tool for detection of lesions along the spinal cord. A magnetic stimulus (painless) is given, through the skull, to the cerebral motor cortex and subsequently electrical activity will pass through the motor tracts in the spinal cord and elicit a response in the musculature of the horse. This response is measured in the forelimbs in the extensor carpi radialis muscle and in the hindlimbs in the extensor carpi radialis muscle with electromyography. These electromyographic responses (MMEPs = magnetic motor evoked potentials) are measured: the onset latency and the amplitude are determined. In horses suffering from spinal cord lesions the MMEP’s will demonstrate several typical abnormal features (even in mild spinal cord lesions): prolonged and variable latency, low amplitude and frequently polyphasic waveforms. MMEP’s are always recorded in all four limbs. Recordings of the forelimbs and hindlimbs are compared and the recordings of the left and right are compared to respectively distinct cervical spinal cord lesions from lesions located caudal of the second thoracic vertebra and to detect asymmetrical lesions. In Europe spinal ataxia is mostly caused by lesions in the cervical part of the spinal cord and in most cases these lesions are the result of cervical vertebral malformation (CVM) or the so called ‘Wobbler’ syndrome. Other possibilities are infectious disease (EHV), trauma, fractures and tumours. When the lesion is located in the cervical spinal cord, radiography is performed. If the lesion is located caudal of Th2, final diagnosis is more difficult to obtain in the horse. Scintigraphy, radiography of thoracic and lumbar vertebra and (rectal) ultrasound are indicated.

Cervical vertebral radiography/myelography
The radiographs will be assessed for: encroachment of the caudal physics dorsally into the vertebral canal (ski jumps), caudal extension of the dorsal aspect of the arch of the vertebral canal, dorsal angulation and arthropathy of the articular facets. In addition to these characteristics of CVM (Wobbler syndrome), examination for other abnormalities such as fractures, malformations and tumoral lesions should be performed. When diagnosing CVM, it is mostly important to identify the presence of stenosis of the cervical vertebral canal. Therefore measurement of intra- and intervertebral sagittal ratios is indispensable. The addition of these measurements improved accuracy of radiography in diagnosing CVM. A ratio less than 52% for C3 to C5 and less than 56% for C6 and C7 or a ratio of <0.485 at any inter- or intravertebral site is strongly indicative of CVM.

Cervical myelography is used to help determine the exact site of compression especially when surgery is an option.

Further reading
Numerous changes have occurred since 1969 when the first analysis of perioperative equine fatalities revealed a mortality rate of 1.7% [1]. The volume of information available to improve both medical and veterinary anaesthetic and surgical practice has burgeoned with subsequent effects on the skills and expertise of veterinary specialists. Major developments in physiological monitoring technology and drug therapy have accompanied specific innovations in equine anaesthetics and surgery, e.g. improved surgical table design and post operative recovery strategies. Yet, perioperative mortality in horses – as determined in both multi- and single-centre studies remains:

a) considerably higher than it does in human beings and other domesticated species [2]; and b) largely unchanged since 1969. That anaesthesia-associated mortality in human beings and other domesticated animals has fallen - presumably because of the aforementioned innovations – is of concern, because it implies such developments are of less benefit in equidae. Of greater matter is that the serial examination of equine mortality appears not to have improved matters. This deserves consideration because multi-centred studies are time-consuming for both investigators and correspondents, while further ones are planned. One explanation is that identified risk factors may not be universally applicable, and that confounding factors may be important in some centres. Another is that risk factors, being inevitable, become regarded as unavoidable and so are ignored. A third is that their significance may be misinterpreted because technique changes which may themselves increase risk. The adage, “if it isn’t broke...” persists for good reason. Alternatively, events in equine anaesthesics may be occurring at such a pace that data, when published, are redundant. A final explanation is that the seven day post operative ‘cut-off’ point delineating survival or otherwise is excessive, and incorporates risk factors beyond the anaesthetists’ control; a more focused examination of post operative morbidity may elucidate this. Whatever the reason, it is sad to reflect that three multi-centred CEPEF [3,4,5] and several single-centred studies have revealed the importance of reasonably self-evident risk factors, e.g. body position, duration of anaesthesia, knowledge of which has done little to change the safety of equine anaesthesia. Importantly, findings appear not to have encouraged clinical and fundamental research in directions that may have meaningfully contributed to decreasing risk. Much recent equine anaesthetic research has focused unproductively on the comparison of surrogate (rather than outcome) measures in the evaluation of (not so) different anaesthetic techniques – a possible result of the increased importance placed by trainees on achieving European college examination credentials. Research efforts should be refocused on the principle adverse outcomes of equine anaesthesia: the likely causes of death, post operative pain and morbidities and the avoidable causes of catastrophic orthopaedic injury.

The latest initiative to identify the causes of equine mortality – CEPEF 4 [6] – has been criticised [7] for “barking up the wrong tree” because in finding “large variability in anaesthetic techniques and approaches” its authors are proposing the imposition of internationally accepted standards for the practice of equine anaesthesia. This will not guarantee a reduction in mortality if it, like morbidity [8], is centre-dependent – which it probably is [9]. However, a preoccupation with individual trees may be obscuring a wider sylvan perspective. Sustained risk in the face of improving standards of anaesthetic management may arise because increasingly complicated (more prolonged) procedures are being attempted in older (higher risk) animals with poor prognoses on the request of owners whose emotional ties with the animal outweighs other factors. These possibilities should be examined in future CEPEF studies because they have potential implications for human medicine.

It should also be noted that CEPEF studies to date have not incorporated data from ‘field’ anaesthetics in which short duration and straightforward operations are conducted on (usually) healthy horses in animal-familiar environments with a minimum of equipment, while these are limited data on the risk of standing surgical anaesthesia. This is unfortunate because data from these sources would readily reveal the potential effects of hospitalisation and associated stressors, and general anaesthesia with postural derangement, respectively, on risk.

Until the time that definitive answers arise from CEPEF studies that embrace all aspects of equine anaesthetic practice, the value of centre-based clinical audit combined with the honest and critical evaluation of unexpected events - whenever they arise – should not be overlooked. In the final analysis, the risk of equine anaesthetics is obviated when – whenever they arise – should not be overlooked. In the final analysis, the risk of equine anaesthetics is obviated when futile procedures on high risk cases are not carried out. In addition to continued epidemiological studies establishing risk, equine anaesthetic research should focus more directly on reducing morbidity and mortality figures.

References
Subjective gait analysis epitomises the art of lameness examination and is used to determine in which limb or limbs the horse is lame and to formulate and execute a plan for diagnostic analgesia. With experience, careful observation and honesty, a lameness detective has little need to rely on inertial sensors to evaluate, grade and diagnose a lame horse. These are five key observations used to subjectively evaluate gait of lame horses.

**Head and neck nod (undulation, movement, HNN)**

The head and neck will elevate (rise) to unload a lame (the most lame) forelimb and settle back to baseline (nod down) during weight-bearing of a sound (or less lame) forelimb. Differences between clinicians exist regarding which portion of the undulation is most easily recognised (I see nod DOWN). A HNN can be a result of forelimb pain, ipsilateral hindlimb pain (a horse with ≥3 out of 5 degree hindlimb lameness will manifest a HNN mimicking ipsilateral forelimb pain) or coexistent ipsilateral forelimb and hindlimb pain.

**Pelvic hike (rise and settling, PH)**

The pelvis will rise (hike up) during protraction (advancement) of a lame hindlimb to unload weight and drop (settle) during weight-bearing to load the sound (or less lame) hindlimb. The pelvis is a single unit and PH is observed by evaluating a fixed point rather than comparing movement of right and left. Differences between clinicians exist regarding which portion of the PH is most easily recognised (I see hike UP). A HNN without PH is forelimb lameness; a HNN with PH is either ipsilateral hindlimb lameness or both forelimb and hindlimb lameness.

**Shortening of the cranial phase of the stride (SCPS)**

A hugely important observation is a measure of the horse’s willingness to put a limb in front of the contralateral limb during protraction. A horse will shorten the SCPS in the lame limb and the diagonal limb (a stride-to-stride adjustment the horse must make to maintain balance during trot). SCPS in a diagonal limb occurs with singular forelimb or hindlimb lameness, but may represent authentic coexistent diagonal lameness. Diagnostic analgesia begins in a forelimb in horses with HNN or in a hindlimb if a PH is observed. Resolution of an abnormal SCPS of both the principal and diagonal limbs represents a key observation when blocking.

**Fetlock drop (FD)**

Unless a horse has severe suspensory desmitis in which there is a substantial loss of fetlock support, the horse will hyperextend (dorsi-flex, drop) the fetlock that is receiving more load (the less lame limb) when compared to the lame limb. During real time this observation takes practice but can easily be seen using slow-motion video. For example, a horse with LF lameness will drop the RF fetlock more than the LF fetlock during trot (a SCPS LF/RH and HNN will be observed as well).

**Drifting**

A horse will drift away from a lame hindlimb if lameness is pronounced (≥3 out of 5 degrees). For example, a horse with substantial LH lameness will drift to the right, have a SCPS in the LH/RF, a PH during LH protraction and may have a HNN consistent with LF lameness. Drifting in horses with forelimb lameness is rare but can occur with carpal pain where horses appear to be pushing away to the contralateral side.

Bonus observations include the use of sound, observation of a toe drag, and recognition of a short, choppy gait. Sound can be useful – an unshod horse’s hoof strike may be difficult to hear and fairness dictates if horses are shod they must be shod symmetrically. The principle is a horse will manifest a softer hoof strike on the ‘lame diagonal’ (if the horse is lame in a LF, the lame diagonal is the LF/RH) and land harder/louder on the ‘sound’ diagonal. Horses with asymmetrical front feet (large, platter-like foot compared to a small, upright foot) may lead you astray. Hindlimb toe drag is common but is sometimes subtle and can best be seen during slow motion replay of lameness examination video segments. I have seen toe drag most commonly in horses with stifle pain and in those with proximal suspensory desmits but it can be observed with any source of pain. Often after diagnostic analgesia a toe drag may persist even in horses in which PH abates. The short, choppy gait is common in horses with bilateral or quadrilateral lameness in which pain is symmetrical. In racehorses subchondral bone pain originating from the distal aspects of the third metacarpal and metatarsal bones is the most common reason for this gait (not foot pain) whereas in non-racehorses such as western performance horses this gait is typical of bilateral foot or distal hock joint pain.

These observations are made when trotting horses in a straight line on a hard surface. Observations made during walk and comparing gaits at walk and trot are valuable lameness tools. Some horses with upper forelimb pain (elbow, shoulder regions) may manifest a HNN, which is more prominent (magnitude of the undulation) at a walk than at a trot. A horse with severe hindlimb lameness and SCPS when trotting, which has a decreased caudal phase of the stride when walking commonly have pain originating from the digit or the pelvis. There are numerous classic gait deficits easily recognised during movement. A simple, highly productive test for the effect of turning on the magnitude of baseline lameness is to circle a horse. Circling will often reveal pronounced lameness not seen at a trot in a straight line particularly in horses with bilateral, nearly symmetrical lameness in which a short, choppy gait is not apparent.
Integrating subjective and objective lameness evaluation

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Introduction

The advent of inertial measurement units (IMUs) now allows objective gait analysis to be performed in the field rather than a dedicated gait laboratory.

Two lameness indicators are commonly used: the head nod to assess the forelimbs and the ‘hip hike’ or tuber coxae excursion to assess hindlimb soundness [1]. Experienced lameness diagnosticians will use additional movement parameters and also the prevailing environmental conditions must be recorded as these will affect the horse’s ability to express the head nod or hip hike [2]. With that taken into consideration, the horse will still seek to unload the painful limb.

IMU placement

The standard set-up to assess a lame horse uses an IMU placed on the poll, tuber sacrale and both tuber coxae (Fig 1). The transmitter is placed in a pocket attached to the surcingle; the information is received by a laptop on the side of the trot up area.

Forelimb lameness head nod

In a sound horse at trot the curve of vertical displacement of the poll vs. time shows a sinusoidal pattern (Fig 2).

Fig 1: IMU set up: Sensors on poll, tuber sacrale and both tuber coxae; transmitter on surcingle.

Fig 2: Forelimb IMU data from a sound horse; Max diff = Maximum differential, Min diff = Minimum differential

The head moves up and down twice per stride cycle. It moves down during beginning of the stance or impact phase (deceleratory) and moves up at the end of stance or push-off phase (acceleratory). The maximum differential (Max diff) compares the height reached following the push off phase whereas the minimum differential (Min diff) compares the lowest point the head reaches during the impact phase. This data gives the potential to determine which part of the stride cycle the horse is finding uncomfortable.

Hindlimb lameness

Clinicians appear to vary in which part of the horse’s anatomy they observe during evaluation of a horse for hindlimb lameness [3]. The author uses the increased range of tuber coxae movement on the side of the lame leg when the contralateral limb is weightbearing; this movement occurs at the tuber sacrale as well. IMUs are placed on the tuber sacrale and both tuber coxae.

Fig 4: IMU from the tuber sacrale of a horse with no visible lameness

The data in Figure 4 is taken from the tuber sacrale of a visibly sound horse. We would expect a uniform sinusoidal wave from the tuber sacrale sensor.
The data in Figure 5 is taken from the tuber coxae sensors on the same horse as that in Figure 4. The Min diff of the right tuber coxae when the left hind is weightbearing is 3 mm lower than the left tuber coxae when the right hind is weightbearing. This confirms the presence of a mild (1/10) right hindlimb lameness using the same principles as without sensors in place, i.e. increased range of movement in the tuber coxae of the affected limb.

Incorporation into clinical decision-making

With such sensitivity available for IMUs to detect asymmetry the question of what threshold we have for horses to be termed ‘lame’ must be considered. Repeatability studies have demonstrated that a threshold of 6–7 mm for head movement asymmetry and 3 mm for pelvic movement asymmetry needs to be exceeded before any improvement following diagnostic analgesia can be considered as such [4].

Orthopaedic examination and subsequent diagnostic work-up is clearly a complex decision making process reliant on observation of the horse under a variety of conditions [2]. This typically involves observation of the horse in a straight line in walk and trot, lungeing on the soft and hard surfaces, flexion tests, palpation and diagnostic analgesia. Mentally retaining such an array of information, some of which may not be consistent, is challenging and prone to expectation bias, i.e. a preconceived idea of the cause of the horse’s lameness. Therefore an objective diagnostic aid aimed at supporting clinical decision-making but based on fewer parameters is appealing.

The large amount of data generated by IMUs, and the ability to detect which part of the stride cycle is affected, may ultimately allow users to relate some of these additional parameters to specific pathologies. This would then enable targeted blocking of those conditions reducing the time taken to resolve the lameness and the needle sticks required in fractious horses. Currently this concept is some way off but gathering of data in a large enough sample size with specific orthopaedic conditions may allow such conclusions to be drawn in the future.

References


NOTES

Fig 5: IMU data from the right and left tuber coxae of a visibly sound horse; LTC = Left tuber coxae, RTC = Right tuber coxae.
The role of ridden lameness evaluation
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The initial lameness work-up
The attending veterinarian is often asked to perform a lameness examination for the complaint of subtle lameness or poor performance in the sport horse. Such horses are rarely overtly lame and require a very intensive investigation. After acquiring a thorough history, a typical lameness examination should first involve a thorough visual examination of the horse taking notice of body symmetry and muscle structure. Observing the horse walking out of its stall or paddock may give big clues about chronic lameness issues [1]. After the visual inspection, a thorough palpation examination, as well as a brief oral examination, should be performed. Flexion manipulations can then be performed in a ‘passive’ sense while noting any resistance or painful responses. Hoof testers may be employed at this point before starting any exercise. Next the horse can be moved in-hand at a walk and trot taking note of any obvious lameness, unusual foot flight or limb motion. It is useful to see the horse walk in circles and figures of eight as well as on a straight line. Jogging on a straight line is normally the next step; however, some horses, especially if they have been inactive for a period of time, may present some behavioural difficulties. Very mild sedation with detomidine hydrochloride (Dormosedan)® may be of significant benefit. Many horses may even appear lamer after relaxing a bit. Jogging in-hand in circles as well as on a straight line may provide further clues as to the nature of the lameness. The next step is to perform ‘active’ flexion tests of all limbs. A detailed record of observations should be maintained for each stage of the examination. Following flexion tests it is advisable to observe the horse walk on a lunge line and under saddle. Some horses are difficult to lunge and may pose a hazard for injury to horse and handler. Again such horses may be lightly sedated or simply watched under tack. Lunging on a circle may greatly accentuate some lameness issues but confuse or even mask others [2].

The riding examination
The riding examination may give the veterinarian a great deal of information not otherwise apparent during the in-hand examination. Such an examination may require some training and experience in observing horses working under saddle but can prove most useful at arriving at a conclusion of the likely origin of performance discomfort. Rider weight may change the balance of the horse in such a way as to augment lameness. Weight on the back may be a source of discomfort and may be demonstrated by a change in the shape of the back, height of head carriage, shortening of stride, or disobedience. The horse should be asked to perform the various gaits while under saddle and carefully observed for changes in the level of lameness with each gait, transitions from one gait to another and at directional changes. Rider position and balance may affect the appearance of lameness. The author frequently asks for a sitting trot, rising trot and rising trot on the wrong diagonal. While some investigators have suggested that there is no greater challenge for the back at a sitting trot as opposed to the rising trot [3], the constant pressure and increased neck extension seen in the sitting trot are clearly uncomfortable for some horses manifested by a change of gait and possibly behaviour. Canter work may be quite different under saddle as opposed to on the lunge, showing a more stabbing or fore-shortened gait, lead swapping or bucking. For the horse that demonstrates little or no real lameness but there is a performance complaint, it may be advisable to watch this horse perform more serious work such as jumping or more engaged and lateral work for the dressage horse. Disturbed performance or disobedience may be evident in cases of neck, back or sacroiliac related discomfort. Some organic issues such as gastric ulcers may cause similar behaviour when worked under saddle [4]. Watching the horse on different footing surfaces, ranging from turf to non-slippery paved or compressed surfaces may also reveal lameness characteristics not previously noted. Horses that are more obviously lame under saddle may be candidates for diagnostic analgesia.

Greve and Dyson have previously published on the incidence of saddle slip and its relationship to hindlimb lameness. Often horses are not overtly lame and may simply demonstrate a mildly reduced protraction phase of stride or somewhat stilted canter gait, but the additional information gleaned from saddle slip may help identify a hindlimb lameness. Saddle slip typically occurs on the same side as the lame hindlimb [5]. In addition to the normal activity under saddle, repeating flexion tests with a rider aboard may reveal further evidence of lameness issues over that noted during the in-hand examination.

References

Manufacturer’s address
* Pfizer Animal Health, Exton, Pennsylvania, USA
Neurological conditions giving rise to lameness

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Gait abnormalities are commonly encountered in equine veterinary work and reaching a diagnosis to enable provision of appropriate prognosis and treatment is important for both patient and client. It can be difficult to distinguish between the relative contributions of weakness, lameness and central or peripheral nervous system involvement. Mixed deficits also occur that can complicate the clinical picture.

The term ‘lameness’ is generally reserved for a gait abnormality associated with pain; in most cases the deficit is consistent between strides (either at the walk or trot). Localising the site of the painful focus is a key component of the lameness examination, and involves flexion tests, palpation and application of hoof testers. Confirmation is usually made by a variety of local analgesic techniques. Furthermore, most musculoskeletal lameness will improve with systemic nonsteroidal anti-inflammatory medication. In some horses however, extensive and repeated lameness investigations fail to identify any cause for the gait deficit. In these cases, and particularly in those that have not shown any response to a ‘phenylbutazone trial’, other potential causes of the abnormality should be considered. Mechanical deficits for example, may be a painless manifestation of an old musculoskeletal injury. Some mechanical deficits are readily recognised by their characteristic presentations (for example fibrotic myopathy and upward fixation of the patella).

A commonly overlooked but important sub-category of lameness cases have compression of caudal cervical spinal nerve roots [1]. Similarly, radiculopathy is a common feature of cervical disc prolapse in humans with localised cervical and shoulder pain and parasthesia of the arm and hand. In horses, cervical radiculopathy may be static or dynamic in nature. In the latter cases gait abnormalities may only be seen with the head and neck flexed (or collected) or may be exacerbated by turning. Horses with radiculopathy usually have articular process degenerative joint disease, or synovial cysts and occasionally cervical fractures. In these cases there is compression of nerve roots within the intervertebral foramina(e) [2]. Some equine cervical radiculopathy cases that present as lameness are associated with localised shoulder or thoracic limb muscle atrophy. Electromyography (EMG) and/or muscle biopsy is useful in determining whether the atrophy is associated with a neurogenic cause (damage to the associated lower motor neurons) or whether it is associated with disuse. Some, though not all, horses with cervical radiculopathy have concomitant cervical pain and/or signs of spinal cord compression, such as ataxia and upper motor neuron weakness.

In humans, radiculopathy of lumbar spinal nerves may manifest as sciatica and lumbar back pain. Similarly, thoracolumbar spinal nerve root compression may be a source of chronic back pain in horses, although definitive diagnosis is difficult. Vertebral spondylosis and discospondylosis affecting the lumbar vertebrae, diagnosed by radiography, ultrasound and scintigraphy has been described in horses [3–5]. As diagnostic options are limited, it remains unclear to what extent horses are affected by nerve root compression in the back. Lumbar vertebral trauma may affect spinal nerve roots that contribute to the lumbar-sacral plexus, causing pelvic limb lameness, and if severe, weakness and muscle atrophy.

Whilst spinal cord diseases (such as cervical vertebral malformation and stenosis) commonly cause gait deficits, these are usually manifest as combinations of ataxia and paresis, and the signs are typically symmetrical in most affected horses in Europe. However, degrees of asymmetry, particularly when subtle, can mimic forms of lameness: equine protozoal myeloencephalitis is commonly implicated in countries with this disorder. Additional gait deficits with proven or probable neurological origin include syndromes associated with often asymmetric limb hyper- or hypometria: these include syndromes that are presumed to involve defective reflex arc control or their upper motor neuron inputs, such as stringhalt and other similar movement disorders. Recently there has been interest in the shivers syndrome, which might be linked to central gait processing deficits [6–8].

References

Current best management of splint bone fractures: to cut or not to cut?

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The second and fourth metacarpal or metatarsal bones, the ‘splint’ bones, are an integral part of the carpometacarpal and tarsometatarsal articulation. There are extensive soft tissue attachments to the proximal part of the bone, including the palmar metacarpal and plantar metatarsal fascia.

Fractures of the mid portion of the splint bones are often open and comminuted. Open fractures have been shown to be 3.5 times less likely to heal successfully than closed fractures [1]. Generally surgery to resect the fracture fragments and possibly the distal end of the proximal part of the splint bone is recommended, either with [2] or without [3] resection of the distal portion of the bone. It has been suggested that two-thirds of the fourth metacarpal and second metatarsal bones, one-half of the second metacarpal bone, and all of the fourth metatarsal bone can be removed without compromising carpal or tarsal stability [2]. However, evaluation of carpal stability in a cadaver study suggested that removal of 80% of the second metacarpal bone did not compromise carpal stability [4].

Fractures of the proximal portion of the splint bones are complicated by the proximity or involvement of the carpometacarpal or tarsometatarsal joint. Resection of the affected portion of the splint bone may potentially lead to destabilisation of these joints. Surgical treatments recommended include amputation of the affected portion of the splint bone without internal fixation if digital palpation suggests stability [2], amputation followed by anchoring of the proximal fragment to the cannon bone using a single screw [5], amputation followed by anchoring the proximal fragment using a bone plate [2], fracture repair using a bone plate [1], and in the case of the fourth metatarsal bone, complete resection of the entire splint bone [6].

Avascular splint bone fragments can sequestrate, resulting in persistent infection. However, sequestra do usually dissolve given time, and surgical removal becomes easier as soft tissue attachments are sloughed. In the proximal third of the splint bone, the presence of a medullary cavity and extensive soft tissue attachments mean that fragments are seldom avascular, and sequestration is much less likely. Septic arthritis of the distal tarsal or carpal joints is a potential sequel. Open articular fractures can be managed with aggressive measures to reduce the chances of septic arthritis developing, such as needle lavage, joint medication and regional perfusion with antibiotics.

At the ECVS meeting in 2012 Caroline Tessier presented a case of a horse which underwent surgery to amputate the distal aspect of the fourth metatarsal bone. The horse sustained a fatal fracture of the third metatarsal bone during recovery from anaesthesia. When questioned, a clear majority of the audience also had experience of this unfortunate event. A subsequent review of the literature, and a retrospective study of cases from Donnington Grove Veterinary Surgery, revealed a 1.8% incidence of fatal cannon bone fracture (Table 1).

Table 1: Incidence of fatal cannon bone fracture in recent publications

<table>
<thead>
<tr>
<th>Year</th>
<th>Study</th>
<th>Incidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>Jackson et al.</td>
<td>0%</td>
</tr>
<tr>
<td>2007</td>
<td>Sherlock and Archer</td>
<td>1.5%</td>
</tr>
<tr>
<td>2012</td>
<td>Bladon 2013 (unpublished data)</td>
<td>1.7%</td>
</tr>
<tr>
<td>2013</td>
<td>Jenson et al.</td>
<td>1.5%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>1.8%</td>
</tr>
</tbody>
</table>

Two studies have compared conservative and surgical management of splint bone fractures [1,7]. The first showed a success rate of 91% (30/33) for conservatively managed fractures, and 83% (50/60) for surgically managed cases, not significantly different. The authors did note, but did not statistically validate, that longer convalescence was observed in conservatively managed cases. The other study reported 14 horses with splint bone fractures managed conservatively, of which all survived and 13/13 which were sound before fracture became sound again. Of 18 horses managed surgically, 17 survived (94%) and 16 (89%) became sound. These authors also reported that the costs of veterinary treatment were significantly lower for conservative treatment (£746; range £145–£2034) compared with surgical treatment (£2303; range £793–£3723) (P = 0.0002).

We conducted a retrospective study of fractures of the small metacarpal/tarsal bones of horses from Donnington Grove Veterinary Surgery. The results since 2008, when conservative management became commonly recommended, are presented in Table 2. Consistently the lowest success rate was obtained with distal splint bone fractures.

Table 2: Results of splint bone fractures, comparing surgical and conservative management

<table>
<thead>
<tr>
<th>Horses (n = 66)</th>
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<tbody>
<tr>
<td>Surgery under GA</td>
</tr>
<tr>
<td>15</td>
</tr>
<tr>
<td>9</td>
</tr>
<tr>
<td>Returned to exercise</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>44%</td>
</tr>
<tr>
<td>25%</td>
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It was concluded that surgery for fractures of the ‘splint’ bones was unnecessary in the majority of cases. Further, it was concluded that surgery does carry a significant risk of fatal complications. The success rate with apparently simple distal fractures was lower than anticipated, presumably due to association with concurrent soft tissue injuries.
References


NOTES

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A review of tenoscopic management of tarsal sheath injuries

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The tarsal sheath encloses the tendon of insertion of the lateral digital flexor (LDFT) which comprises the combined deep and superficial heads of the deep digital flexor. It extends from the musculotendinous junction in the caudal crus to the junction of proximal and middle one-thirds of the plantar metatarsus. Proximally the sheath is voluminous as it is unrestrained by overlying structures. At the level of the tarsocrural joint the two structures are separated only by their synovial and thin fibrous walls. The tarsal flexor retinaculum covers the tarsal sheath from the level of the sustentaculum tali to the tarsometatarsal joint forming the tarsal canal. In the proximal metatarsus the overlying metatarsal fascia is thinner and the sheath again more voluminous. Within the tarsal canal the LDFT is in intimate contact with the fibrocartilaginous surface of the sustentaculum tali. Throughout the sheath there is a continuous mesotenon which extends from the caudal/plantaromedial surface of the tendon to the sheath wall and when intact, this precludes free passage of an arthroscope circumferentially around the tendon. A universal arthroscopic portal medially 1–2 cm proximal to the sustentaculum tali provides a reasonably comprehensive view of the sheath's contents but additional portals may be necessary for access to specific lesions.

Tearing of the lateral digital flexor tendon

Intrathecal tearing of the LDFT can occur at any level within the tarsal sheath but appears to be most common proximal to and at the level of the sustentaculum tali. These are readily identified ultrasonographically and are most common cranially/dorsally. Unlike tears of the tendons within the digital flexor tendon sheath, tears of the LDFT do not necessarily follow a strict linear alignment and frequently spiral. They are often accompanied by tearing of the mesotenon which initially can compromise visibility but defects in the mesotenon also permit passage of arthroscopic instruments both cranial/dorsal and caudal/plantar to the tendon. Confident determination of the proximal and distal extent of the tears is important. Granulomatous masses are frequently found at these sites and are the most plausible explanation of previously reported tenosynovial masses within the tarsal sheath.

Lesions of the sustentaculum tali

The tarsal sheath reflects off the plantar medial margin of the sustentaculum tali and therefore lesions which involve the medial margin only are usually extrathecal. Radiological identifiable defects in the plantar subchondral bone of the sustentaculum tali are likely to be accompanied by defects in the overlying fibrocartilage and thus communicate with the tarsal sheath. This usually can be confirmed ultrasonographically but the presence of distension in conjunction with radiologically identifiable lesions in this location are a strong predictive indicator. Both primary and secondary infection can result and must be considered in differentials. The entire plantar fibrocartilaginous surface of the sustentaculum tali is accessible from the tarsal sheath using arthroscope and instrument portals dorsal to the mesotenon. The space between the LDFT and sustentaculum tali is limited and care must be taken to avoid tendon trauma. Multiple arthroscope and instrument portals are frequently employed in order to limit potential for iatrogenic damage.

Synoviocoeles

Tearing of the tarsal sheath wall can result in the formation of synoviocoeles. Tears appear always to involve the caudal proximal sheath wall resulting in a fluid filled swelling cranial to the tendons of insertion of the gastrocnemius and superficial digital flexor. The swellings contain fluid with varying quantities of irregular echogenic material and a communication with the tarsal sheath may be recognised ultrasonographically. Synoviocentesis usually reveals evidence of xanthochromic synovial fluid.

Endoscopy has revealed smooth avillous synovial linings and communication between the cavity and the cranially situated tarsal sheath. Defects of the tarsal sheath wall have been consistently located close to the proximal reflection of the sheath wall onto the LDFT. They have a transverse orientation usually revealing the enclosed LDFT. The arthroscope can be passed through the defect into the tarsal sheath and advanced as far distally as the sustentaculum tali. No other defects have been identified within affected tarsal sheaths.

It is considered that the defect in the sheath wall creates a valve effect. To prevent this, the communication between the cavity and the sheath wall is enlarged by distal division of the caudal sheath wall from the tear to the level of the proximal margin of the sustentaculum tali. Fibrin deposits that may have accumulated within the synoviocoele are also removed.

NOTES
Fragments that are hard to remove: the proximal intertarsal joint and the extensor process in Friesian horses

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Proximal intertarsal joint

The tarsus is one of the most common sites for osteochondral (OC) fragmentation in the horse, with the majority of fragments found in the tarsocural joint (TCJ) [1–3]; however, fragments located in the proximal intertarsal joint (PIJ) have been described [4]. The clinical significance of these OC fragments in the PIJ remains controversial [5–7]; however, the condition has been associated with lameness and prognosis with removal appears favourable [4]. Arthroscopic access to the PIJ has been described via a standard dorsomedial portal with or without resection of the perimeter of the opening between TCJ and PIJ [7]. Retrieval of fragments has been accomplished by blind grasp over a standard dorsolateral portal in the TCJ [5], an arthrotomy incision into the dorsal capsule of the PIJ [4] via the TCJ after resection of the membrane between TCJ and PIJ [6] and via a third portal medial in the talocrural joint [7]. At our clinic a case series in which OC fragments were removed from the PIJ, was reviewed.

Surgical technique

All horse were operated in dorsal recumbency under general anaesthesia with the tarsus placed in 90° of flexion. Following distention of the TCJ a dorsomedial portal was made, followed by a lateral instrument portal. If present, fragments of the TCJ were removed and lesions debrided, using both portals. Subsequently the PIJ was approached with the arthroscope in the lateral or medial tarsocural portal and through the communication from TCJ into the proximal PIJ. Inserting the scope through this communication was facilitated by a hook-probe through the opposite portal to lift the edge of the foramen. Following fragment localisation, an extra direct portal into the PIJ was created using needle guidance, and fragment removal was accomplished with Ferris Smith rongeurs. Closure of all portals as well as post operative care was routine.

Results

Eleven horses met the inclusion criteria. The median age was 2.2 years (range 1–9 years) and the breed distribution represented the hospital population. Only one horse was lame at presentation and 6 horses were presented with distended TCJ. In all horses, in addition to the fragments removed from the PIJ lesions in the TCJ were present. Lesions were located at the distal intermediate ridge of the tibia in 4 cases, the medial malleolus in 4 cases and multiple locations in 3 cases. Ten of the 11 cases were presented for check-up evaluation 6–8 weeks post surgery and all were free of lameness and with excellent cosmetic results. Long-term follow-up was available for 9 of the 11 cases. Of the 6 Standardbreds intended for racing, 3 raced, 2 did not due to reasons unrelated to the operated leg and one was lost to follow-up. Of the 5 horses intended for riding, 4 were used as intended and one was lost to follow-up.

Conclusions

The described technique with a lateral or medial portal in the TCJ and a direct approach to the dorsal pouch of the PIJ did not require resection of the membrane between TCJ and PIJ, allowed removal of all fragments and led to favourable results.

Extensor process in Friesian horses

Arthroscopy of the distal interphalangeal (DIP) joint has replaced arthrotomy, as it has in other joints, for small intra-articular fragment removal [8–9]. However for the removal of large (>25% of the joint surface of the DIP joint) extensor process fragments, there is still no consensus about the optimal treatment [9]. Usually a conservative, expectative treatment is tried in the first place [9]. Insertion of screws in lag fashion has been described, but only in some individual cases with a positive outcome [10–12]. In cases of recurrent lameness, surgical removal of the fragment is recommended, but arthrotomy only results in a fair prognosis for a return to athletic performance [13]. Arthroscopic removal of these large extensor process fragments has been described in only a small number of cases, but with a relatively good outcome [14]. At our clinic a case series of Freisian horses from which a large extensor process (>25% of the joint surface of the DIP joint) fragment had been removed arthroscopically were reviewed.

Surgical technique

Horses were operated in dorsal recumbency with the affected coffin joint in extension. A standard arthroscopic approach using dorsolateral and dorsomedial portals was used [15]. The use of motorised synovial resectors improved visualisation of the extensor process fragments. Sharp dissection was used to create a dissection plane between the fragment, the joint capsule and adjacent extensor tendon. Fragment mobilisation was followed by subsequent systematic fragment removal by piecemeal using curettes and Ferris Smith rongeurs. The portals were routinely closed and an adhesive bandage was applied. Recovery was assisted by head and tail ropes. Post operative radiographs were made the day following surgery and the bandage was changed. All horses had an elastic bandage for 10 days until suture removal. Horses were box rested for 14 days followed by controlled exercise for one month, after which a clinical follow-up examination was performed. Further rehabilitation was adjusted to the individual clinical progress. On the pre- and post operative lateromedial radiographs of the foot, the angle between the extensor process and the dorsal surface of the distal phalanx was measured and compared.

Results

The total group of 20 Friesian horses ranged in age from one to 19 years (mean 4 years). All horses showed a clinical foot lameness, in which the degree of lameness ranged from one to 4 out of 10 (mean 3/10). Involved articular surface ranged from 27% to 37% (mean 32%). In all horses fragments were of chronic nature, as radiographic evidence of osteoarthrosis of the affected joint were present, including peri-articular osteophytes and remodelling of the extensor process. After fragment removal, remodelling resulting in change of the angle of the remaining extensor process ranged from 2° to 32° (mean 12°). The follow-up time ranged from 2 to 96 months (mean 43 months). Of the 20 horses, 2 had been...
lost to follow-up and 2 others are still rehabilitating. Of the 16 remaining horses 3 horses (19%) stayed persistently lame and 13 horses (82%) could be used for the intended level of work.

Conclusions and discussion
Arthroscopic removal of large extensor process fragments of the distal phalanx has a surprisingly good long-term prognosis for return to intended use in Friesian horses. Following fragment removal the extensor process appeared to become part of a subsequent remodelling process.

References
Ulnar fractures are common in foals and horses. Fracture types and configurations (Fig 1) are generally related to age. In foals up to 3 months of age type Ia (apophyseal) fractures predominate. In yearlings and yearlings type Ib fractures (involving the growth plate and the metaphysis) are more commonly observed. Once the growth plate is functionally closed (approximately 15-18 months of age), Type II-V fractures predominate.

The majority of ulnar fractures arise from external trauma of a kick or sudden fall. The horses present with various signs of lameness and regional swelling that directly relate to the extent of the trauma and the fracture complexity. Most horses will present with acute, severe lameness, mild to moderate regional swelling and evidence of skin damage at the site of the injury. With loss of integrity of the triceps apparatus, the horse will be unable to fix the carpus and will present with a dropped elbow appearance. However, with nondisplaced fractures, lameness may be the primary presenting complaint.

Definitive diagnosis is based on radiographic documentation of the fracture on a medio-lateral and a cranio-caudal projection. For the mediolateral projection the affected limb is extended cranially and the beam is obliqued slightly cranial to caudal. If more complex fracture configuration is suspected, it may be important to perform stressed cranial to caudal radiographic projections to assess the integrity of the humeral joint and to detect additional fractures of the proximal radial physis in young horses.

First aid treatment for horses with fracture of the ulna accompanied by a wound should include appropriate wound therapy consisting of removal of hair at the wound margins, careful cleansing and debridement, and a sterile bandage to prevent further contamination. Systemic broad spectrum antimicrobial therapy should be initiated immediately. Although it is not possible to immobilise the fracture per se, splinting the carpus in extension allows the animal to weightbear on the affected limb. The splint should extend from the ground to proximal antebrachium on the caudal aspect of the limb.

**Conservative management**

It has been advocated to treat simple, nondisplaced, nonarticular fractures, especially type V fractures of the ulna with strict stall confinement. A full limb splint is applied if the patient is not fully weightbearing on the limb. Functional soundness was reported in 7 out of 10 [1] and 3 out of 7 [2] horses with type V fractures with conservative management. However, including all types of ulna fractures the prognosis for conservative treatment is poor: 28% [3], 33% [1] and 43% [4].

In general, horses with ulna fractures that are conservatively managed have a prolonged convalescence time and a protracted lameness. These fractures may displace further, heal slowly or may never heal completely. If synovial fluid enters the fracture gap, healing is disrupted and a pseudoarthrosis may develop over time. It has to be taken into account that with extended healing time, the risk for developing complications such as pressure sores from the splint-bandage, contralateral limb laminitis and carpal contracture is substantially increased. Historically, the primary determination for choosing conservative management over surgical therapy is economics. However, the prolonged convalescence time, the expenses for frequent veterinary attention and poor outcome has to be taken into account when discussing the treatment plan with the owner.

**Surgical management**

Internal fixation is recommended in almost all situations. Open reduction and internal fixation using the tension-band principle is the treatment of choice for articular and displaced fractures. Tension band fixation can be accomplished using a plate applied to the caudal aspect of the ulna or using tension-band wire or cable fixation.

The indication for a tension band using pins and wires is in foals (<3 months) with Salter Harris type I fracture of the apophysis of the proximal olecranon or for simple, minimally displaced fractures at or distal to the level of the humero-radial articulation. The major advantage is the minimally invasive approach and the lower risk of entering the joint space or engaging the caudal cortex of the radius.

For all other cases plating techniques are preferred. Standard or broad 3.5 DCP or LCP plates using 3.5 mm cortical or locking screws might be considered in young foals (<6 months). For older foals and adult horses simple narrow 4.5 DCP or LCP plates can be used to stabilise almost all olecranion fractures. In large Warmblood horses with complex fractures broad 4.5 DCP or LCP plates might be necessary. In those horses double plating, i.e. a shorter plate at the lateral...
aspect of the ulna, may be necessary if there is an obvious lateromedial instability of the fractured olecranon.

The primary closure of the wound is straightforward. The use of drains is not recommended. Cover the wound with a stent bandage, because other types of bandage are usually not possible. Recovery from general anaesthesia is a particular risk with this fracture. A special recovery system such as pool, sling or assisted recovery is advisable.

The prognosis following plate fixation of ulnar fractures is favourable, 70–87% [2,5,6] of horses are expected to go back to their intended use. Plate removal is indicated in foals, racehorses or horses with healed fractures but residual lameness.

References

Surgical Treatment of Neoplasia
Chaired by Derek Knottenbelt

08.30–08.50

Skin neoplasia: the good, the bad and the uncommon
Harry Carslake
The Philip Leverhulme Equine Hospital, University of Liverpool, Leahurst Campus, Neston, Cheshire, CH64 7TE, UK

The purpose of this session is to provide an overview of neoplastic conditions that can affect the skin, from those that are common to the more rare lesions. The diagnostic approach to these cases and a brief summary of the treatment options available will also be discussed.

Introduction
The skin is the most common site of neoplastic disease encountered in equine veterinary practice, representing approximately 50% of all diagnosed neoplasms [1,2]. Several surveys have examined the frequency of different types of cutaneous neoplasia in biopsy submissions, revealing that sarcoids are the most common, followed by squamous cell carcinoma, melanoma and papilloma (Table 1) [3–5].

When compared with neoplastic disease in other organs, lesions in the skin offer the best opportunity for early detection, accurate diagnosis and successful management.

<table>
<thead>
<tr>
<th>Tumour type</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sarcoi d</td>
<td>1543</td>
<td>46.0</td>
</tr>
<tr>
<td>Squamous cell carcinoma (SCC)</td>
<td>633</td>
<td>18.9</td>
</tr>
<tr>
<td>SCC in situ</td>
<td>28</td>
<td>0.8</td>
</tr>
<tr>
<td>Melanoma</td>
<td>344</td>
<td>10.3</td>
</tr>
<tr>
<td>Soft tissue sarcoma</td>
<td>238</td>
<td>7.1</td>
</tr>
<tr>
<td>Squamous papilloma</td>
<td>189</td>
<td>5.6</td>
</tr>
<tr>
<td>Fibroma</td>
<td>80</td>
<td>2.4</td>
</tr>
<tr>
<td>Lipoma</td>
<td>21</td>
<td>0.6</td>
</tr>
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</tr>
<tr>
<td>Leiomyoma</td>
<td>3</td>
<td>0.1</td>
</tr>
<tr>
<td>Myxoma</td>
<td>3</td>
<td>0.1</td>
</tr>
<tr>
<td>Mast cell tumour</td>
<td>99</td>
<td>3.0</td>
</tr>
<tr>
<td>Lymphoma</td>
<td>57</td>
<td>1.7</td>
</tr>
<tr>
<td>Giant cell tumour</td>
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<td>1.0</td>
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<td>Haemangiosarcoma</td>
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<td>0.6</td>
</tr>
<tr>
<td>Basal cell tumours</td>
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<td>1.2</td>
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<td>Carcinoma</td>
<td>8</td>
<td>0.2</td>
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<tr>
<td>Apocrine tumours</td>
<td>4</td>
<td>0.1</td>
</tr>
<tr>
<td>Total</td>
<td>3351</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Diagnostic approach

1. Signalment and history

Signalment should be considered, as breed, age and colour predilections exist for some types of skin neoplasia [3]. Historical information, such as a pre-existing wound at the site of the lesion, recurrent colic or spontaneous resolution of similar lesions in the past will help guide the clinician towards a diagnosis or indication of possible metastatic disease.

2. Examination of the suspected neoplasm

Details such as size, consistency, surface appearance and infiltration should be recorded, and local tissues including draining lymph nodes should be checked for signs of local spread. Diagnostic imaging (particularly ultrasonography) can provide useful additional information about the extent of a tumour and involvement of adjacent structures. In many cases a diagnosis is made based on the location and appearance of a skin mass; however, the only way to definitively diagnose a mass is by histological examination of a biopsy.

3. Full physical examination

Signs of metastatic or paraneoplastic disease such as weight loss, brisket oedema or tachypnoea can be subtle, so a full physical examination is essential to ensure they are not overlooked. The entire skin surface of the horse should be examined and all skin lesions recorded.

4. Further diagnostic sampling of the lesion

In most cases of cutaneous neoplasia a tissue biopsy will provide a definitive diagnosis, which guides appropriate management and prognosis and avoids unnecessary treatment of a misdiagnosed lesion. Given the risk of biopsy accelerating tumour growth, it should only be performed if it will be followed up with appropriate management of the lesion.

Submission of full clinical details with a biopsy offers the pathologist the best chance of achieving an accurate diagnosis and useful assessment of the lesion. In most human and some canine skin tumours histology and immunohistochemistry are used to help grade the lesion, allowing more specific management and prognosis. There has been some work towards tumour grading and prognostic markers in horses [6], but further work is required before it is more widely applied in clinical practice.

Fine needle aspirate (FNA) is a less invasive diagnostic tool that can be used in lesions which are difficult to biopsy. In some types of tumour (e.g. mast cell tumour and melanoma) it offers a good chance of a definitive diagnosis, whereas in others (e.g. sarcoid) it is rarely diagnostic, and clients should be warned in advance that a biopsy might be required.

5. Further diagnostic procedures

Further investigation of possible metastatic or paraneoplastic effects of skin neoplasia can be performed using clinical pathology and/or diagnostic imaging. Even in the absence of other abnormalities on physical examination, procedures such as transrectal palpation and transabdominal ultrasonography in cases of cutaneous melanoma, or guttural pouch endoscopy in cases of squamous cell carcinoma of the head may be considered.
Therapeutic options
Compared with other organs the skin offers easy access for surgical excision, radiotherapy or local medication with cytotoxic drugs, chemotherapy or immunotherapy, and a multitude of therapeutic approaches have been reported for equine skin tumours. Systemic medication has also been used and an area of current research is the identification of tumour associated antigens such as tyrosinase [7] and GD3 in melanoma as possible targets for immunotherapy.

References
Squamous cell carcinoma is, by far, the most common penile and preputial neoplasm [1] and is especially common in old horses, particularly those with nonpigmented genitalia [2]. Penile and preputial squamous cell carcinomas generally have a low grade of malignancy and metastasis to the inguinal lymph nodes occurs late in the disease. Metastases to internal organs are likely if the carcinoma has invaded cavernous tissue.

Horses with a few small preputial or penile carcinomas can be treated by excising the lesions and suturing the wounds, by applying a cryogen to the lesions [3], or by intratumoural injection of a cytotoxic or antimitic drug [4,5]. Horses with small but extensive lesions of squamous cell carcinoma can be treated successfully by periodically applying 5-fluorouracil cream to the lesions [6]. Horses with extensive neoplastic lesions of the external genitalia may require preputial resection or partial phallectomy. En bloc resection of the prepuce and free portion of the penis becomes necessary if lesions involve the external lamina. Horses with metastatic spread of a carcinoma can be treated with a systemically administered chemotherapeutic agent, such as doxorubicin or piroxicam [7], but little information is available about the efficacy of systemically administered chemotherapy in horses.

Segmental posthectomy

Resection of a circumferential segment of the internal preputial lamina, or segmental posthectomy, is performed to remove preputial neoplasms so extensive that simple excision of the lesion is impossible. The procedure is also termed posthioplasty, circumcision, and reefing. Segmental posthectomy is performed, with the horse in dorsal recumbency, after applying a tourniquet proximal to the site of posthectomy, by making parallel, circumferential incisions through the preputial integument distal and proximal to the lesion and connecting these incisions with a longitudinal incision. The integument between the incisions is excised. Bleeding vessels are ligated or cauterised, and the adventitia and integument are apposed separately with fine, interrupted absorbable sutures.

Amputation of the urethral process

The urethral process can be excised to remove a carcinoma [8]. The procedure is most easily performed with the horse anaesthetised and in dorsal recumbency. A catheter is inserted into the urethra, and with traction on the urethral process, two needles are placed at right angles to each other through the urethral process and the catheter, proximal to the portion of the process to be excised. A circumferential incision extending through all layers, including the corpus spongiosum penis (CSP), which extends into the process, is made around the base of the process between the lesion and the anchoring needles. The urethral mucosa is sutured to the epithelium of the stump of the process using fine absorbable sutures placed in a simple-continuous pattern that encompasses and compresses the CSP.

Partial phallectomy

Partial phallectomy can be performed with the horse sedated after anaesthetising the pudendal nerves at the level of the ischial arch, but the procedure is most easily performed with the horse anaesthetised and in dorsal recumbency. The urethra is catheterised, the penis is extended, and a tourniquet is placed proximal to the proposed site of amputation. The most common techniques of partial phallectomy are the Vinsot's technique, the Williams' technique, and the Scott's technique [9–11]. Common to all these techniques is compression of the cavernous tissue (i.e. the corpus cavernosum penis and the CSP) and creation of a urethral stoma. The free portion of the penis and prepuce must be removed en bloc when the external lamina of the prepuce is affected with carcinoma [12,13]. The stump of the penis is retroverted, and its end is sutured to a short prepuce is affected with carcinoma [12,13]. The stump of the penis is retroverted, and its end is sutured to a short

References

HALL 1b
THURSDAY 10th SEPTEMBER

09.10-09.30
How can the pathologist help? Grading schemes and use of immunohistochemistry
Lorenzo Ressel
School of Veterinary Science, University of Liverpool, Leahurst Campus, Neston, Wirral, CH64 7TE, UK

Histological diagnosis of a neoplasm followed by immunohistochemical confirmation of its origin and coupled with a morphological prognostic assessment (grading), is a crucial step in the management of neoplastic disease in human beings.

Immunohistochemistry is a special technique that can be applied on routine histological tumour sections to investigate the expression of a protein. In tumour pathology immunohistochemistry is often used to identify proteins that are typical of a specific embryological origin of the tissue, leading to a more accurate diagnosis in the cases in which the morphology of the neoplasm is ambiguous. This aids in the management of surgical and/or medical treatment including follow-up, based on the biological knowledge for that particular tumour.

The tumour grade is a measure of one or more morphological (or occasionally immunohistochemical) characteristics of a neoplasm that reflect its degree of differentiation. Assigning a grade to a tumour corresponds to predicting potential malignancy (e.g. metastatic spread, recurrence, local infiltration) thus providing precious information in regard to the prognosis for the patient. In human medicine specific grading systems exist for the majority of different tumour types and they are generally of two categories: they are termed ‘prognostic’ when they provide information on the survival of the affected patient, or ‘predictive’ if they provide information on the susceptibility of the lesion to a specific treatment.

Only recently in small companion animals (dog and cat) histological grading [1] and immunophenotyping of tumours [2] is routinely applied in oncologic pathology with the attempt to provide prognostic and predictive information for the treatment of the disease. The first confirmatory studies that review the results of the application of previously published prognostic systems in a day-by-day diagnostic environment have only very recently been published [3], testifying that the field is early on in development.

In equine medicine the application of immunohistochemical phenotyping of neoplasms and the creation of specific grading schemes is still in its infancy, and only a few studies have so far been performed. A good example is the application of specific markers to diagnose morphologically doubtful equine melanomas [4] or the use of immunohistochemistry to assess the phenotype of equine lymphomas [5]. In the case of cutaneous lymphomas it has been recently proposed [6] that some particular immunophenotypes of lymphoma are linked with a longer survival time after surgical treatment alone. Morphological grading schemes have been attempted in some of the most common equine neoplasms. Recent studies established a correlation between the morphological appearance of the neoplasm (morphological grading) and the outcome of the disease in penile papillomas and carcinomas [7]. This is still an open debate if morphological or immunohistochemical features can predict the outcome of equine mast cell tumours [8,9] while equine melanomas, despite continuous efforts in research, are still unpredictable based on morphological and/or immunohistochemical evaluation.

Despite the early age of tumour immunophenotyping and prognostic assessment in equine species, it is hoped that equine clinicians and pathologists will join for the creation of prospective studies and establishment of solid phenotype panels and grading schemes in order to improve the quality of life in the equine patient.

References
09.30–09.50

The iKnife: real time molecular phenotyping in surgical oncology

James Kinross
The Department of Biosurgery and Surgical Technology, Imperial College London, St. Mary's Hospital, London, W2 INY, UK

Clinical diagnosis, prognosis and treatment selection are increasingly dependent on the use of molecular tools that aid classification of diseases and their sub-types and help define underlying individual variations in patient biology. The application of stratified and ‘novel therapeutic approaches optimised via predictive modelling of deep biological information on individual patient variation’ will have a significant influence in the surgical management of cancer [1]. One of the most widely applicable areas of development of precision medicine relates to the diverse applications of metabolic phenotyping (metabotyping) to clinical diagnostics, prognostics and molecular epidemiology. The metabotypes of individuals can be measured from the composition of accessible biofluids or tissues sampled in the clinic. Metabotypes vary extensively between individuals and populations and result from the complex interplay of host genes, lifestyle, diet and gut microbes.

However, there are currently no widely accepted methods which provide real time in vivo, in situ tissue diagnostics within the operating theatre environment. The iKnife is a novel approach that has adapted the theory of metabolic phenotyping for the surgical treatment of cancers. It uses the conventional surgical electro-cautery (diathermy) and the smoke generated from this is captured and directed into a mass spectrometer, a method referred to as Rapid Evaporative Ionisation Mass Spectrometry (REIMS) [2]. Using multivariate statistical methods the iKnife is able to compare the mass spectral signature of the analysed tissue to a large scale database of prevalidated tissue mass spec signatures. The iKnife is then able to provide a visual feedback on the phenotype of the tissue being dissected and it provides real time data to the clinician on the quality of the oncological resection. This talk will outline the basis of metabolic phenotyping, provide an overview of the technology that underpins the iKnife and it will present clinical data from the first in man studies performed using this technology in breast, bowel and neurological cancers.

References
13.30–15.15
*Panel: Jim Schumacher, David Bardell, Patrick Pollock and Safia Barakzai*

The panel will discuss contentious issues surrounding wound management and look at different approaches to dealing with more challenging trauma cases.

**NOTES**
Moral Maze: 
Is Equine Sports Medicine Ethical?

Chaired by Roger Smith

16.00–17.25
Panel: Madeleine Campbell, Michael Schramme, Karen Coumbe, Dominik Burger, Neal Ashton, Frances James, Jenny Hall and Marcus Swail

Expert witnesses will be challenged by informed interrogators to investigate whether current veterinary involvement with sports horses is ethical.
Almost all grazing horses become infected with intestinal nematodes (the commonest of which are the small strongyles); but most animals have low burdens, with higher burdens in some individuals. Younger animals (especially those ~1–3 years) are more at risk of infection and tend to have higher worm burdens. Generally, the higher the burden, the greater the risk of clinical disease. Thus, it is important that high worm burdens are avoided in individual horses.

Strongyles have been controlled for over 40 years using a range of broad-spectrum anthelmintics, which have been traditionally administered in interval treatment programmes. The long-term frequent use of these anthelmintics has led to the development and widespread prevalence of resistance, particularly in the small strongyle group of nematodes. As nematode infections and worm egg excretion are highly over-dispersed amongst individual horses, targeted treatment programmes have been promoted to reduce the frequency of anthelmintic use and thus, selection pressure for resistance. As part of targeted treatment programmes, faecal egg count (FEC) analysis is being increasingly used to direct anthelmintic treatment decisions. In these programmes, at certain times of year, only those horses with moderate to high FECs are treated with anthelmintic and those animals with negative or low burdens left untreated.

This talk will review the use of FEC analysis in equine practice and how to get the most value out of FECs, taking into account their limitations and the need to reduce variability in counts at all levels in the process, from sample collection to reading the egg counts in the laboratory.
Tapeworm – where are we now?

Chris Proudman

School of Veterinary Medicine, Faculty of Health & Medical Science, University of Surrey, Guildford, GU2 7TE, UK

The tapeworm antibody ELISA test is 25 years old. This birthday presentation is an opportunity to review what has been learnt about the test during this time, how it has been developed as a diagnostic tool and how it can be most cost-effectively applied to the prevention of intestinal disease.

Work has been undertaken to characterise the antigens on which the ELISA test is based. Mass spectroscopy has been used to determine a more accurate molecular weight of the antigenic proteins and protein sequencing data has been acquired. The use of this data to synthesise recombinant tapeworm proteins will be described.

A recent modification of the originally described serological test is the use of saliva as the test sample. The biological basis of this development will be explored and validation data of the modified test will be presented.

Use of the ELISA test to diagnose and monitor tapeworm infection in horse populations has undoubtedly prevented many painful and unnecessary colic episodes and probably had a positive impact on colic-related mortality. Experience with the application of this test ‘in the field’ has refined our understanding of how it can be most effectively used and the limitations of the test.

The tapeworm antibody ELISA test is good for:

- Estimating tapeworm infection intensity in horses of unknown parasite status.
- Identification of horses at ‘high risk’ of tapeworm associated colic.
- Monitoring the efficacy of tapeworm control programmes through periodic screening of at-risk populations.
- Investigation of tapeworms as a potential cause of colic.

The tapeworm antibody ELISA test is not good for:

- Monitoring response to treatment in individual horses.
- Testing the efficacy of anti-tapeworm anthelmintics.

The cost-effective application of the tapeworm ELISA test, results interpretation and test limitations will be discussed in the light of published research. Both pyrantel and praziquantel are highly effective anti-tapeworm drugs. The appropriate use of these anthelmintics in a targeted worm control programme will be discussed and illustrated through case studies.
Cyathostominosis: a clinician’s perspective

David Rendle
Rainbow Equine Hospital, Rainbow Farm, Old Malton, Malton, North Yorkshire, Y07 6SG, UK

Cyathostominosis have become the most common cause of parasite-associated disease in horses and with increasing reports of resistance of these parasites to anthelmintics in the UK, clinical disease is only likely to become more common.

Clinical signs
A spectrum of clinical signs may be seen as a result of cyathostominosis ranging from lethargy and weight loss through colic to peracute diarrhoea and rapid death. Signs may not be related specifically to the intestinal tract with peripheral oedema and pyrexia being the only clinical signs in one report. Weight loss can be dramatic. Clinical disease is more likely in horses under 5 years of age.

Classic larval cyathostominosis resulting from mass eruption of larvae is most likely to be seen in the late winter or spring; however, cases may be seen at other times. Recent anthelmintic administration may be a risk factor for disease. Diarrhoea is not necessarily acute and may be chronic or even intermittent. Nonspecific mild colic is common with severe infestation; however, infarctions and intussusceptions have also been reported.

Diagnosis
Haematological and blood biochemical analysis is invaluable in investigating suspected cases of cyathostominosis although there are no pathognomonic findings. Virtually all cases will develop a neutrophilia. Hypoalbuminaemia is a consistent finding that will be present if there is extensive intestinal inflammation. Less consistent findings are anaemia, hyperglobulinaemia and an increase in alkaline phosphatase concentrations. Eosinophilia is an inconsistent finding. Serum protein electrophoresis is of no value in the diagnosis and monitoring of cyathostomin infection.

Cyathostominosis should be considered in any horse with a protein losing enteropathy especially if it is young or the history of anthelmintic use is unknown or inappropriate. Establishing that hypoalbuminaemia is due to intestinal disease may not always be straightforward; however, marked protein losses as a consequence of hepatic or renal disease are rare in horses and the only other likely explanation for marked hypoalbuminaemia is an effusive process within the abdominal or thoracic cavities. Ultrasonographic examination is helpful in ruling out the presence of an effusate and in identifying whether there is thickening of the colon or caecum consistent with cyathostominosis. Thickening of the small intestine would indicate that another cause of intestinal disease is more likely. An oral glucose absorption test may also be helpful in differentiating large and small intestinal disease. Be aware that the large intestine may appear thickened in the absence of primary intestinal disease if the horse has low colloidal oncotic pressure.

Faecal analysis is often performed when cyathostominosis is suspected but is of limited benefit in clinical cases as egg numbers may not correlate with larval numbers. Serological tests for the presence of cyathostomin larvae are awaited. Frequent diagnosis is based on a compatible history and exclusion of other possibilities. In horses with a large cyathostomin burden the administration of anthelmintics may result in large numbers of larvae being shed in faeces within a couple of days of treatment.

Treatment
Whilst luminal cyathostomins will be killed by ivermectin, moxidectin, pyrantel, fenbendazole and mebendazole; larval stages are more resistant to anthelmintics. Ivermectin has limited activity against late larval 3 and 4 larvae whilst moxidectin will eliminate around 60-90% of these stages. Hypobiotic L3 larvae are more challenging to eliminate and reports of efficacy for both ivermectin and moxidectin are highly variable, ranging from 10% to 90%, with moxidectin generally considered to be more effective.

The marked lipophilic nature of moxidectin has led to concern over its use in lean animals. However, macrocyclic lactones are extremely safe in mammals and have a wide safety margin so provided they are not grossly overdosed, they should be safe to use in cases of acute or chronic cyathostominosis. Most of the reported adverse reactions have been associated with gross over-estimation of the horse’s bodyweight by owners or from slippage of a faulty syringe locking mechanism.

Fenbendazole administered at the standard dose rate daily for 5 days is also licensed for the treatment of horses with larval cyathostominosis and initial reports suggested 91% to 99% of early L3 to late L4 larvae were killed; figures that exceed those for moxidectin. However, in more recent studies this regimen has not been effective. Benzimidazole resistance is now common, even ubiquitous, in the UK and it has been established that where adult cyathostomins are resistant, larval stages will also be refractory to benzimidazoles. It is a common misconception that fenbendazole is a ‘gentler’ means of eliminating cyathostomins and it is often used prior to moxidectin. As resistance to fenbendazole is so common in the UK it may be gentler in the majority of cases by virtue of having little or no effect; however, where it is effective its use has been demonstrated to result in a greater intestinal inflammatory response than moxidectin. The use of fenbendazole in the treatment of cyathostominosis is therefore difficult to justify over moxidectin even if faecal egg count reduction tests have demonstrated efficacy against the relevant population of cyathostomins.

In mild cases of larval disease, treatment with anthelmintics may be all that is required; however, repeated doses of anthelmintics may be necessary to bring about sufficient reduction in larval numbers. In more severe cases where there is evidence of moderate to marked intestinal inflammation (i.e. hypoalbuminaemia, thickening of the caecum and ventral colons on ultrasonographic examination, increases in plasma acute phase proteins, etc.) further adjunctive treatments may be required. Glucocorticoids are often used to reduce inflammation in cases of larval cyathostominosis and may be administered to acute cases 24 hours before the administration of an anthelmintic. Nonsteroidal anti-inflammatory drugs (NSAIDs) are probably of limited benefit in reducing intestinal inflammation but can be useful for analgesia. The potentially deleterious effects of both glucocorticoids and NSAIDs on mucosal healing have to be considered. The author will use glucocorticoids (generally injectable dexamethasone followed by oral prednisolone) for their apparent (all be it anecdotal) effects on intestinal inflammation and patient demeanour but will avoid NSAIDs where possible and instead utilise opioids or other forms of analgesia.
Support of colloidal oncotic pressure is critical in cases with marked hypoalbuminaemia and colloids such as hetastarch, pentastach or plasma are indicated when albumin levels drop much below 20 g/l. In horses with marked protein losing enteropathy the use of large quantities of crystalloids without prior administration of colloids may worsen intestinal oedema and may be deleterious. Other treatments that may be beneficial in the treatment of cyathostominosis include intestinal adsorbents and nutritional support. Recovery may take many months, presumably as a result of the amount of time it takes for intestinal inflammation to resolve and for the intestine to repair. The author will typically taper treatment but will continue it until albumin and other acute phase proteins return to within normal limits.

Where clinical cases of cyathostominosis are identified, investigation and treatment of cohorts should also be considered. A thorough review of anthelminthic use on the property should be performed, anthelmintic resistance should be investigated using faecal egg count reduction tests, and targeted or strategic de-worming programmes should be implemented.
**Background**

Until recently *Oxyuris equi* (pinworm) infection has received little attention. It was believed to cause mild clinical signs, only affecting a limited age range of young horses and appeared to be easily controlled by routine anthelmintic treatment. Recent reports of *Oxyuris equi* infection conflict with our conventional understanding of the parasite's biology and anthelmintic susceptibility. Many reports have involved mature adult horses that have received apparently appropriate recent anthelmintic treatment. *Oxyuris equi* has a direct lifestyle. The infective eggs containing L3 larvae are ingested, the eggs hatch and L3 larvae invade the caecum and ventral colon where they mature into L4 larvae over around 10 days. The L4 larvae gradually move to the dorsal colon and mature into L5 larvae over another 40 days. L5 larvae mature into reproducing adults over a further 100 days. Adults primarily inhabit the right dorsal colon. Fertile adult females migrate through the lumens of the small colon, rectum and through the anal sphincter to be much their eggs in a gelatinous mass in the peri-anal region. Ovulation is believed to be a suicidal event. Eggs fall or are rubbed off and become infective in 3–5 days. The pre-patent period is reported as 4.5–5 months.

Clinical signs frequently affect only a minority of horses within a group. The primary clinical sign is peri-anal pruritis which can be severe. It is also suggested that colic may result from inflammation of the caecal and colonic mucosa. Perianal pruritis is not a specific sign and diagnosis should be confirmed by demonstration of *Oxyuris equi* eggs by microscopy of a perianal cellotape preparation or direct evidence of the adult females or the gelatinous mass of eggs. Adult females are white and up to 15 cm long with a highly tapered tail. The sensitivity of the cellotape test is unknown, however in pinworm (*Enterobius vermicularis*) infection in people it is suggested the test is performed on 3 consecutive mornings to achieve acceptable sensitivity.

**Changing biology?**

All of the main classes of anthelmintics have good reported efficacy against *Oxyuris equi*. However, recent reports suggest anthelmintic resistance is emerging. Reports of possible resistance appear to be particularly associated with macrocyclic lactones. Persistence of clinical signs despite treatment with ivermectin/moxidectin has been reported by several authors in the UK. The continued presence or rapid reappearance of *Oxyuris equi* eggs despite repeated treatment with ivermectin/moxidectin was demonstrated from mature horses in Germany in which egg shedding ceased after subsequent mebendazole treatment. In the US and New Zealand adult *Oxyuris equi* that had survived treatment with ivermectin/abamectin were killed by pyrantel or oxendazole.

There are also anecdotal reports of persistent infections after pyrantel and fenbendazole treatment although these appear to be much less common.

Conclusive demonstration of anthelmintic resistance in *Oxyuris equi* is problematic. The extent of egg shedding is not a valid indicator of the parasite burden; egg count reduction tests therefore cannot be performed. The magnitude of the burden can only be determined by post mortem examination.

Considering the extensive and indiscriminate use of many anthelmintics it would be surprising if anthelmintic resistance was not present in *Oxyuris equi*. The parasite's lifecycle results in little refugia under interval treatment strategies and anthelmintic treatment regimes are not optimised for *Oxyuris equi* control.

In addition to the probable anthelmintic resistance, there may be additional changes to the biology of *Oxyuris equi*. Eggs have been observed in the peri-anal area of foals of under 3.5 months indicating that the pre-patent period can be significantly shorter than the conventionally reported 4.5–5 months. There are also numerous reports of clinical signs in mature adult and geriatric horses, a broader age range than the conventional description of *Oxyuris equi* as an age restricted condition of youngstock.

**Treatment**

Treatment requires helminth control and treatment of clinical signs.

Daily washing of the perianal region with mild detergent can remove the irritant eggs. Application of topical barrier creams such as Vaseline or liquid paraffin may prevent fresh eggs from adhering to the perianal skin. Emollient creams or topical corticosteroids may reduce pruritus from severely affected areas.

**Anthelmintics**

If *Oxyuris equi* eggs are detected following recent anthelmintic treatment then use of a different class of anthelmintic is prudent. There appear to be fewest reports of benzimidazole resistance. Many anthelmintics have lower documented efficacy against L4 larvae than adults. It may therefore be appropriate to treat affected horses with repeated doses of anthelmintics such that younger larvae are killed as they mature. At present the author uses 3 doses of pyrantel embonate or mebendazole at 2–3 week intervals in persistent severely affected cases.

The use of rectally administered or perianal topical anthelmintics is sometimes suggested but it is unclear if these are beneficial. Adult females only inhabit the distal small colon briefly and likely die at ovulation. The persistence of rectally administered anthelmintics and the efficacy of anthelmintics against *Oxyuris equi* eggs are unknown.

**Environmental control**

In-contact horses should be monitored for evidence of *Oxyuris equi* egg shedding. Those that are shedding eggs should be treated with anthelmintics and perianal washing.

Complete removal of *Oxyuris equi* eggs from the environment is usually unachievable. The efficacy of conventional disinfectants against *Oxyuris equi* eggs is unknown but rigorous cleaning may help to reduce environmental contamination. Close attention should be paid to locations at which horses are likely to have scratched such as gate posts. Occasionally a change in environment may be beneficial.

**Summary**

*Oxyuris equi* infection appears to be a growing problem. The extent of anthelmintic resistance is unknown but resistance should be expected and will be perpetuated...
by continued overuse of anthelmintics. Anthelmintic treatment should be focused on clinically affected cases and anthelmintic use on the property should be reviewed to prevent indiscriminate use.

**Further reading**

Infectious diseases involving the upper respiratory tract of horses are a common medical entity. Equine herpesvirus-1 (EHV-1), EHV-4, equine influenza virus (EIV) and Streptococcus equi ssp. equi are among the most common pathogens recognised with infectious upper respiratory tract disease (IURD). Lesser characterised respiratory pathogens such as EHV-2, EHV-5 and equine rhinitis A and B virus (ERAV, ERBV) have also been associated with IURD. All these respiratory pathogens spread rapidly due to their short incubation time and transmission occurs via fomites, droplets and aerosols. Although outbreaks can occur at any time of the year, they are most commonly seen in the late autumn, winter and spring, because of the high concentration of young susceptible horses. The morbidity to infectious respiratory pathogens can reach 100% in a population of susceptible horses, while the mortality is generally low. The severity of clinical signs depends mostly on the age and the immune status of the infected horse.

The diagnosis of IURD relies on the combination of historical information, physical findings, blood work and antigen detection in nasal secretions. In the case of a viral disease, the blood work may show mild anaemia and lymphopenia during the acute phase, while bacterial diseases such as strep and leukocyte count at the time the patient displays nasal discharge. Quantitative polymerase chain reaction (qPCR) has supplanted conventional culture-based detection methods for the diagnosis of IURD. PCR is fast, reliable, cost-effective and more sensitive than conventional detection methods. It is important to use the appropriate sample type to achieve the highest diagnostic sensitivity. While nasal secretions collected using a 15 cm rayon- or dacron-tipped swab are generally used for qPCR detection of common and less common respiratory pathogens, deeper airway samples such as nasopharyngeal swabs/washes and guttural pouch lavage fluid have been shown to yield a greater sensitivity for specific respiratory pathogens such as EIV and S. equi ssp. equi.

According to the OIE expert surveillance panel on EIV, only representatives of the Florida sublineage (H3N8) circulate amongst horse populations with clade 1 strains being present in North America, Europe, South Africa and Japan, and clade 2 representatives being present in Europe, India and China. International horse transportation represents a real danger at introducing new EIV strains and clades in susceptible horse populations. Recent biosurveillance data from the USA has shown that equine influenza is seen with greater frequency in older and previously vaccinated horses. The lack of vaccine effectiveness is supported by data provided by the OIE expert surveillance panel on EIV. The panel recommends that commercial killed and inactivated EIV vaccines should contain epidemiologically relevant viruses and should be updated in a timely manner to confer optimal protection.

EHV-1 and EHV-4 are important, ubiquitous equine viral pathogens affecting the upper respiratory tract of horses and causing significant economic losses to the equine industry. Exposure to these viruses and clinical disease are commonly manifested in foals, weanlings and yearlings, although clinical signs can be seen in all age groups. Like other α-herpesviruses life-long latent infection can establish after natural infection to EHV-1 and EHV-4. Reactivation and shedding of EHV-1/-4 creates the opportunity for transmission to other horses, which is considered important in the epidemiology of these viruses and might explain why outbreaks can occur in closed populations. In recent years, genetic classification of EHV-1 strains into neuropathogenic (D752) and non-neuropathogenic (N752) has brought several diagnostic challenges in result interpretation for the equine practitioner and regulatory authorities. One needs to keep in mind that EHV-1 can, independent of the genotype, cause all various clinical syndromes (rhinopneumonitis, abortion, neonatal death and myeloencephalopathy).

It is difficult to determine the exact role the two γ-herpesviruses EHV-2 and EHV-5 play in the development of IURD. These viruses are widespread in horse populations; hence the detection of any of these viruses can occur in healthy but also in sick animals. These viruses are optimally adapted to their host, which means that significant clinical expression of infection is rarely encountered. Recent work has shown that different genetic variants of these viruses circulate amongst healthy horses, hypothesising that viral re-infection or re-activation may be the origin of clinical disease. Another characteristic of the γ-herpesviruses is their ability to immunomodulate the immune system. This characteristic makes EHV-2 and EHV-5 potential co-factors for infection or disease.

Equine rhinitis A and B viruses (ERAV, ERBV) have been given little attention by practitioners compared to other respiratory viruses, mainly because of the lack of diagnostic modalities. These viruses are common in horse populations but knowledge of their epidemiology, pathogenesis and association with disease is poor. These important pathogens are capable of infecting both the lower and the upper airways. Both natural and experimental infections of seronegative horses with ERAV has been associated with fever, anorexia, seromucoid nasal discharge, coughing, lymphadenopathy and occasionally lower limb swelling. The diagnosis has remained a true challenge for ERVs until recently. The infection may be diagnosed by virus isolation, detection of viruses by qPCR or demonstration of rising antibody titres to ERAV or ERBV through virus neutralisation using an acute and a convalescent serum sample. One of the diagnostic challenges with ERAV is that shedding time is very short following the development of clinical signs. Further, prolonged excretion of ERAV in urine in racehorses is common, particularly in 2- and 3-year-olds and is probably an important source of infection for other susceptible horses.
Strangles prevention: treating carriers and vaccine use, now and in the future

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Introduction
Strangles is a highly contagious and infectious disease caused by the bacteria, Streptococcus equi subspecies equi (S. equi). It is the most commonly diagnosed equine infectious disease in the UK. It is an infection of the upper respiratory tract (nose and throat) and can cause abscesses in the head region. The disease is spread either directly from horse to horse or indirectly via fomites. Direct infection occurs by bacteria being shed in the discharge from the nose or abscess of an infected horse coming into contact with a noninfected horse. Also importantly disease can be spread from the nose of horses showing no signs of disease (short- or long-term carriers). Indirect infection occurs when the bacteria being shed from the horse’s nose or discharge from an abscess is carried to other horses by any object, such as people’s hands/clothing, tack, grooming and yard equipment (fomites). Horses recovering from strangles can shed the bacteria for up to 6 weeks after recovering from the illness and still pose a threat to other horses – short-term carriers. On average 10% of horses recovering from the disease will develop into long-term carriers. Identifying these carrier horses is key to stopping the outbreak re-occurring on the original yard and preventing spread from yard to yard.

Carrier state diagnosis
Ultimately direct visualisation of both guttural pouches endoscopically and guttural pouch lavage (GPL) is required to identify carrier animals. Key points to facilitate this process is passing the scope up the ventral and not the middle nasal meatus and passing the guide wire/plastic catheter (the former being easier for the novice) into the dorsal aspect of the gullet pouch (GP) ostia. Rotating the scope in the direction that opens the GP flap while there is synchronous advancement the scope will facilitate entry to GP. Then instil 20–30 ml of sterile saline aimed at the top of the GP washing as large a surface area of the GP as possible. Keeping the horse’s head elevated at this time ensures the saline collects at the bottom, of predominately the medial compartment, and does not exit the pouch. Move the scope ventrally and aspirate the saline. Submit the sample separately, or left/right GP pooled, for qPCR and culture. Three nasopharyngeal swabs (NPS) or serology can be used to screen asymptomatic horses before GPL if appropriate.

Carrier state treatment

Carrier state treatment
GP grossly normal/small flecks of mucopus and microbiological +ve (qPCR and or culture)
Instilling, under endoscopic guidance, penicillin/gelatin mix into GP. Re-test with GPL 1–2 weeks later. Some cases will need more than one treatment. Rare persistent cases may need daily saline lavage best achieved with indwelling Foley catheters and systemic penicillin treatment.

Chondroids
Where chondroids are present these need to be physically removed with a helical basket passed down the endoscope biopsy channel. The most challenging cases are when large volumes of ‘cheesy-like’ pus are present and sometimes surgical intervention is required.

Fig 1: Suggested policies for admitting new horses
Vaccination – now and in the future

Equilis StrepE is the only European licenced strangles vaccine. It can be used from 4 months of age. A relatively small dose (0.2 ml) is administered submucosally with a special applicator in the lip of the horse. Horses often suffer from a transient fever post vaccination and a proportion of horses develop a small abscess at the vaccination site. Therefore client communication and education is paramount before considering vaccination. Also vaccination needs to be done on a group basis (e.g. yard level) as herd immunity is important in improving vaccine efficacy. Therefore I think vaccination is not appropriate for all clients, however it is useful tool in our fight against strangles. For yards which can implement strict biosecurity measures it is less likely to be beneficial given the lack of 100% efficacy and mild side effects on administration – I call this group zero tolerance where avoidance of the disease is more palatable than current vaccination. If however biosecurity measures cannot be total (albeit this should always be strived for) then depending on the client’s informed evaluation of risk then vaccination becomes a more attractive option – see Figure 1. I fundamentally believe that although zero tolerance should be our aspiration and diagnosing and treating carriers is fundamental to eradicating strangles it is naive to think that every horse that needs to be scoped will be and vaccination offers hope of reducing disease incidence in this group of horses so that they are less of a risk to our zero tolerance owners. I will also discuss vaccines across the world and what is on the vaccine horizon.

Glossary

S. equi: Streptococcus equi subspecies equi
NPS: Nasopharyngeal swab
PCR: S. equi specific polymerase chain reaction (as performed by the AHT).
GPL: Guttural pouch lavage – endoscopically guided and always both GPs – 20 ml of saline flushed and then aspirated.
Serology: S. equi ELISA specific A and C antigens.

References


NOTES
Equine infectious diseases in Africa – what are the threats to equids in Europe?

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Specific risks for introduction of disease

Direct importation of equids from Africa to Europe is relatively uncommon, and movement from countries such as South Africa for racing purposes is well regulated, export occurring from a designated African Horse Sickness free zone. However, the well-known example of zebras of Namibian origin causing a catastrophic outbreak of African Horse Sickness on the Iberian peninsula in 1987 (below) highlights the consequences of breakdowns in biosecurity. Increasing international movement of equids, trade in biological products and the removal of many pre-export veterinary checks for travel within Europe could all contribute to dissemination of specific pathogens in the UK. Climate-related augmentation of vector distribution, survival and efficacy of virus dissemination is likely to become increasingly important in Europe for several equine viral infections [1]. The recurrence of West Nile Virus in parts of Europe and the Mediterranean basin over the last 5 years shows that rapid changes in viral distribution may be occurring [2]. The London 2012 Equestrian Games Risk Register [3] identified two notifiable diseases as needing particular monitoring with regard to biosecurity measures: African Horse Sickness and equine infectious anaemia (EIA), and these are discussed further here.

Aetiopathogenesis of African horse sickness

African horse sickness (AHS) is caused by an Orbivirus, of which there are 9 main serotypes, with some cross-neutralisation. Following infection and spread to the regional lymph nodes, horses undergo a viraemia lasting 4–8 days prior to progressive microvascular endothelial cell injury. The development of pulmonary oedema, pleural and pericardial effusions and myocardial damage may be extremely rapid, and fatal in up to 95% naïve individuals (peracute ‘dunkop’ pulmonary form). As indigenous zebras and donkeys in sub-Saharan Africa are more adapted to the presence of abundant biting insects, the virus may develop repeated subclinical infections with prolonged viraemia, acting as reservoirs of the virus.

Transmission of African horse sickness

The primary vectors of the virus in endemic sub-Saharan Africa are two Culicoides species: Culicoides imicola and C. obsoletus. Migration of the virus beyond its normal range is directly related to the movement and survival of these or alternative vectors. The risk of introduction of African horse sickness virus (AHSV) to the UK is officially categorised as low by the Animal Health and Veterinary Laboratories Agency but is likely to increase with further global warming [1]. The recent invasion of Blue Tongue Virus (BTV) (serotype 8), a related Orbivirus, into northern Europe revealed that (i) wind-borne vector transmission was possible from continental Europe to England; (ii) new species of resident Culicoides vectors were capable of maintaining infection [4].

The AHSV serotype 4 outbreak on the Iberian peninsula from 1987 until 1990 (resulting from introduction of an infected zebra from Namibia) proved that the virus was able to overwinter in that part of Europe. There was extension from this outbreak to Southern Portugal and Morocco [5]. AHSV-4 was isolated from C. pulicaris and C. obsoletus during this outbreak, which are two of the northern European vectors of BTV. Recent spread of multiple serotypes of AHSV into North Africa is disconcerting as extrapolation from the Blue Tongue outbreak suggests that viral spread from there to the Mediterranean basin is possible [4]. Incursion into the UK via introduction of horses incubating the virus or the introduction of insect vectors via wind dispersal seem the most likely potential routes for entry of AHSV. Up to 90% Culicoides feeding on horses in the Netherlands have been shown to be C. obsoletus, and it is likely that a similar vector potential is present in the UK [6].

Aetiopathogenesis of equine infectious anaemia

Equine infectious anaemia virus (EIAV) is a retrovirus within the Lentivirus group. Acute infection may be followed by pyrexia, organ inflammation and immune cell destruction leading to death within 2–3 weeks as seen in Ireland in 2006. If the horse survives the acute phase, a subacute or chronic phase may occur during which signs such as fever, depression, weight loss, anaemia, oedema and petchiation occur. Survival of the acute phase leads to apparent carrier status of the virus, and it is this presentation that is most likely to arrive in the UK (EIAV cases 2010 and 2012).

Transmission of equine infectious anaemia

Large haematophagous insects are the principle mode of transmission in endemic areas, but the virus is readily transmitted in contaminated biological products and aerosolised blood (Ireland 2006) and by needles and equipment. Acutely infected horses are the most viraemic with a much lower viral burden in carrier individuals. An epizootic is only likely to occur if an acutely infected horse is mixed with susceptible individuals in the presence of abundant biting insects.

Specific infectious threats to the UK: prevention

The Coggins agar gel immunodiffusion test (AGIDT) is the internationally accepted test for the screening of EIAV in horses prior to importation from affected countries. A major limitation of this test is that seroconversion can take up to 157 days post exposure to the virus [7]. The EIA ELISA offers an improved sensitivity and speed of diagnosis. Correct information regarding movement history of the horse and compliance with EU restrictions is vital, particularly with previous residence in an endemic country. In Europe, EIAV is endemic in Romania and Northern Italy. The AGIDT must be repeated at 90 day intervals in horses to be imported from Romania. The EIA status of the majority of horses in the EU is not known, such that introduction of the virus to the UK under the Tripartite Agreement due to prior movement from other Member States remains possible. The endemic status of EIA within Romania and Italy has been known for several years but the recent occurrence of two outbreaks within Germany highlights the risk of this infection to other parts of Europe. The origin of the infection within Germany has not been confirmed.

Disease alerts

Disease alerts regarding the status of EU member states with regards to infections such as West Nile Virus and...
*Trypanosoma brucei* (Dourine) should be followed closely. Advances in the diagnostic technologies available for the detection of pathogens continue to enhance the reliability and sensitivity of testing for notifiable and exotic diseases. However, detailed clinical evaluation and early recognition of potential infections of significance remains of fundamental importance in the prevention and control of emerging infectious threats to the UK horse population.

**References**


**NOTES**

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Tick-borne disease in horses: what can we learn from other species?

Simon Tappin

Tick-borne diseases have recently received a lot of interest, both in human and veterinary medicine. Ticks have long life cycles requiring them to feed on several different hosts at different stages, making them extremely efficient disease vectors. Tick populations and distributions are changing as a result of climate change and animal movement. *Dermacentor reticulatus* for example, a tick usually found in southern Europe, is now established in Poland, Belgium and Germany, with increasing numbers in the UK. Milder winters reduce tick mortality, leading to increasing tick numbers as well as allowing ticks to become active earlier in the year and feed for longer periods.

**Borrelia**

Lyme disease, caused by the spirochete *Borrelia burgdorferi*, takes its name from the town in Connecticut, USA where the symptoms of infectious polyarthritis were first described in people in the mid 1970s. The reported incidence of Lyme disease in people is increasing from 0.5 cases per 100,000 of the population of England and Wales in 2001 to 1.75 cases per 100,000 in 2011. In the UK the most common vectors are *Ixodes ricinus* and *hexagonus* however *B. burgdorferi* has also been isolated from *D. reticulatus* and *Rhupicephalus sanguineus*.

The prevalence of canine Lyme disease is unknown, but thought to be relatively uncommon. Dogs are regularly exposed to ticks carrying *B. burgdorferi*, with an estimated annual risk of a dog encountering an infected tick in the UK being around 1 in 200 and around 10% of UK dogs are seropositive, with higher exposure seen in rural compared to urban areas. Although the first UK case of canine Lyme disease was reported in 1990, UK museum collections document *B. burgdorferi* within ticks since the late 1800s. Serological exposure is also commonly reported in horses; however, the development of disease is uncommon.

Classical canine clinical signs include fever, with associated lethargy, followed by shifting limb lameness, with the limb closest to the site of tick attachment affected first. Clinical signs seen in the horse are similar and include stiffness, lameness in more than one limb (often with minimal joint effusions), lethargy and behavioural changes. A proportion of dogs develop chronic non-erosive polyarthritis, occurring with chronic infection. In the USA (but not yet the UK), Lyme nephritis characterised by progressive tubular collapse and death occurs in a subset of infected dogs.

Diagnosis of Lyme disease is usually made by serology. The presence of antibodies to the constant part of the frequently changing *Borrelia* surface protein C6 usually documents infection. PCR is no longer recommended as *B. burgdorferi* moves through tissue rather than the bloodstream leading to frequent false negative results.

In dogs doxycycline is the drug of choice, although several other antimicrobials have efficacy. Oral doxycycline is also used successfully in horses; however, intravenous tetracycline obtains higher tissue concentrations and has been shown to be more effective. Seven to 10 days of intravenous tetracycline is commonly used followed by a 1-2 month course of oral doxycycline or minocycline, which has better oral bioavailability.

Canine vaccines have been available in the USA since the early 1990s and appear very effective. They have recently become available in the UK and are used in dogs with an increased risk of infection. Experimental work suggests the canine vaccine is effective in horses and has been used off-label in the USA in high-level sport horses.

**Rickettsia**

Infection with *Anaplasma phagocytophilum*, (formerly *Ehrlichia equi*) leads to both equine and canine granulocytic anaplasmosis (EGA/CGA) and *Anaplasma platys* to canine cyclic thrombocytopenia. *A. phagocytophilum* is transmitted by *Ixodes* species with rodents, sheep and deer the main reservoir hosts. A low prevalence (0.74% in recent study) of *A. phagocytophilum* has been found in *Ixodes* ticks in the UK. CGA is rarely recorded in the UK, with signs similar to *E. canis* infection and associated lameness, immune mediated disease, joint swelling and neurological signs secondary to meningitis. EGA is also rarely reported in the UK and is generally associated with fever, depression, partial anorexia, limb oedema, icterus and reluctance to move, although younger horses may not present with classic signs. Diagnosis of *A. phagocytophilum* is based on visualising morulae within peripheral neutrophils, PCR or rising serological titres. CGA is usually treated successfully with oral doxycycline and EGA with intravenous oxytetracycline. Fever should improve rapidly and is associated with a good prognosis.

*Ehrlichia canis* is endemic in southern Europe and is transmitted by *R. sanguineus*. Although *Ehrlichia* is not currently endemic in the UK, a case of *Ehrlichia* has recently been reported in a dog that had not travelled abroad. The acute signs include fever, anorexia and lymphadenomegaly. Most dogs clear the organism at this stage; however, persistent chronic infection leads to leukopenia, anaemia and thrombocytopenia. Diagnosis is made by serology, PCR or finding the *Ehrlichia* morulae and is treated with doxycycline.

**Piroplasmosis**

Piroplasmosis infection leads to anaemia and is caused by *Babesia caballi* in dogs, and *Theileria equi* (previously *B. equi*) and *B. caballi* leading to equine piroplasmosis (EP). *B. caballus* is endemic in southern European, particularly below the level of the Loire Valley. *B. caballus* is carried by *D. reticulatus* (present within the UK but not thought to harbour *Babesia*) and *R. sanguineus* (only rarely found in the UK). Worriyingly there are also cases of *B. caballus* infection within the UK in untravelled dogs. The UK is considered EP free; however, EP is endemic in many European countries, where a wide range of *Dermacentor, Rhipicephalus* and *Hyalomma* species can act as vectors.

Piroplasmosis results in an array of clinical signs which vary between strains. Most signs result from haemolytic anaemia or the systemic inflammatory response this generates and multiple organ failure which results, although a chronic EP is reported. Diagnosis is most convincingly made by demonstrating the presence of organisms within infected erythrocytes (peripheral capillary beds can yield a higher number of infected cells). PCR is the most sensitive and specific way of diagnosing infection, and also allows determination of the species present. Treatment for piroplasmosis relies on parasite clearance and supportive care; in general, imidocarb is suggested as the most effective drug for parasite clearance.
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This will be an interactive session with experts in the field discussing the management of infectious disease cases and wider disease outbreaks.

NOTES
Pre-purchase examination is a key part of equine practice and provides an important service to the equine industry; however, it also provides many challenges, even for experienced veterinary surgeons. This pre-purchase examination panel brings together four extremely experienced equine vets who have a particular focus on pre-purchase examination. They include Mette Uldahl from Denmark who played an influential role in development of Danish PPE, Chris Rea who leads the vetting panel at Doncaster Bloodstock Sales, David Green of the Veterinary Defence Society and Marcus Swail who was team veterinarian for the Irish Show Jumping and Eventing teams spanning three Olympic Games. The panel is chaired by Malcolm Morley who chaired the 2012 pre-purchase examination review. They will be looking at challenging pre-purchase examination cases and debating some of the more contentious areas that practitioners are likely to encounter.

NOTES
In the early 1900s, when there were over 100,000 working horses at livery in London, Colyer described periodontal disease as “the scourge of the horse” [1]. It is true that equine periodontal disease is clinically more apparent in susceptible horses when they are stabled rather than when outdoors at grass, but the reason for this is unclear. When indoors, horses eat preserved forage such as hay or silage (haylage), which usually has larger stalks and contains more cellulose material than grass. When such forage becomes impacted into periodontal spaces, especially into diastemata between cheek teeth, it takes longer to decompose than grass and thus is likely to cause more prolonged inflammation of the periodontal tissues. It could be argued that grazing horses may also quid, but that such quidding goes unnoticed in extensive pastures. However, horses that are prone to periodontal disease usually put on weight when at grass, whereas they commonly lose weight in the winter when they are quidding [2]. There is minimal objective evidence on seasonal differences in the severity of equine periodontal disease associated with diet.

Nearly all periodontal disease in horses is associated with the presence of abnormal spaces between or around the cheek teeth [2]. Horses may spend 16–18 hours a day intermittently ingesting and masticating their normal low-calorie fibrous diet. During its mastication, they create massive forces (up to 1700 Newtons) on the occlusal surface of their cheek teeth [3] that will force forage into such spaces. Most equine periodontal disease is associated with cheek teeth diastemata, that can be termed as primary diastemata, when spaces develop between the cheek teeth due to inadequate caudal angulation of the clinical crowns of the rostral cheek teeth (Triadan 09s and/or inadequate rostral angulation of the clinical crowns of the caudal cheek teeth (10s and 11s). Alternatively, in some cases of primary diastema the cheek teeth have apparently normal angulation, but the teeth have developed too far apart in the supporting bones [4].

Other causes of diastema include unilateral or bilateral displacement of cheek teeth, usually of the Triadan 09s and 10s, and these can be classified as secondary diastema. These frequently severe displacements are developmental in origin, possibly due to overcrowding if the jaws were not big enough to accommodate all of the teeth in a straight row during eruption [4]. The mandibular cheek teeth of older horses can also acquire displacements, which are commonly lingual displacements of the lower 10s and 11s, that may be associated with abnormal masticatory actions and the presence of abnormally high occlusal angles (>45° or shear mouth). Because the equine cheek teeth normally taper from their occlusal to their apical aspect and the rostral and caudal cheek teeth lose much of their angulation with age, older horses commonly develop widespread diastemata which are termed senile diastema [5].

Other less common causes of secondary diastemata include the presence of supernumerary teeth that most commonly develop at the caudal aspect of the oral cavity, because the occlusal margin of the supernumerary tooth does not have tight contact with that of the adjacent tooth (11s). These interproximal (interdental) spaces may be oblique and wide, and thus can trap food and cause painful periodontal disease. Overgrown teeth, particularly the mandibular 11s and maxillary 06s at the periphery of the cheek teeth rows, may become displaced caudally or rostrally respectively, and thus allow a diastema to develop between the overgrown and adjacent tooth [4,5].

Another major factor that can influence the development of periodontal disease is the shape and size of cheek teeth diastemata. Valve diastemata (wider on the gingival than at the occlusal levels) trap food more than open diastemata (same width at occlusal and gingival margins). Additionally, narrow open diastemata can trap food more than wider open diastemata. Possibly because of the increased levels of masticatory occlusal forces at the caudal aspect of the oral cavity, diastemata tend to occur more commonly between the caudal cheek teeth than the rostral and there is often deeper food impaction at these more caudal sites that, additionally, are more difficult to examine and treat.

Regardless of cause, when food becomes impacted in the space between two adjacent cheek teeth, it causes inflammation of the underlying gingival epithelium. The gingiva will then become ulcerated, thus exposing the underlying very sensitive periodontal connective tissues [6]. The constant presence of these foreign bodies and secondary infection with multiple bacteria (including spirochetes) cause deep infection and inflammation of the periodontal tissues which then become hypersensitive to further inflammation and masticatory pressures. Consequently, affected horses may have so much pain when masticating that they will sometimes quid their forage, as they cannot tolerate any further periodontal pain. This great periodontal sensitivity can also be recognised by the discomfort shown by affected horses when probing their diastema or removing impacted food from them, even when they are deeply sedated.

These fibrous food particles, often several centimetres long, take a long while to decompose when embedded in the periodontal membranes. Further pieces of forage on the occlusal surface that lie parallel to diastemata will later be forced into the defect during mastication, thus causing deeper impaction of food along with pain in these already hypersensitive periodontal tissues. Although there is undoubtedly much bacterial involvement in this equine periodontal disease, the underlying problem is essentially the presence of porous foreign bodies embedded in sensitive inflamed connective tissues. Consequently, the
The aim of equine periodontal treatment should initially be to remove these foreign bodies. This should be followed by a strategy to prevent these tissues from becoming impacted again with similar foodstuffs and so allow the periodontal tissues to heal and the gingiva to grow from both sides of the diastemata to cover the inflamed periodontal tissues, thus removing inflammation and pain.

References
1. Colyer, F. (1931) Abnormal conditions of the teeth of animals and their relationships to similar conditions in man. The Dental Board of the United Kingdom, London, pp 38-43.
Periodontal disease is a major cause of tooth loss in small animals, humans and equines. Equine periodontal disease has been documented in several studies and reports since the early 1900s and in 1905 was described as “the scourge of the horse”. Baker [1] recorded the prevalence of periodontal disease in the over 15 year age group to be 60%, and Wafa (1988) [2] found it to be 37% overall amongst all age groups with again 60% this time in horses over 20 years of age. Ireland et al. [3] found a 45% prevalence in horses over 15 years of age but suspected that periodontal disease was probably under-reported in this study. Similar figures have been found in donkeys with du Toit et al. [4] recording an overall prevalence of 50% suffering from periodontal disease.

Personal observations by the author and anecdotal evidence from other equine practitioners are that increasing numbers of periodontal disease cases are being identified and presented for treatment. This is likely to be due to an ageing population of domesticated horses and better identification of dental diseases generally.

Anatomical and physiological considerations

The periodontium comprises four structures - the gingiva, periodontal ligament (PDL), the peripheral cementum and the dental alveolar bone. The PDL is a fibrous connective tissue interposed between the dental cementum and the alveolar bone. It provides fixation of the tooth and withstands masticatory forces at the same time. These functional requirements are met by a unique architecture of a collagen fibre bundle system in combination with an ample blood vascular system. Due to the lifelong eruption of the equine tooth the equine PDL has to provide mechanisms for continuous tissue remodelling and tissue repair.

There is constant remodelling of the periodontium resulting in a living vascular structure, which constantly detaches and reattaches to the tooth to “lift” it towards the occlusal surface. Once the cementum of the periodontium becomes supra-gingival, it loses its ability to remodel and therefore at this stage can be considered virtually inert. There is however a marked increase in the amount of cementum produced by the periodontium at the alveolar crest resulting in a “thickening” of cementum here that results in natural ‘bridging’ of the interproximal spaces (IPS).

Pathogenesis of periodontal disease

There has been little published data regarding the aetiology and pathogenesis of equine periodontal disease. It is however widely accepted that, as in other species, untreated periodontal disease is in time likely to progress to periodontal ligament disruption and eventual tooth loss. The prevalence of periodontal disease has been quoted to be over 60% in horses aged 15 years or over; empirical observations by the author show this to be conservative. Periodontal disease can develop in horses of any age mainly as a result of developmental malocclusions and domestication and may be severe in horses as young as 4 years. Horses are skilled eaters and are able to selectively avoid masticating in painful areas of the mouth. Development then occurs as a vicious circle of focal overgrowth, pain, feed stasis and inflammation resulting in deterioration of overgrowths due to lack of mastication at the affected site. Eventually horses will become symptomatic as they decompensate, but as with most modern interventionist dentistry it is the job of the modern dental practitioner to identify the changes well in advance of this stage.

Most periodontal disease occurs secondary to other developmental or pathological conditions: diastema, dental displacements and rotations, fractures or functional abnormalities. Primary periodontal disease is rare. Horses have a pellicle layer which in areas of stasis may develop to a thick plaque like substance which in turn appears to occasionally cause marked peripheral caries with destructive lytic lesions; however, these have yet to be linked definitely with periodontal disease. Despite the current lack of evidence, it seems logical that loss of interproximal cementum and dentine through such lytic caries would result in the stasis of food in the resultant space.

Feed types play an important role. The softer the feed, the larger the range of motion and the less crushing motion used. With soft feedstuffs, such as green grass pasture, a wider range of mandibular motion is used. Feed material is ground in a circular pattern, rather than crushed. This wide range of motion creates a large amount of soft tissue contact, gingival crevicular fluid (GCF), and saliva flow. The soft tissue contact together with saliva mechanically cleanses the teeth, thus preventing feed stasis. Horses secrete 50 ml/min of saliva from the parotid salivary gland. Salivary flow is stimulated by mastication. Without mastication, salivary flow is limited to the amount needed to maintain a moist intraoral environment. Horses in free-range situations feed for approximately 14 hours per day. By calculation only, not by direct measurement, that would mean horses create over 40 litres of saliva per day when feeding on grass from one gland alone. The previously mentioned benefits of saliva, mechanical cleansing, acid buffering, and antibody production are very important in prevention of gingivitis and periodontal disease when its flow is both voluminous and continuous. GCF fluid flow and its advantageous components, leukocytes, and antibodies are important also. Together, these two host defence mechanisms provide a substantial barrier to infection.

When horses consume harder feeds such as hay and grain, all the above parameters change in favour of the development of periodontal disease. Range of motion is reduced; focal dental areas of pain are avoided and become protuberant; feed stasis occurs; and decay and the cascade is set in motion. The saliva that is produced is absorbed by the dry feed to some degree, thus reducing its effectiveness. Because the time of feeding is reduced, the total daily saliva and GCF production is dramatically reduced. The net result is a much greater time for static feed material to decay. Reduced soft tissue contact and reduced range of motion leads to decay of feed material, thus creating the environment for periodontal disease to flourish.

Examination and assessment

Oral examination is carried out as previously described paying particular attention to IPS, and the buccal and lingual aspects of cheek teeth for gingival recession, impacted food material with or without occlusal diastemas.
Following this, meticulous cleaning of diastemata is required using picks, angled crocodile forceps, flushing units and scalers. 30 mm endodontic files (e.g. ‘K-flex’ files - SybronEndo) held in long-handled forceps or needle holders are especially useful for removing trapped food from deep pockets. Haemorrhage is likely, and is considered beneficial as this indicates deep debridement and cleaning. Periodical caries lesions should be debrided and any sharp cemental ridges smoothed. This process can be painstakingly slow, and may require significant levels of sedation and analgesia. Flushing is used repeatedly. Nerve blocks may be required; however, mandibular nerve blocks should not be performed bilaterally (to avoid lingual nerve blockade) and local anaesthesia of periodontal pockets may be preferable, e.g. lidocaine viscous gels.

The condition of the tooth and periodontium is examined for gingival inflammation and erosion, condition of sulcular epithelium, pocket depth and mesial/distal length, condition of the supragingival and subgingival cementum, attachment loss, and tooth mobility. The IPS should be examined particularly carefully to assess the type of junctional contact between the teeth, i.e. parallel or otherwise, and for displacements, rotations and fractures.

Periodontal disease assessment should be performed using a combination of examination using a mirror, oroscopy and radiography to give a tooth mobility/periodontal disease index [5] as follows:

- Grade 0: no PDL loss
- Grade I: gingivitis, no attachment loss
- Grade 2: <25% attachment loss
- Grade 3: <50% attachment loss
- Grade 4: >50% attachment loss

Treatment and prevention

In recent years there have been a number of treatments advocated for the management and treatment of equine periodontal disease. These include corrective dental floating, removal of necrotic food material impacted in IPS, use of abrasive prophy powders mixed with water and propelled by pressurised gas, widening of IPS using motorised burrs, application of temporary ‘patches’ of dental impression material, application of semi-permanent interproximal ‘bridges’, the use of perioceutic agents and exodontia.

The treatment may be broken down into simple steps which will cover all types of periodontal disease:

1. Meticulous cleaning of IPS and periodontal pockets
2. Short-term measures to improve periodontal health
   a. Corrective floating, equilibration
   b. Perioceutic agents, e.g. doxycycline gel
   c. Temporary ‘patches’ to prevent immediate influx of food material
3. Long-term measures to prevent further periodontal disease
   a. Diastema widening
   b. Bonded hard ‘bridges’ to occlude diastema more permanently.

Diastema widening

Mechanical widening of diastemata can be a very successful procedure in the short-medium term; however, consideration needs to be given to the anatomy of the IPS and the potential proximity of the pulp horns, and the risk of thermal trauma to pulpar tissue by using a mechanical rotating burr in such close proximity to sensitive pulp.

Water cooling should be mandatory for diastema widening, and if tools do not incorporate a water irrigation channel, water may be flushed using a variety of other more crude methods, e.g. fluid pump, syringe and extension set or diastema irrigation pump.

An IPS of approximately 6 mm or more in width is unlikely to trap food material resulting in peripheral caries and periodontitis. Therefore, logically narrow diastemata will require more dental tissue to be removed in order to achieve this width than wide diastemata. Bettiol and Dixon [6] showed that:

- Pulp horns (PH) are usually 5.75 mm from IPS
- PH may be 1.3 mm from IPS
- ‘Valve diastemata’ should be safer (2.5x wider at base than occlusally)

- Higher risk of pulp exposure caudally (caudal aspect cheek teeth, PH 2,4)
- → remove more from mesial/rostral aspect of cheek teeth behind IPS.

The author recommends

- Water cooled handpiece essential/highly recommended
- 4–6 mm burr – diamond, carbide
- Start with narrow burr (3–4 mm)
- Keep checking alignment, oroscopy preferred
- Start occlusally under visual control
- Or gingivally with conical burr in ‘valve’ area of diastema.

Further research and long-term studies are required in this area to ascertain the effectiveness and safety of these treatments. Personal experience has shown that after careful examination and assessment of cases a combination of the above techniques, initially utilising minimally invasive procedures can produce excellent results. For more severe and chronic cases, the use of interproximal ‘bridging’ or widening of diastema can also be very effective. Bridges may be:

- Polysiloxane applied only as temporary ‘patches’
- PMMA (bone cement) [7]
- Plaster of Paris + gentamicin
- Temporary crown/bridge material [8]
- VOCO Structur 2 – Cold polymerising paste-paste resin polymer
- Excellent handling and bonding to teeth
- Chemically bonded to debrided teeth using total etch technique
- Prevent food accumulation in IPS
- Long-term success 55% mandibular, 86% maxillary (Pearce 2013, unpublished data).

References


Further reading


Colyer, F. (1987) Abnormal conditions of the teeth of animals in their relationship to similar conditions in man. The Dental Board of the UK.
Emerging possibilities in management of periodontal disease

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Periodontal disease is a destructive process of the support structures of the tooth that is known to be progressive and can lead to the premature loss of teeth. The structures that are affected by the process are the gingiva, periodontal ligament, alveolar bone and cementum of the tooth. Periodontal disease can further be broken down into two subcategories, the first of which is gingivitis and the second periodontitis. Gingivitis is considered the reversible form of the periodontal disease process. This component does not affect the alveolar bone or demonstrate attachment loss of the tooth. Periodontitis is irreversible; causing loss of the attachment of the tooth. This is demonstrated by a loss of alveolar bone, periodontal ligament widening and changes related to the cementum of the tooth. Alveolar bone loss is demonstrated radiographically and is generally in one of three patterns; 1) horizontal bone loss, 2) vertical bone loss, or 3) a combination of horizontal and vertical bone loss. It is accepted that these changes are graded by obtaining radiographs of the affected teeth.

The radicular hypsodont teeth of the horse are drastically different in function from the brachydont dentition of other commonly treated species with periodontal disease. However, the basic periodontal tissues are the same and if the relationship of these structures is altered then periodontal disease will ensue. In the brachydont species, such as the dog and cat, certain factors must be present for periodontal disease to happen. The first is a plaque biofilm and the second is host response that alters the local environment of the tooth and periodontia. The environment of the gingiva and gingival sulcus becomes altered with more inflammatory products as the plaque persists. If this process is left unchecked or preventive measures are not taken then the inflammatory process will continue and the junctional epithelium of the gingival sulcus will be breached. This leads to inflammatory mediators, inflammatory cells and osteoclasts being recruited that will affect the periodontia subgingivally or the beginning of periodontitis. Periodontitis is progressive and leads to a decrease in tooth attachment, mobility of the tooth, and eventual tooth loss. Factors that are known to increase the risk of periodontal disease in the brachydont species are certain anatomical features, systemic metabolic diseases, and food materials that promote an increase in plaque formation. Abnormal anatomical relationships that can promote periodontal disease are crowding of teeth in the dental quadrants, buccal deviation of teeth, lingual deviation of teeth, and partial eruption of teeth. These factors can all lead to a decrease in the normal cleansing process of the teeth by the oral soft tissues and an increase in plaque formation leading to periodontal pocket formation.

The horse can be affected by all of the same factors that promote periodontal disease in the brachydont species. We often only look for diastemata formation when inspecting the oral cavity for periodontal disease. While this is an important finding, often the disease process has been progressing for some time. We should be taking the approach of trying to identify specific animals that are at an increased risk for periodontal disease similar to the approach taken in brachydont species. When performing oral examinations on horses we should be identifying early changes in the periodontia such as gingivitis and malocclusions that can be related to abnormal interproximal spaces. Malocclusions would include: lingual or buccal deviations of teeth, abnormal angulations of teeth in the dental quadrants, crowding of teeth, and skeletal malocclusions that lead to overlong areas in the dental quadrant causing greater stress on the periodontia. Identification of the malocclusions and appropriate treatment can reduce the patient’s risk of chronic progressive periodontal disease. The occlusal adjustment should be seen as the first line of defence against periodontal disease in the equine patient similar to the periodontal treatment process of removing plaque and calculus in the brachydont species. Further diagnostic imaging is warranted in all patients to stage the periodontal disease process to further aid in treatment planning.

A disease process in all species that can often be misinterpreted as periodontal disease is tooth resorption. Tooth resorption is identified in the teeth of mammals as one of seven different types. External inflammatory resorption is a resorptive process that has features resulting in widening of the periodontal ligament, loss of tooth structure, and loss of alveolar bone. The changes related to an advanced resorptive lesion affect the periodontia with signs that include gingival enlargement, tooth mobility, parulis lesions and swelling of the mucosa. Although the signs of tooth resorption are similar to periodontal disease, tooth resorption is an altogether different disease process. Diagnostic imaging must be obtained to diagnose which disease process is the cause of the changes seen in the periodontia. Radiographic changes related to tooth resorption and periodontal disease will be discussed in a different abstract.

Many comparisons can be made between all species and periodontal disease despite their differences in anatomy and function. Periodontal disease is a progressive process and early diagnosis is essential. In all species, the diagnostic process of obtaining dental radiographs is essential for determining the stage of the lesions and confirming an accurate diagnosis. Once the diagnosis is confirmed and the clinical stage defined, the treatment plan can be constructed and performed.
Dental examination for pre-purchase examination

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Do you routinely use a mouth speculum and light source to examine a horse’s mouth during a pre-purchase examination (PPE)?

Do you just look at the incisors to gauge the horse’s approximate age and see if it matches the passport? Do you hold the tongue and use a pen torch to look along the cheek teeth arcades? Do you use a mouth speculum, flush the mouth and utilise a torch and mirror to perform a dental examination? Do you use an oroscope to perform a detailed dental examination?

What is in the PPE Guidance Notes?
The BEVA/RCVS PPE Guidance Notes [1a], supported by The Veterinary Council of Ireland and Veterinary Ireland state that stage one of the PPE “includes an examination of the incisor teeth” and that “The examination does not include... a detailed mouth examination with a speculum”. The PPE Certificate [1b] also states that “unless specified in additional procedures, this examination does not include a detailed mouth examination with a speculum”.

What information can be collected from an external examination?
Dental problems are common in the horse and many horses can have undiagnosed, painful dental conditions that require sometimes costly treatment yet are not obvious to the owner. The external examination should include palpation of the masticatory muscles, base of the ear, lymph nodes and bony and soft tissue structures of the head with particular reference to examination of the mandibles. Additionally the practitioner should ascertain the presence of any nasal or ocular discharge, percussion of the sinuses and assessment of the incisor bite [2].

Problems affecting the incisor and canine teeth are usually easily recognised by owners and include conditions such as brachynathism, wry nose, oligodontia, wear abnormalities and equine odontoclastic tooth resorption and hypercementosis (EOTR) [2,3]. It is straightforward to count the incisor teeth although sometimes less easy to discern which belong to the deciduous dentition and which to the permanent dentition. Few problems generally afflict equine canine teeth other than calculus build up and associated periodontal disease but fractures are not uncommon [3]. Wolf teeth are frequently present and easily diagnosed although ‘blind’ or unerupted wolf teeth, mandibular wolf teeth and submucosal fracture fragments can all be easily missed yet cause marked performance problems in the horse. Visual inspection of the oral mucosa of the rostral mouth can reveal all sorts of lesions such as neoplasia, bitting damage and soft tissue trauma.

What are you likely to be missing if you do not use a mouth speculum and light source?
Equine dentistry is one of the most common tasks performed by equine practitioners and the use of an oral dental mirror, accurate dental head-torch illumination and, increasingly, oral endoscopy, is standard practice for routine equine dentistry examinations. Should we be carrying out the same level of oral examination on our pre-purchase examinations?

Anyone can count to six so identifying supernumerary teeth or missing teeth that may be problematic for the horse and potential purchaser should be straightforward. Displacement of the cheek tooth rows and the presence of overt diastema and periodontal disease are also readily apparent on oral palpation... and an often lingering malodorous smell on your hands (the author always advises the use of gloves whilst performing dental examinations!). However, for further visualisation of the oral cavity, the use of a dental mirror and appropriate light source is a helpful aid to identify less readily apparent pathology such as smaller diastema, periodontal disease and occlusal defect... even on unsedated horses [4]. Dental caries, disorders of wear and particularly dental fractures are also easily diagnosed with careful palpation followed by visual inspection [2]. This can be greatly enhanced with an appropriate light source and if you don’t currently use one, you will be amazed at what you can see when you do!

What other clues are available to help you?
Accurate palpation of temporomandibular joints (TMJ) and musculature plus careful observation of chewing cycle can often yield valuable information [5]. Obviously a unilateral nasal or ocular discharge would alert the practitioner to further potential problems, but a discrete bony lump on the ventral mandible, a small draining fistulous tract in a hairy Cob or slight difference in thickness of the hemi mandibles in a large Warmblood are just as important in providing early clues to dental pathology.

What about ageing the horse?
Current advice is that determination of the age of a horse based on its dentition is recognised as being imprecise, but relying on documentation is not without its risks. The most accurate guide to age is a passport completed in a foal at the same time as microchipping: it is inadvisable to rely on the age entered on a vaccination certificate and thus exact ageing using dentition alone should be avoided. In the absence of documentary evidence, the term ‘aged’ may be used to refer to a horse considered after examination to be over 15 years of age [1a].

What happens if the horse’s temperament is not suitable for dental examination?
As in all PPE’s effective communication with the prospective purchaser is key to a successful PPE and a happy client. A dialogue should occur if the horse is not amenable to examination and requires sedation before any further decisions can be made. Additionally, the presence of any lesion present should be discussed, including any ramifications for insurance, as would occur with any other abnormalities found during the course of the PPE. Furthermore, the opportunity exists for a specialist second opinion for dental pathology found in a similar procedure to those suspect cardiology or ophthalmology irregularities that require further clarification. It is important to discuss and record any limitations to the intended examination; temperament can limit the extent of an oral examination in an unsedated horse.
So would you now routinely use a mouth speculum and light source to examine a horse's mouth during a pre-purchase examination? “If you don’t look you can’t miss” ...or do you have an alternative view?!

References

NOTES
Dental radiographs are an integral part of the diagnostic process of the oral cavity in any species. In the equine specie the clinical crown is the only portion that lends itself to inspection when performing the oral examination. The remainder and majority of the tooth is encased in the alveolar bone and precludes visual inspection. Disease processes that necessitate advanced treatments are often progressing in the subgingival area and require radiography to properly diagnose the stage and type of lesion. In other species it has been proven that there is a significant diagnostic yield of radiographs in combination with the oral examination compared to the oral examination alone. This has not been studied in the horse but our assumption is that similar findings would be obtained.

The disease processes that radiographs are commonly obtained to diagnose are: 1) periodontal disease, 2) endodontic disease, 3) resorptive lesions/hypercementosis, 4) trauma/foreign bodies, and 5) skeletal malformations. The oral cavity of the horse is challenging to image due to superimposition of several structures. The positioning of the tube head and sensor plate must be such that superimposition is kept to a minimum. This is accomplished with the use of oblique and bisecting angle techniques. The area of interest differs between certain disease processes. For instance in endodontic disease the apical region of the tooth and crown are the areas of interest, and in periodontal disease the alveolar bone margin and periodontal ligament is the area of interest. To accurately image all of the pertinent dental structures in the horse 18 different images would be obtained. The financial implications of this often negate a full set of dental radiographs in the horse and most often images are obtained of areas noted with problems on the oral examination.

The oral examination indications for obtaining radiographs are best described by first understanding what disease process was identified on the oral examination. The radiographic positions will be described as they relate to individual disease processes. It is accepted that whenever possible the images should be obtained with the mouth open. Exceptions would be when obtaining dorsal-ventral views, and true lateral projections. Extra oral dental radiographs can be obtained with the majority of systems currently being utilised in equine practice. Certain computed radiography systems also provide the ability to obtain intra oral radiographs.

**Periodontal disease** is noted on the oral examination as gingivitis, gingival recession, periodontal pocketing, diastema formation and increased mobility of the tooth. These findings would all indicate the need for obtaining radiographs. The area of interest would be the alveolar bone margin and the periodontal ligament space. Positioning the tube head and sensor plate to offset the quadrant of interest and highlight the subgingival area to identify horizontal bone loss, vertical bone loss, and an increase in periodontal ligament space. In severe cases where periodontal-endodontic lesions are suspected the apex of the tooth must be obtained.

**Endodontic disease** is noted on the oral examination as loss of integrity of the crown of the tooth. This includes tooth fractures, exposed pulp horns, and caries of the infundibula. Identification of any of these findings on the oral examination is indication of imaging of the crown, reserve crown, root and periapical structures of the tooth. Radiographic findings of endodontic disease are loss of crown integrity, failure to narrow the pulp chamber or horn, periapical lucency formation, and external inflammatory root resorption. The tube head and sensor plate are positioned using oblique projections of the cheek teeth highlighting the apex, reserve crown and clinical crown of the teeth. These projections should be obtained without superimposition of the opposite quadrants without significantly fore-lengthening or fore-shortening the teeth.

**Sinusitis** can be secondary to dental disease. A lateral radiograph with the horse's head positioned nose down will allow the identification of a fluid line if one is present. The fluid line will be parallel to the ground due to gravity and structures such as the infraorbital canal will be seen nearly parallel to the occlusal surface. The dorsal ventral radiograph is also a useful position for identifying pathology in the sinus cavities.

**Trauma/fractures** are most often seen in the interdental space affecting the mandible and less frequently the maxilla of horses. When trauma is suspected radiographs should be obtained prior to a speculum being placed and the oral examination performed. Obtaining radiographs to visualise fractures are most often obtained in a lateral oblique fashion to minimise superimposition and in a dorsal ventral projection. If trauma is suspected in the incisor quadrants a bisecting angle technique intra-orally can be utilised. Metal foreign bodies are usually identified with a combination of lateral and dorsal ventral views.

**Resorptive lesions and hypercementosis** are a radiographic diagnosis. Advanced stages of the pathology will be noted clinically but early lesions are only diagnosed after obtaining radiographs. Areas of increased calculus formation, gingival recession, parulis lesions, and when epithelium is noted inappropriately on tooth surfaces, should all be radiographed for evidence of resorptive lesions. The lesions when noted should be staged to determine the vitality of teeth and the need for treatment.

**Malocclusions** can often be diagnosed with dental radiographs but more appropriately they are diagnosed during the visual oral examination process. Dental radiographs can identify malocclusions that are secondary to a diseased tooth that lacks the functional ability to erupt. This in turn causes an overlong opposing tooth. Dental radiographs in a lateral projection can also confirm that the odontoplasty that was performed was appropriate and provides documentation of the corrective process.

Dental radiography should be directly or indirectly in the arsenal of practitioners providing dental care to their patients. The process can be completed with most radiographic systems that are at the disposal of equine practices. The positions and techniques are easily learned and can readily be repeated. Further, there is a growing population of individuals with advanced training that can provide help in interpreting dental films.

**NOTES**
In cheek teeth with both a normal and pathological occlusal surface, radiography is often used to determine the significance of these abnormalities to the apical region of the tooth. Several studies have looked at the use of radiography for detection of apical pulpitis, the most recent finding computed radiography to have a sensitivity of 76% and a specificity of 90% [1].

Given this moderate sensitivity clinicians often turn to other imaging modalities to make a definitive diagnosis. Nuclear scintigraphy has excellent sensitivity and specificity for diagnosis of apical infection but does not provide any anatomical detail [2]. Magnetic resonance imaging (MRI) requires a general anaesthetics and currently only two systems are available within the UK. Few studies have investigated the use of MRI in dental disease, but it may be of benefit in detection of early endodontic pathology [3].

Computed tomography has been used for imaging of the equine head extensively under general anaesthesia. Modifications to general anaesthesia systems have allowed diagnostic images to be obtained under standing sedation, with 8 centres having this service available throughout the UK. Many studies have used standard CT systems and micro-CT to precisely map the endodontic system of the cheek teeth [4]. Large-scale studies investigating pathological dental changes using CT are lacking but there are increasing case reports on the use of CT for investigation and treatment of dental disease.

**Apical pulpitis**

The clinical signs of apical pulpitis depend on the precise cheek tooth involved but most often maxillary 06s, 07s and mandibular 06s–11s present with a facial swelling with or without a draining tract, whilst maxillary 08s–11s present with a unilateral nasal discharge. With the most common route of infection of equine cheek teeth thought to be anachoesis (a blood or lymphatic borne infection) of the endodontic system of the tooth, often these teeth will have a normal occlusal surface, though in advanced cases, these may have pulpar exposure due to a lack of secondary dentine production [5]. In the early stages of disease where the pathology is limited to the cheek tooth, with little change to the periapical area, equivocal radiographic findings are often found. Computed tomography of such cases often reveals hypoattenuated areas within the pulps of affected teeth consistent with gas formation [6]. Other CT findings often associated with apical infection include an increased periodontal space around the apical portion of the tooth and remodelling or increased cementum deposition around the dental apices [6].

Computed tomography is also useful in cases where buccal sagittal fracture has been diagnosed and it is unclear whether this fracture has affected pulp or is just within the secondary dentine.

**Infundibular disease**

Many CT studies have looked at the infundibulae and described hypoattenuation of the apical aspect of the infundibulae consistent with infundibular cemental hypoplasia [7]. Infundibular disease may predispose teeth to midline sagittal fracture but may also cause apical infection by extension into the pulp. Radiography provides limited information about the infundibulum whereas CT can provide detailed information regarding the integrity of the enamel and the health of the pulp. A recent case series has highlighted the use of CT in such cases [8], though a thorough oral examination can provide useful adjunctive information.

**Dental dysplasia**

Dysplastic and supernumerary teeth are often associated with periodontal disease and may require exodontia. Some teeth may have a dysplastic occlusal surface, though some may have apical malformations or displacements which make them difficult to extract. Radiography often provides limited information in such cases, whereas CT can provide useful three-dimensional information, which can aid surgical planning and prevent potential complications.

**Sinusitis**

The most common causes of sinusitis are a primary sinusitis and secondary dental sinusitis [9]. As previously discussed, signs of apical pulpitis are readily diagnosed on CT examination. In cases of primary sinusitis, the cross-sectional nature of CT imaging means each sinus compartment is visible without superimposition. Signs of sinusitis noted on CT include thickening of the sinus mucosa, fluid lines within the sinus and hypoattenuation within soft tissue attenuation within the sinuses which may indicate inspissated exudate [6].

Empyema of the dorsal and ventral nasal bullae (non-sinus portions of the dorsal and ventral conchae) has recently been described, with CT the only method of making a definitive diagnosis [10].

**Complications**

Cases where there is a non-healing alveolus following extraction or a persistent draining tract are good candidates for CT examination. Dental or alveolar fragments can be identified and mapped to a site within the alveolus which may aid removal. In cases with persistent nasal discharge, the affected sinuses can be clearly identified.

**Conclusion**

Computed tomography is a cost effective way of diagnosing apical pulpitis in cheek teeth where radiography has been equivocal. It provides useful information for infundibular disease and can assist with surgical planning.
References


A comparative perspective on endodontic disease

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Endodontic disease is the process that affects the live pulp of the tooth and ultimately the vitality of the tooth. The live pulp of the tooth is contained within the tooth in structures that are lined by dentin. These chambers are named according to the anatomy of specific teeth. Single rooted teeth have a pulp chamber and root canal. Multi rooted teeth have a root canal associated with each root, a common pulp chamber, and then pulp horns extending from the common chamber towards the occlusal surface. The brachydont tooth has the common pulp chamber in the coronal portion of the tooth above the gingival margin with very short pulp horns. The radicular hypsodont tooth has the common pulp chamber situated near the apex of the tooth in the alveolar bone with long pulp horns extending towards the occlusal surface. The function of the live pulp is production of dentin, which can be in three forms. Primary dentin is produced during the development of the tooth. Secondary dentin is produced during maturation of the tooth. In brachydont teeth it is accepted that secondary dentin production begins after the final phase of root development. Tertiary dentin is produced as a repair process and lacks the organisation and tubule numbers of the other forms of dentin. The process of dentin production happens at the odontoblastic layer of the pulp and continues throughout life. This process causes the pulp horn/chamber to narrow as the tooth ages. The other function of the pulp tissue is sensory for all sensory input of the teeth. The trigeminal nerve, via two branches, is responsible for afferent input that can be classified into two parts: pain or dull throbbing pain via two different types of nerve fibers. The trigeminal nerve, via two branches, is responsible for all sensory input of the teeth.

There are functional differences in the pulp of brachydont and radicular hypsodont teeth. The radicular hypsodont tooth, like the brachydont tooth, is constantly narrowing their pulp chambers/horns. The radicular hypsodont tooth is also undergoing attrition that necessitates a higher rate of dentin production at the occlusal surface. Brachydont teeth will also demonstrate reparative dentin production in cases of abrasion to the tooth. However this is considered a response to pathology of the tooth where in hypsodont teeth this is a normal physiological process. In either type of tooth, if the pulp is unable to produce dentin, in response to insult or in the normal process of attrition, the live pulp can be subject to invasion of bacteria and an inflammatory process will ensue.

The radicular hypsodont teeth contain structures called infundibula, which are noted in all incisors and the maxillary cheek teeth. They are filled during development by cementum. The infundibula can fail to be filled with cementum during development and a void will be left in the tooth where food will impact during mastication. When food impacts in the tooth the decay process will progress to tooth loss. This process is termed infundibular caries. If a substantial amount of tooth is lost in the location of the infundibula the pulp horns can become breached due to their close proximity of the infundibula. Tooth fracture is another common outcome of infundibular caries. The brachydont teeth do not contain infundibula.

Treatment of endodontic disease has two options if the tooth is proven to be non-vital diagnostically. The first is extraction of the tooth. The second is root canal treatment with removal of all diseased pulp tissue and debridement of the pulp horns, chamber and root canal. These structures are then disinfected, dried and sealed with a biocompatible material [1]. The final step in the root canal process is restoration of the crown of the tooth. The root canal process in the brachydont tooth is highly successful due in part by the access to the root canal that can be obtained. The access should be made to allow a straight line from the opening created in the tooth to the root canal being treated. This also includes the ability to access and treat the common pulp chamber of the tooth in the crown. In the radicular hypsodont tooth this type of access is only obtainable in the incisor teeth and canine teeth. The cheek teeth rarely can be accessed in such a way to obtain straight line access to the root canals due to the common pulp chamber location. Without proper debridement, disinfection, and obturation the root canal treatment will be unsuccessful. Treatment via a surgical approach with removal of the apex of the tooth and retrograde treatment is highly successful in brachydont teeth [2] but still remains to have limited success in the radicular hypsodont tooth [3]. Another challenge in the root canal process of the radicular hypsodont tooth is the shape of the pulp horns and root canals. The brachydont tooth has a more cylindrical shape allowing easy instrumentation. The radicular hypsodont teeth tend to be more oval in shape and vary in size from the occlusal surface to the apex making instrumentation with circular instruments more difficult.

Endodontic disease is common in both the radicular hypsodont tooth and brachydont tooth. The diagnostic process must be performed to determine the vitality of the tooth before a treatment plan can be constructed. While advancements have been made in the root canal process, the radicular hypsodont tooth still has challenges due to the structure of the pulp system of these teeth. Further work and studies are needed to bring about better treatments for endodontic disease before the success rate of root canal treatment will match the extraction process.

References

NOTES
Dental fractures comprised 6.8% of cheek teeth lesions presented to a referral clinic in one study [1], and 0.4% of horses examined routinely in first opinion practice [2] and the majority of these were pathological fractures [1] with 80% afflicting maxillary dentition. When normal or increased masticatory forces are placed on a structurally weakened tooth, it is prone to fracture. Other risk factors of dental fracture include; peripheral overgrowths, malocclusions resulting in stress foci and misalignment. More rarely dental fracture of cheek teeth can be attributed to direct trauma. It has been speculated that teeth afflicted by severe caries, albeit with vital endodontium may be more prone to fracture but this currently remains unvalidated, and the mechanical significance of caries is discussed elsewhere. Clinical signs most commonly associated with fractured teeth included, quidding, weight loss, biting problems, halitosis, and periodontal disease, although 39% were asymptomatic in one study [2].

The configurations of dental fractures were discussed by Dacre et al. [3] and Ven Enden et al. [4]. Most common were parasagittal fractures, along a plane coalescing two pulp horns or two infundibulae. Other configurations included fracture through the enamodental junction, without direct pulp cavity involvement. Clinical signs associated with those fractures that do not involve the endodontium usually arise from buccal displacement of a dental fragment that causes painful mucosal ulceration. Trans-dentinal fissures are often observed on occlusal examination with a mirror or using dental endoscopy but these are not correlated with a predisposition to fracture and appear to be an incidental finding. While identification of a fractured tooth on oral examination is straightforward, the increasing use of dental endoscopy has increased the likelihood of their detection and enables a more accurate configuration of the fracture. Furthermore, standard radiographs are limited for fracture configuration as the 2D image suffers from superimposition of fracture fragments. Dorsoventral plane radiographs can be helpful to supplement these.

The more recent widespread accessibility of computed tomography (CT) that is performed in the standing, sedated horse has been helpful in analysis of dental fractures. CT has enabled 3D reconstruction of teeth with small peripheral fractures to be diagnosed and for revealing any possible communication of fracture planes with pulp, enabling an estimate of the dental vitality. In addition, the 3D nature of this imaging modality enables all fracture planes to be revealed and which is helpful in selecting the most suitable treatment. Many fractured teeth are not amenable to extraction per os along the normal eruption pathway due to an absence of a clinical crown, comminution or carious demineralisation. The removal of such teeth can be further complicated in chronically fractured teeth where there may be mineralisation of the periodontium or hypercementosis. Displacement in a buccopalatal direction of fracture fragments of teeth fractures parasagittally is associated with mesial drift of the adjacent teeth, that can result in an apical portion of the diseased tooth that is broader (in a mesio-distal axis) than is the space between the adjacent teeth at the gingival level. This results in a wedge shaped space through which a fractured tooth becomes stuck (like the key stone of a bridge). The situation is complicated further in sagittal fractures where impacted food has passed through the perforated alveolar bone into the paranasal sinus. This represents a permanent, acquired oro-antral fistula with chronic sinus inoculation with food material and anaerobes from the buccal cavity.

Teeth with peripheral fractures with no pulp involvement are in many cases vital and careful dorsoventrally (rapping) of their occlusal aspects in order to reduce masticatory loading, will enable them to be retained and for the remaining tooth to erupt as normal. Such teeth may have an underlying pathological weakness and may be prone to further fractures, but premature extraction with its associated technical challenges is often unappealing. In aged horses slab fractures that do not have an oro-antral fistulae associated with them can often be treated conservatively by removing any displaced sharp fragments that cause soft-tissue ulceration, and leaving the larger fragment in situ. Such teeth usually have a well modelled thicker alveolus that appears to be less prone to perforation and paranasal sinus contamination. However, it should be remembered that the alveolus will not granulate with dental fragments in situ, and such teeth are structurally weakened and may be prone to spontaneous fragmentation over subsequent months and will accumulate impacted feed in the alveolus. Despite this, the conservative approach may be more attractive than the costs, technical challenges and risks associated with fracture fragment removal.

Teeth with more comminuted fractures or those with pulp involvement are often diagnosed when the tooth is non-vital. In addition, there may be caries resulting in mechanical weakness, although the periodontium may be relatively intact. Such teeth can be challenging to manage. This is further compounded by the involvement of paranasal sinus disease. A variety of techniques for extraction must be mastered that can be applied specifically to a dental fracture fragment or dental root fragment, after careful consideration. These include:

1. **Per os extraction of dental fragments**
2. **Unification of fragments using acrylic followed by per os extraction**
3. **Minimally invasive transbuccal trocharisation enabling periodontal separation and extraction per os**
4. **Minimally invasive trans-buccal screw extraction**
5. **Radiographically guided minimally invasive repulsion**
6. **Surgical techniques involving retrograde repulsion via the paranasal sinuses or via buccotomy incisions**

The latter will often involve general anaesthesia and, although many of these techniques can be performed in the sedated horse, it should be done in a controlled clinical environment with radiography available.

Before embarking on dental removal of fractured teeth careful counselling on the degree of difficulty and likely expense should be discussed, and the cost/risk/benefits of any proposed treatments should be considered.
References

Further reading
Caries of the maxillary cheek teeth (CT) infundibulae is the most common type of dental caries identified in equidae. Clinical consequences of this progressive destruction of infundibular cementum, that occasionally extends to the adjacent enamel and dentine, include the development of midline sagittal CT fractures or apical infection, both of which can lead to intractable parasental sinus infection. Infundibulae have evolved in the maxillary CT to increase the length of exposed enamel ridges on their occlusal surface for masticatory efficiency. Both infundibulae should be entirely filled with cementum [1]. During development, vascularisation from the dental sac enters through the occlusal surface of the infundibulum, which intersects with vessels that enter through the apical aspect of the developing tooth to create one major blood vessel with side branches coursing through each infundibulum to support cemental deposition. Cemental deposition of the occlusal infundibular area ends when the tooth erupts and loses its occlusal blood supply. However, infundibular cemental deposition may continue apically if the vasculature that perforated the infundibular dental organ persists [2]. Variable amounts of viable vasculature have been found apically in maxillary cheek teeth years following eruption [3].

Occlusal surface cemental defects or carious lesions have been reported in 52–97% [3–5] of CT infundibulae, with differences in classification of these lesions likely contributing to the wide difference in reported prevalence. Since some degree of occlusal infundibular lesions is commonly found, it is difficult to differentiate between lesions that may later become clinically significant and those that will remain asymptomatic. Even infundibulae that appear to be grossly normal on their occlusal aspect can contain central linear cemental defects, discoloured and porous cementum, cemental hypoplasia or areas of localised caries deep to the occlusal surface, with some cemental abnormality reported in 90% of adult maxillary cheek teeth [3]. Infundibular cemental hypoplasia is typically manifested as a persistent central vascular channel within infundibulae filled with poorly conformed cementum [6]. As the teeth wear, these areas of hypoplasia within the tooth which were sealed off from the occlusal surface will become exposed on the occlusal surface. These defects may then become impacted with food and bacteria, and later develop infundibular caries, although this relationship is incompletely understood [3].

In an ongoing study at The University of Edinburgh, 74 maxillary CT (containing 148 infundibulae) were extracted post-mortem from adult horses. All teeth were imaged by computed tomography to determine infundibular depth and assess for the presence of infundibular cemental defects. Evidence of cemental defects was found on computed tomography in 132/148 (89%) infundibulae although only 94/146 (63.5%) of these had occlusal defects. The ratio of the infundibular to crown length significantly decreased with age. Deeper infundibular defects were present in 89/104 (85.6%) of infundibulae with occlusal caries (81% of grade 1 [only cementum affected], 86% of grade 2 [enamel also involved], and 100% of grade 3 caries [cementum, dentine and enamel involved]). Additionally, histological examination has found evidence of potential blood breakdown products or feed material trapped deep within the porous cementum of grossly ‘normal’ infundibulae.

The high prevalence of infundibular defects has led to uncertainty regarding their causal relationship with severe dental disease, as only 16% of maxillary cheek teeth apical infection were identified as being caused by infundibular caries [6]. However, if maxillary CT fracture through both infundibulae, the palatal and buccal pulp chambers often become exposed and apical infection is nearly certain. Regardless of the inciting cause, maxillary cheek teeth apical infection can lead to severe sequelae such as secondary sinusitis, bone remodelling or draining tracts. The treatment for CT fracture often involves extraction of the tooth that usually resolves the clinical signs but leads to the need for continued and frequent dental management. Ongoing studies may help to differentiate normal anatomical variation and innocuous cemental defects from changes within the infundibulae that are likely to cause midline sagittal fracture or apical infection. The increased clinical use of computed tomography will hopefully allow for more conclusive diagnoses and treatment of problematic infundibular caries in the future.

Treatment of caries was initially attempted using high-pressure abrasion with aluminium hydroxide micro-particles to remove impacted food and carious dental material from affected infundibulae prior to performing endodontic-type restoration, but this technique was shown to be ineffective. Investigation into improved treatment methods using long, low-speed dental drills and H files with staged computed tomographic examination of the effectiveness of both cleaning and filling methods is ongoing with preliminary success, as has also been observed clinically [7]. These procedures are likely to be more effective if the morphology of deeper and more complex infundibular defects is known before treatment.

References
Conclusions: conception rate. mares were treated out of the breeding season, with a 35.7% conception rates of 60.0% and 83.3%, respectively. Thirteen were treated; 10 pre-covering, and 6 post covering with have produced a live foal. In the breeding season, 16 mares to foaling of 367.6 days. Of the 29 horses, 55.2% (16/29) ultrasound scan was 31 days, with average time post flushing 5.6 years). The mean time post flushing to the first positive procedure was 13.1 years (range 6–22 years). Mean duration Warmblood and one Hanoverian. Mean age at the time of the procedure was used in 27 Thoroughbreds, one EPRs and from Weatherbys (www.bloodstockreports.co.uk). To determine the conception and foaling rates of fertility in mares with repeated returns to oestrus. Objectives: To determine the conception and foaling rates in mares treated by laparoscopic topical application of prostaglandin E2 (PGE2) to the oviduct(s) in mares: i) in the breeding season (January–May), pre-covering; ii) in the breeding season, post covering; and iii) out of the breeding season (June–December). Study design: Follow-up study. Methods: Analysis of electronic patient records (EPRs) identified 29 mares that underwent oviductal flushing via laparoscopic surgery between 1 January 2008 and 12 October 2014. One mare underwent the procedure twice; once in the breeding season (pre-covering) and once out of the breeding season. Follow-up data were collected via EPRs and from Weatherbys (www.bloodstockreports.co.uk). Results: The procedure was used in 27 Thoroughbreds, one Warmblood and one Hanoverian. Mean age at the time of the procedure was 13.1 years (range 6–22 years). Mean duration barren prior to the procedure was 1.9 years (range 49 days– 5.6 years). The mean time post flushing to the first positive ultrasound scan was 31 days, with average time post flushing to foaling of 367.6 days. Of the 29 horses, 55.2% (16/29) conceived successfully, with 87.5% of these confirmed to have produced a live foal. In the breeding season, 16 mares were treated; 10 pre-covering, and 6 post covering with conception rates of 60.0% and 83.3%, respectively. Thirteen mares were treated out of the breeding season, with a 35.7% conception rate. Conclusions: Oviductal flushing within the breeding season was more successful in this study than flushing performed out of the breeding season. Restoration of fertility in this study was lower than that previously reported and potential reasons for this include limited pre-surgical diagnostic testing, differing prior pathologies or reasons for sub-fertility, and case selection. Ethical animal research: Research ethics committee oversight is not currently required by this conference: retrospective study of clinical records. Explicit owner informed consent for inclusion of animals in this study was not stated. Source of funding: C.E. Wylie is funded by the Margaret Giffen Trust. Competing interests: None declared.

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Reasons for performing study: The birthweight of Thoroughbred foals has increased in recent years. It is unknown whether this is associated with increased broodmare obesity or endocrine dysfunction. Objectives: To determine insulin, leptin and triglyceride concentrations in obese and non-obese Thoroughbred mares throughout gestation and to investigate their association with foal birthweight. Study design: Prospective, cohort study. Methods: Fifty-seven pregnant Thoroughbred mares were included in the study. From 40 days post-breeding, body condition score (BCS), weight and venous blood samples were obtained every 60 days throughout gestation. Feed was withheld for 6 h before blood sampling. Serum/plasma insulin, leptin and triglyceride concentrations were measured using validated/standard methods. Foal birthweight was recorded. Association of hormone or triglyceride concentration with time, BCS and birthweight were analysed using a linear mixed effects model. A Pearson correlation co-efficient was calculated between hormone or triglyceride concentration, BCS and birthweight. Results: Serum insulin concentrations were significantly greater (P<0.05) at 0–59 days compared with 240–299 days and at 60–119 days compared with 180–359 days gestation. 55% of mares had BCS ≥ 7. There was 1.5% incidence of fasting hyperinsulinaemia throughout gestation and no association of fasting insulin concentration with BCS. Leptin concentration was significantly (P<0.0001) greater at 180–239 days compared with all other time points and was significantly (r = 0.29, P=0.005) correlated with BCS. Triglyceride concentration was significantly (P<0.02) greater at 240–299 days compared with earlier time points but was not associated with BCS. Foal birthweight was significantly positively correlated with BCS (r = 0.13, P<0.001) and inversely correlated with leptin concentration at 60–119 days and 240–299 days gestation (r = –0.64, P<0.05). Conclusions: Mare BCS correlated with foal birthweight such that obese mares had heavier foals. Significant fasting hyperinsulinaemia was not identified in this population. Increased leptin concentration in early and late gestation was associated with decreased foal birthweight and may be useful to predict foal birthweight. Ethical animal research: Informed client consent was obtained for all animals used in the study. Source of funding: Private donor. Competing interests: None declared.

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Reasons for performing study: The measurement of immunoglobulins is important in foals, as individuals with evidence of failure of passive transfer are at increased
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risk of infection and death during the first month of life. **Objectives:** To identify which test is most suitable for determining the foal’s IgG concentration as applied in practice. A distinction was made between hospitalised foals and healthy low risk foals in the field. **Study design:** Prospective study including 46 foals <7 days old, divided into 4 groups based on age and health status. Sensitivity and specificity were calculated manually. Significance was set at P<0.05. **Methods:** Several screening tests were compared to the IgG concentration measured by turbidimetric immunoassay: serum and plasma total protein, albumin and protein spectrum including gamma globulin concentration (GCC) measured by chemistry analyser, total protein by refractometer, glutaraldehyde coagulation test and a semi-quantitative enzyme immunoassay (SNAP). IBM SPSS Statistics 20A was used. A one-way ANOVA with a 95% confidence interval (CI) was used for determining significant differences among tests and between groups. Correlations between the turbidimetric immunoassay and the screening tests were calculated using linear regression with a 95% CI. **Results:** Group differences were not found. The most accurate alternative test was the combination of total serum protein measured by a chemistry analyser (R 0.83) and GCC (R 0.84) with sensitivity and specificity of 79 and 100% and 95 and 93% respectively. A total serum protein of ≥249 g/l and a GCC of ≥26 g/l corresponded with an IgG concentration of ≥28 g/l. **Conclusions:** According to this study, the most reliable alternative test suitable in a clinical setting for the determination of IgG concentration was measuring total serum protein by a chemistry analyser in combination with serum GCC. **Ethical animal research:** The research was approved by the Animal Welfare Committee of Utrecht University (approval number 2012. II.05.078). Explicit owner informed consent for inclusion of animals in this study was not stated. **Source of funding:** None. **Competing interests:** None declared.

09.15-09.30
Antimicrobial sensitivity of bacteria isolated from neonatal foal samples in New Zealand (2004 to 2013)

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**Reasons for performing study:** Guidelines for the rational use of antimicrobials enable practitioners to improve antimicrobial stewardship and slow the development of antimicrobial resistance (AMR) [1]; these must be regionally relevant [2]. New Zealand (NZ) is geographically isolated and the importance of AMR on equine studs is unknown. **Objectives:** To identify AMR patterns of bacteria isolated from NZ foals so as to provide regionally specific information for the development of antimicrobial stewardship guidelines. **Study design:** Retrospective study of clinical pathology records. **Methods:** A database search of bacterial culture submissions from foals <3 weeks of age from April 2004 to December 2013 was completed. Culture results, antimicrobial sensitivities, and demographic factors were tabulated. The Kirby-Bauer disk diffusion susceptibility test was used to define sensitivity. Multi-drug resistance (MDR) was defined as non-sensitivity to 3 or more core antimicrobials in a panel (cefotiofur, enrofloxacin, gentamicin, penicillin [not included for Gram-negative bacteria], tetracycline, trimethoprim-sulSAMH methoxazole). **Results:** Bacterial isolates (n = 127) were cultured from 64/102 (62.7%) of foal submissions. Four bacterial groups (Staphylococcus spp., Streptococcus spp., Enterococcus spp. and Escherichia coli) accounted for 100 (79%) of bacterial isolates cultured. At least one or 2 MDR isolates were cultured from 24 (38%) and 8 (12%) foals, respectively. Culture positive and negative foals were demographically similar. **Conclusions:** A significant number of bacterial isolates from foals have reduced antimicrobial susceptibility to commonly used antimicrobial drugs. The results are of concern from treatment and stewardship perspectives. Multi-drug resistance was found, indicating a need for regionally relevant antimicrobial use recommendations. **Ethical animal research:** Not applicable. **Sources of funding:** Massey University McGeorge fund; New Zealand Equine Research Foundation. **Competing interests:** None declared.

References:
Impact of age at first immunisation on equine influenza short and mid-term protective antibody levels in Thoroughbred foals

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Reasons for performing study: Every year, several equine influenza (EI) epidemics are reported worldwide. Equine influenza vaccination is the most efficient method of prevention; however, not all horses develop sufficient immunity after EI immunisation, increasing the risk of infection, infectious virus excretion and the spread of the disease. Objectives: This study aimed to better understand poor vaccine response mechanisms during the primary EI vaccination. Study design: Cohort study. Methods: The EI humoral immune response was measured in 118 Thoroughbred foals set in 3 different stud farms (SF#1 to SF#3) after the primary course of EI vaccination. All foals were immunised with a recombinant canarypox-based EI vaccine, following the vaccine manufacturer’s recommendations. The age at first vaccination was 4 to 8 months. Sera were tested by single radial haemolysis (SRH) against the A/equine/Jouars/4/2006 EIV strain (Florida clade 2) at the time of the first vaccination (V1), 2 weeks and 3 months after the second immunisation (V2), 2 days and 3 months after the third immunisation (V3). Results: Short (V2 + 2 weeks) and midterm (V3 + 3 months) SRH antibody levels were statistically different between the stud farms (P-value = 0.0011 and 0.003, respectively), with SF#1 > SF#2 > SF#3 and SF#1 SRH antibody titres below the protection threshold (i.e. 85 mm²) at all time points studied. SRH antibody levels induced by EI vaccination were related to the age of foals at the first immunisation (SF#1 median age 143 days, SF#2 median age 181 days and SF#3 median age 156 days), but were independent of the presence of maternal derived antibodies (MDA; P-value 0.41). Given the results in SF#1, a booster immunisation (V4) was brought forward to restore protective levels of antibody.

Conclusion: Independently of the presence of MDA, the age of foals at first immunisation plays an important role in the establishment of adequate antibody levels. Ethical animal research: All animal work received ethical approval, and consent was obtained from the owners. Sources of funding: This study was supported by the Basse-Normandie Region council (France) and the European Regional Development Fund. Competing interests: None declared.

Colic 1

Sponsored by HBLB

Chaired by Michael Hewetson

13.30–13.45

Colic: horse owner knowledge and experience


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Reasons for performing study: Colic is the commonest equine emergency problem, and one of the main causes of equid deaths. The horse owners’ ability to recognise colic is a critical first step in determining case outcome. Objectives: To assess equine owners’ knowledge and recognition of colic. Study design: Online questionnaire of horse owners. Methods: An online survey was designed to evaluate owners’ approach to colic in the horse. The survey included questions on owner demographics, their recognition of colic (including owner’s opinions of their ability to recognise colic, their approach, and their recognition of colic using case vignettes), and their knowledge of normal ranges for clinical parameters. Descriptive and chi squared statistical analysis was performed. Results: The survey was completed by 1061 UK respondents. Six per cent of owners thought they could recognise all types of colic, 61% said they could recognise most cases and 30% said they could recognise some but not all cases. Owners said they would assess faecal output (73% of respondents), gastrointestinal sounds (69%), respiratory rate (62%) and heart rate (50%) in horses with suspected colic. One fifth (22%) of owners would call a vet immediately without assessing any parameters. Many respondents either did not know, or provided incorrect estimates of normal values for clinical parameters: 30.4% were ‘unsure’ of the normal heart rate and 35.5% gave heart rate values which were outside reference ranges; only 24.5% gave appropriate values for normal respiratory rates and only 31% gave normal temperature values. There was no statistical significance between participants’ age, educational qualifications, or their experience with horses and their knowledge of normal clinical parameters. Conclusions: Owners varied in their approach and ability to recognise colic, and many had significant gaps in their knowledge of normal parameters. Educational materials...
Investigating the normal management regimens of working equids and identifying barriers to the recognition and treatment of colic by owners in Morocco

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Reasons for performing study: Colic is a common reason for owners to seek veterinary treatment for their working equids in Morocco. There is limited information regarding cultural, religious or educational barriers to obtaining treatment or about the typical workload of these animals which may predispose them to colic. Objectives: To characterise the typical workload and feeding regimens of working equids in Morocco; to characterise the ability of owners to recognise the clinical signs and causes of colic; and to identify specific barriers to the veterinary treatment of colic. Study design: Questionnaire-based survey. Methods: A standardised, structured questionnaire was administered, with the assistance of an Arabic speaking interpreter, to the owners of working equids presenting their animals to 2 centres run by SPANA (The Society for the Protection of Animals Abroad). Participation was voluntary and informed consent was obtained prior to the interview. Results: All of the 102 participants that completed questionnaire were male. Ninety-eight owners used their animals for pulling carts, with 12% of animals working 7 days per week. 14% of animals were offered water by their owner once per day and 2% every other day. 25% of animals were loose and allowed free to feed unsupervised when not working. 29% of owners were not able to name any cause of colic and 25% did not recognise any clinical signs; only 12% associated colic with gastrointestinal pain. 83% of owners would not seek veterinary treatment due to financial constraints if free treatment at SPANA centres were not available. Conclusions: Colic remains a common problem amongst working equids in Morocco. Improved knowledge of management factors associated with colic and how to recognise abdominal pain may reduce the incidence of colic and improve prognosis. The findings presented can be used to inform and develop owner education programmes.

Ethical animal research: This study was reviewed and approved by the Ethics Committee, School of Veterinary Medicine and Science, University of Nottingham. Informed consent for participation in the study was obtained from all owners and was delivered in the native language. No details identifying the owner were recorded. Source of funding: None. Competing interests: None declared.

Appraisal of the current evidence for diagnostic tests that differentiate medical and surgical colic


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Reasons for performing study: Early identification of surgical cases of colic is critical to improving outcome and welfare. There have been a number of studies on diagnostic tests for colic, evaluating a range of tests to differentiate between medical and surgical cases. Objectives: To systematically review and appraise the evidence on diagnostic tests for identifying surgical colic. Study design: Systematic review. Methods: The primary literature search was conducted in CAB Abstracts (1910-2014), WEB of Science (1950-2014) and MEDLINE (1946-2014) using search terms relating to equine colic. Publications were assessed against inclusion and exclusion criteria, and then reviewed using the QUADAS quality assessment tool. Results: The primary search identified 5508 publications relating to equine colic; 976 related to diagnostic tests, 29 met the inclusion criteria and were assessed using the QUADAS tool. Of these, 16 papers reported on peritoneal fluid parameters, 21 on blood parameters, 10 on blood and peritoneal parameters, 3 on physical and blood parameters and one study on urine parameters. A range of different parameters were evaluated, with the majority of tests only being evaluated in single studies. None of the studies met QUADAS criteria 1 (representative spectrum of patients), 7/29 studies met criteria 2 (description of selection criteria) and 10/29 studies met criteria 9 (description of reference standard). Conclusions: There are currently no published studies which use appropriate methodology to assess the accuracy of a diagnostic test in differentiating medical and surgical colic. This made direct application of the QUADAS tool challenging; predominantly due to the lack of a pre mortem ‘gold standard’ reference diagnostic test for colic. Very few studies enrolled a randomised selection of patients and there was also a propensity to case–control study design, both increasing the risk of bias and under/overestimating diagnostic accuracy. Ethical animal research: Not applicable. Sources of funding: Laila Curtis’ studentship is funded by the School of Veterinary Medicine and Science, University of Nottingham. Tom Cullen is a Junior Clinical Training Scholar funded by the School of Veterinary Medicine and Science, University of Nottingham and Oakham Veterinary Hospital. Competing interests: None declared.

Systematic review of evidence for plasma and peritoneal lactate as a diagnostic test for surgical colic


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Reason for performing study: Measurement of lactate in horses with colic has been described for over 20 years. Objectives: To systematically review the evidence on the use...
of plasma and/or peritoneal lactate as a diagnostic test for identifying surgical colic. **Study design:** Systematic review. **Methods:** The primary literature search was conducted in CAB Abstracts (1910–2014), WEB of Science (1950–2014) and MEDLINE (1946–2014) using search terms relating to equine colic. Publications were assessed against inclusion and exclusion criteria, and then reviewed using the QUADAS scoring system. **Results:** The primary search identified 5508 publications relating to colic; 32 studies related to the use of lactate in the diagnosis of colic, 2 papers met the inclusion criteria and were assessed using QUADAS. Both papers investigated the use of plasma and peritoneal lactate to identify strangulating intestinal lesions. Both were cross-sectional studies, and together they evaluated a total of 71 horses with confirmed strangulating lesions. Appraisal of the studies using the QUADAS tool was performed. Both papers met QUADAS criteria relating to study design and data analysis, but the QUADAS tool did highlight some limitations in terms of sample and control groups in both papers. Data analysis varied, with one study developing a model to predict the presence of a strangulating lesion, which included peritoneal lactate and other measurements, and the other study assessing optimal predictive values associated with concentrations of peritoneal lactate. Both studies concluded that peritoneal lactate was a more useful diagnostic test than blood lactate. **Conclusions:** Despite the large numbers of publications reporting use of lactate, only a small number used study designs considered suitable for evaluation of diagnostic test accuracy as proposed by the Cochrane Library. Although the current evidence is limited, there is agreement on the value of peritoneal lactate as a diagnostic test for strangulating intestinal lesions. **Ethical animal research:** Not applicable. **Sources of funding:** Tom Cullen is a Junior Clinical Training Scholar funded by the School of Veterinary Medicine and Science, University of Nottingham and Oakham Veterinary Hospital. Laila Curtis’ PhD studentship is funded by the School of Veterinary Medicine and Science, University of Nottingham. **Competing interests:** None declared.

**14.30–14.45**

Measures of redox balance in horses undergoing corrective surgery involving strangulating lesions of the small intestine

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**Reasons for performing study:** Colic remains a life-threatening condition in the horse. Ischaemia and reperfusion following correction of small intestinal strangulation may produce oxidative stress. The ability to withstand oxidative stress depends on antioxidant levels and may be linked to horse survival. **Objectives:** To measure peripheral antioxidant levels in horses undergoing exploratory laparotomy with small intestinal strangulation. **Study design:** Case–control study. **Methods:** Blood and plasma were collected from horses undergoing exploratory laparotomy for small intestinal strangulation and stored at -80°C. Controls involved non-colic horses. Total plasma glutathione was measured spectrophotometrically at 412 nm using the 5,5'-dithiobis-(2-nitrobenzoic acid) (DTNB, Ellman’s reagent) reaction. Samples containing scavenger (to remove reduced glutathione, GSH) were used to measure oxidised glutathione (GSSG). Glutathione reductase (GR) activity (u/l) was measured as the rate of GSH production at 412 nm. Glutathione peroxidise (GPx) activity (u/l) was measured as the change in optical density (340 nm) following the consumption of NADPH after GSSG production. All assays were purchased from BioAssay Systems (Hayward, California). Clinical data including arterial and blood gas analysis were collected on admission. **Results:** Glutathione reductase activity in horses with strangulating small intestinal lesions was significantly reduced compared to control horses (12.2 ± 1.1 u/l vs. 15.9 ± 0.8 u/l, P = 0.03, n = 6) whereas GPx activity did not significantly differ between colic and control horses (155.7 ± 48.7 u/l vs. 167.3 ± 50.1 u/l, P = 0.84, n = 6). Total glutathione, reduced or oxidised glutathione did not differ significantly between control and colic horses. A positive correlation existed between GR activity and Ca²⁺ (r = 0.93) and K⁺ (r = 0.75) whereas a strong negative correlation was present between GR activity and HCO₃⁻ (r = -0.92) and PaCO₂ (r = -0.96). **Conclusions:** Reduced plasma glutathione reductase activity with small intestinal strangulation indicates oxidative stress and may be related to systemic electrolyte/bicarbonate abnormalities. **Ethical animal research:** Study approval No. VREC219a. Explicit owner informed consent for inclusion of animals in this study was not stated. **Source of funding:** Supported by the School of Veterinary Sciences, University of Liverpool. **Competing interests:** None declared.

**14.45–15.00**

Evaluation of dexamethasone for the prevention of post operative ileus

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**Reasons for performing study:** Inflammation is key in the development of post operative ileus in rodents, with a similar pathogenesis likely occurring in other species. Dexamethasone reduces inflammation and therefore could help reduce post operative ileus in the horse. **Objectives:** To determine if dexamethasone reduces post operative ileus in horses with small intestinal disease, and assess the effect on incisional health and short-term survival. **Study design:** Retrospective case series. **Methods:** Fifteen horses that underwent small intestinal resection and anastomosis were given 0.1 mg/kg bw dexamethasone intravenously during surgery (DEX). Data from a comparable number of horses that did not receive dexamethasone (NoDEX) was collected retrospectively and sequentially. Horses were matched for the type of resection performed. Fisher’s Exact and Student’s t tests were used for data analysis. **Results:** There was no significant difference in the amount of nasogastric reflux (litres) (DEX 8.06 ± 17.12, NoDEX 10.02 ± 24.03, P = 0.39) produced or in the number of horses that produced nasogastric reflux post operatively. There was no difference in survival to discharge. The severity of incisional discharge/infection was significantly different between groups when scored 0–3 (0 being none, 1 coroners LC and 3 being severe discharge/infection), (P = 0.01), in favour of DEX (2/15 horses affected) vs. NoDEX (7/15). **Conclusions:** Dexamethasone did not appear to have a beneficial effect on the incidence of post-operative ileus. Administration of a single dose of dexamethasone does not appear to have a detrimental effect on short-term survival or on incisional complications. **Ethical animal research:** Research ethics committee oversight not currently required.
by this conference: procedures were performed as part of clinical investigations. Explicit owner informed consent for participation in this study was not stated. Source of funding: None. Competing interests: None declared.

15.00-15.15
Is there evidence for functional 5-hydroxytryptamine 4 (5-HT₄) receptors in the equine jejunum? An in vitro study to explore options for use of human prokinetic drugs, acting as 5-HT₄ receptors, in horses

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Reasons for performing study: Selective 5-HT₄ receptor agonists such as prucalopride are used as human prokinetics, since activation of 5-HT₄ receptors on intestinal cholinergic neurons facilitates acetylcholine release. 5-HT₄ receptors, linked to adenyl cyclase, act via generation of cAMP. None of the 4 in vitro studies on 5-HT in horses provided evidence for neuronal 5-HT₄ receptors, but none used the protocol as described in human studies [1–4]. Objectives: To investigate whether functional 5-HT₄ receptors are present in the equine small intestine. Study design and methods: In vitro organ bath set up, applying electrical field stimulation (EFS) in longitudinal and circular smooth muscle strips. Results: Results were similar in both muscle layers. In the presence of 0.3 mmol/l NG-Nitro-L-arginine methyl ester and 0.3 mmol/l apamine, excluding effects of the inhibitory transmitters NO and ATP, EFS induced voltage-dependent on-contractions; these were neurogenic as they were abolished by 3 mmol/l tetrodotoxin. At a voltage inducing 50% of the maximal amplitude, the submaximal EFS-induced contractions were cholinergic as atropine (1 mmol/l) abolished them. Prucalopride (0.3 mmol/l) did not increase the amplitude of these submaximal EFS-induced contractions. Even in the presence of the nonselective phosphodiesterase inhibitor IBMX, previously shown to enhance the effect of neuronal 5-HT₄ receptors by inhibiting breakdown of their 2nd messenger cAMP [5], prucalopride (3 mmol/l) had no influence. Also 5-HT (10 mmol/l), a full agonist at 5-HT₄ receptors, tested in the presence of methysergide and granisetron to exclude interaction with other 5-HT receptor subtypes, did not enhance EFS-induced submaximal contractions. Conclusions: There is no evidence for presence of 5-HT₄ receptors on the cholinergic neurons of the equine small intestine. These results question the application of 5-HT₄ prokinetic drugs in horses. Ethical animal research: Research ethics committee oversight not currently required by this conference: the study was performed on material collected at an abattoir. Sources of funding: None. Competing interests: None declared.

16.00-16.15

Iohexol as a marker of intestinal permeability in the horse

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**Reasons for performing study:** Infiltrative disease of the intestine is an important cause of weight loss in the horse. Infiltration of inflammatory or neoplastic cells into the intestinal wall and intestinal fibrosis cause changes in the integrity of the intestinal wall. This may lead to altered intestinal permeability which can be measured using the contrast medium iohexol.

**Objectives:** To determine if iohexol intestinal permeability, as evaluated by serum iohexol concentration, could be used to differentiate between healthy horses and horses with infiltrative disease of the large colon.

**Study design:** Prospective non-randomised controlled clinical trial.

**Methods:** Six healthy adult horses and 4 horses with chronic infiltrative disease of the large colon were used in the study. Infiltrative disease was confirmed on post mortem in all cases, and included alimentary lymphoma and mycobacterial granulomatous enterocolitis. Following a 16-h fast, each horse was dosed with 1.0 ml/kg bwt of iohexol as a 10% solution via nasogastric intubation. Blood samples were collected at 0, 30, 60, 120, 180, 240, 300, 360, 420 and 480 min after dosing. Iohexol concentration was determined using HPLC-UV and the differences between the groups were analysed with repeated measures ANOVA.

**Results:** There was a statistically significant difference in iohexol serum concentration between the diseased and non-diseased horses (P = 0.001). The overall difference in the mean iohexol concentration between the 2 groups was 6.07 (95% CI 3.19–8.96) µg/ml, however there appeared to be a trend towards increasing difference at later time points (240, 300, 360 min).

**Conclusions:** The iohexol permeability test has potential as a diagnostic tool for estimation of intestinal permeability in horses with infiltrative intestinal disease. Further studies are warranted to determine whether the test can be used to determine the site of intestinal pathology, predict the prognosis and potentially evaluate the response to treatment.

**Ethical animal research:** The study protocol was approved by the National Animal Experiment Board of Finland (Eläinkoelautakunta ELLA). For client-owned animals, informed consent was obtained. Source of funding: This study was funded by the Faculty of Veterinary Medicine, University of Helsinki, Finland.

**Competing interests:** None declared.

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16.30–16.45

**Diagnostic value of gastric mucosal biopsies in horses with glandular disease**

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**Reasons for performing study:** Equine gastric glandular disease (EGGD) is a common condition, for which the underlying pathophysiology is undetermined. Endoscopic mucosal biopsies have been proposed as a method for adapting therapy. **Objectives:** To evaluate diagnostic information obtained from endoscopic mucosal biopsies. **Study design:** Prospective, experimental study. **Methods:** Twenty-one horses undergoing elective humane slaughter were subjected to gross examination of the glandular mucosa. Glandular pathology was graded using EUSG Council guidelines from digital camera images. Mucosal biopsies were obtained using a ‘single-bite’ (1.8 mm; A and 2.4 mm; B) or ‘double bite’ technique (2.4 mm; C) using endoscopic biopsy instruments. Tissue was formalin fixed, processed and stained using standard protocols. Inflammatory infiltrates visualised histologically were graded (mild, moderate or severe) and compared with ulcer grade. Full thickness biopsies were also obtained adjacent to the biopsy site and of other visual lesions and inflammatory cell counts were compared with mucosal biopsies using ICC. **Results:** Full thickness samples were artefact free and allowed visualisation of all layers. Mucosal biopsy samples contained mucosa in all samples, submucosa in 55% (C), 61% (A) and 66% (B) of samples and glands in 50% (B), 66% (A) and 100% (C). Samples from A were too small for histological assessment (33%) and tissue damage was commonly seen in A and B (n = 8 and n = 10) when compared with C (n = 3). Horses with normal glandular appearance (grade O; n = 7) mostly demonstrated mild gastritis (n = 5). Severe gastritis was identified in mild EGGD (grade 1/2), whilst mild and moderate gastritis was identified in all EGGD grades. There was no histological evidence of ulceration or erosion. There was poor agreement between cell numbers and sampling techniques (ICC=0.29). **Conclusions:** These data show lack of ulcerative pathology and instead inflammation in EGGD. Lesion appearance is a poor indicator of underlying severity. Mucosal biopsies offer limited value in predicting underlying disease. **Ethical animal research:** This study was approved by the University of Nottingham Ethics and Welfare Committee. The study was performed on material collected at an abattoir. **Source of funding:** None. **Competing interests:** None declared.

16.45–17.00

**Understanding intestinal microbiota in equine grass sickness: next generation sequencing of faecal bacterial DNA**

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**Reasons for performing study:** The bacteria *Clostridium botulinum* has been associated with equine grass sickness (EGS); however, the effect on the wider horse’s gut microbiome is currently unknown. **Objectives:** To characterise the bacterial dysbiosis that occurs within the gut microbiome of horses with EGS and to identify and quantify *Clostridium botulinum* within the faecal microbiota of the affected horses. **Study design:** Case-control study. **Methods:** Faecal samples were collected from horses with a histological diagnosis of EGS and matched controls. Faecal bacterial DNA was extracted from samples and the v4 region of the bacterial 16S rRNA gene was amplified. DNA was sequenced on the MiSeq platform and data was analysed using QIIME. Differences in community profile between the 3 groups of horses were identified using linear discriminant analysis effect size (LEfSe) method. **Results:** There was a significant increase in Bacteroidetes and a decrease in Firmicutes bacteria in horses with EGS compared to the 2 control groups. Discriminant analysis identified bacterial genera *Desulphovibrio* and *Veillonella* and the bacterial species *Veillonella parvula* as increased in abundance. There was no noticeable increase in *C. botulinum* in the faecal microbiome of EGS horses in this study. **Conclusions:** The dysbiosis characterised by bacterial sequencing showed a similar shift to that identified previously in colitis horses and human inflammatory bowel disease. It is currently unclear how *Verrucomicrobia* bacteria are linked to grass sickness. **Ethical animal research:** The study was approved by The University of Liverpool ethics committee. Owner informed consent was obtained before sampling. **Sources of funding:** The Equine Grass Sickness Fund and The University of Reading. **Competing interests:** None declared.

17.00–17.15

**Equine Cyathostominæ can develop to infective third stage larvae on straw bedding**

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**Reasons for performing study:** To determine whether horses could become infected with cyathostominæ when bedded in deep litter straw. **Objectives:** The specific objective of the study was to determine whether cyathostomin eggs could hatch and develop to infective larval stages on straw bedding. **Study design:** Experimental study. **Methods:** Four horticultural incubators were set up to simulate 3 straw bedding scenarios, and one grass turf control. Faeces were placed on 12 plots, and larval recoveries performed on samples of straw/grass over a 17-day period. The plots within incubators A, B, and C contained dry straw, watered straw, and deep litter straw, respectively. Plot 1 of each incubator contained a faecal pat of a horse that tested negative for strongyle eggs – these were to serve as negative control plots. Plots 2 and 3 of each incubator contained a faecal pat from horses that had average faecal worm egg counts.
(FWEC) of 269 epg and 921 epg, respectively. A thermostat within each incubator was set to maintain an environmental temperature of approximately 20°C. **Results:** No L3 larvae were recovered from the control plots of each incubator, and none were recovered from any of the plots within Incubator A. L3 larvae were first detected on plots 2 and 3 of Incubator B on Day 8, and on plot 3 of incubators C and D on Day 10. **Conclusions:** It is evident that equine Cyathostominae can develop to infective L3 larvae on straw bedding, but only when the straw is moist. Therefore, it may be speculated that a horse bedded in deep litter straw may become infected by ingesting the infective L3 larvae contaminating the straw. **Ethical animal research:** Not applicable. **Source of funding:** E.C. McGirr was supported by a World Horse Welfare Undergraduate Bursary 2014. **Competing interests:** None declared.

17.15–17.30
**A retrospective dental study on 5334 horses in general practice**

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**Reasons for performing study:** Rasping of sharp enamel points (SEPs) is the most common procedure performed at routine dental examinations; however, there is little evidence to prove the true clinical significance of SEPs [1]. Maxillary SEPs are thought to cause buccal ulceration and pain on external palpation of the cheeks. Mandibular SEPs are thought to cause lingual ulceration. **Objectives:** To examine associations between the presence of SEPs on the cheek teeth rows and the presence of pain on palpation of the cheeks and buccal and/or lingual ulceration. **Study design:** Retrospective clinical case series. **Methods:** Clinical records of routine dental examination performed by 8 veterinary surgeons in a single first opinion practice were examined. Presence of SEPs, buccal and/or lingual ulceration and pain on palpation of the cheeks (externally) were recorded. Chi squared tests were used to examine whether horses exhibiting pain on palpation or oral ulceration were significantly more likely to have SEPs present. **Results:** Prevalence of buccal SEPs was 84.8% and lingual SEPs was 84.3%. Five hundred and forty-eight horses (6.0%) had signs of pain on palpation. Prevalence of buccal ulceration was 5.9%. In contrast, only 0.2% of horses had visible lingual ulceration. Buccal ulceration and pain on palpation were significantly associated with presence of buccal SEPs (P<0.001 for both). Lingual ulceration was not significantly associated with lingual SEPs (P<0.0001). **Conclusions:** Buccal SEPs are common and often result in pain and buccal ulceration. Routine rasping would appear to be justified. Lingual SEPs are common but rarely cause lingual ulceration. The value of routine rasping of lingual SEPs is therefore questionable. **Ethical animal research:** Research ethics committee oversight not currently required by this conference: retrospective study of clinical records. Explicit owner informed consent for inclusion of animals in this study was not stated. **Source of funding:** None. **Competing interests:** None declared. **Reference:** [1] Duncanson, G.R. (2010) Does regular dental treatment influence the long-term dental health of the horse? RCVS Fellowship Thesis.
Proximal Suspensory Desmitis
Chaired by Christoph Lischer
Sponsored by Equine Veterinary Journal Ltd

08.40–09.00
Clinical characteristics and diagnostic analgesia
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Introduction
Proximal suspensory desmitis, i.e. inflammation of the proximal third of the suspensory ligament, is a common cause of forelimb and hindlimb lameness in working horses of all disciplines. If proximal suspensory desmitis is to be correctly identified then the clinical manifestations of the condition and the results of diagnostic analgesia that would be expected in those horses that are suffering from it, are important aspects to consider.

Forelimb
Clinical characteristics
Horses with proximal suspensory desmitis would be expected to present with a history of forelimb lameness that may be sudden or insidious in onset. Lameness may be bilateral or unilateral. When an affected horse is lunged lameness may be more apparent with the affected limb on the outside of the circle; however, that will not always be the case [1–3].

The proximal suspensory ligament is hidden between the small metacarpal bones on the palmar aspect of the third metacarpal bone, dorsal to the superficial digital flexor tendon (SDFT), the deep digital flexor tendon (DDFT) and the accessory ligament of the deep digital flexor tendon (ALDDFT). That deep location makes swelling of the proximal suspensory ligament very difficult to see or feel. Pain may be elicited on palpation of the proximal suspensory ligament with the limb held in flexion but some horses will react to firm palpation of the ligament despite the absence of pathology [1–3].

Diagnostic regional analgesia
Innervation of the proximal suspensory ligament is provided by a deep branch of the lateral palmar nerve which receives contributions from both the median and ulnar nerves [4]. A high 4-point nerve block in which local anaesthetic solution is placed adjacent to the axial surface of the second and fourth metacarpal bones at a deep location and a superficial location will completely desensitise the proximal metacarpus and all structures distal to that point but, as inadvertent injection of the carpometacarpal joint and carpal sheath is common, those structures may also be desensitised. A median and ulnar nerve block would be expected to provide analgesia to the proximal suspensory ligament but it will also desensitise many other structures in the region of the carpus [5].

In order to improve the sensitivity of diagnostic analgesia of the proximal suspensory ligament, attempts were made to find a reliable way to deposit local anaesthetic solution immediately adjacent to the lateral plantar nerve. The first technique that was developed to achieve this is often referred to as the Wheat block [6,7]. The limb is held flexed and a 25 gauge ½ inch needle is introduced perpendicular to the skin immediately distal to the accessory carpal bone and inserted up to the hub such that it will lie in the accessory-metacarpal ligament in which the lateral palmar nerve courses. Local anaesthetic solution (5 ml) is deposited within that dense connective tissue. This is a useful technique; however, inadvertent puncture of the carpal sheath is common [6].

In 2005 Castro et al. published an alternative technique for perineural injection of the lateral palmar nerve [8]. The aim of the technique is to infiltrate the nerve where it lies adjacent to the distal third of the accessory carpal bone at the site where a shallow groove is palpable. With the horse bearing weight a 25 gauge ½ inch needle is placed subcutaneously at that site and local anaesthetic solution is injected. With this second technique inadvertent injection of adjacent synovial structures is not likely.

Hindlimb
Clinical characteristics
Lameness associated with proximal suspensory desmitis in the hindlimb may be insidious in onset, often leading to poor performance rather than overt lameness, or sudden in onset and more severe. As in the forelimb, lameness may be bilateral or unilateral. Again, when an affected horse is lunged lameness may be more apparent with the affected limb on the outside of the circle; however, that will not always be the case [1–3].

The proximal suspensory ligament in the hindlimb is even more hidden than the forelimb with the small metacarpal bones and the plantar soft tissues largely obscuring the ligament from accurate palpation. Swelling of the proximal suspensory ligament is rarely seen unless it is extreme [1–3].

Diagnostic regional analgesia
Innervation of proximal plantar metatarsal structures is provided by the medial and lateral plantar nerves, which are branches of the tibial nerve. Innervation to the proximal suspensory ligament is provided by a deep branch of the lateral plantar nerve (DBLPN) [4]. Several analgesic techniques have been described aimed at the deposition of local anaesthetic solution adjacent to the medial and lateral plantar and plantar metatarsal nerves, however, on evaluation of two common techniques the tarsal sheath or the tarsometatarsal joint were punctured in a large proportion of injection attempts confounding the interpretation of these blocks [9].

A single injection technique aimed at placing local anaesthetic solution immediately adjacent to the DBLPN has been used for some time and the accuracy of the technique was investigated by this author and co-workers [10]. With the hindlimb flexed and held up in a farrier’s grip, the SDFT is deflected medially and a 23 gauge 1 inch needle is inserted perpendicular to the skin surface 15 mm distal to the head of the fourth metatarsal bone. The needle is advanced between the fourth metatarsal bone and the lateral border of the SDFT up to the hub and 1–5 ml of local anaesthetic solution is injected. If the needle is correctly positioned then there should not be any resistance to injection. When
Cadaveric hindlimbs were injected using this technique the tarsometatarsal joint was not entered and the tarsal sheath was only entered in one of 19 limbs. The needle in that limb entered the tarsal sheath because the needle was allowed to drift medially and not maintained in a position adjacent to the fourth metatarsal bone. Despite this technique providing a means to place local anaesthetic solution adjacent to the DLBLN it is clear from recent studies that structures distal to the site of injection, particularly on the lateral aspect of the limb, may be desensitised as may be the distal tarsus [11-14].

References
Comparative imaging of the proximal metacarpus/metatarsus

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Suspensory desmitis involving the ligament’s origin (proximal suspensory desmitis, PSD) is a common injury in the fore- and hindlimbs of athletic horses of all disciplines and may occur uni- or bilaterally. Definitive diagnosis of PSD in both the fore- and hindlimb can be challenging and requires a logical approach combining clinical findings with diagnostic analgesia and multi-modal diagnostic imaging. Nevertheless, a diagnosis of proximal metacarpal or metatarsal pain is sometimes required due to the absence of abnormal imaging findings in the face of convincing results with local analgesic techniques.

Ultrasonography is the most frequently used technique to evaluate the proximal aspect of the suspensory ligament. However, given the ligament’s shape and composition careful image interpretation is required to arrive at valid conclusions. A triangular shape, central hilus, intra-ligamentous mixed tissue bundles together with the high prevalence of ultrasonographic artefacts make hindlimb evaluations particularly challenging. Variations in ultrasonographic technique utilising the off-incidence artefact have recently been described and are associated with the potential to improve assessments and facilitate diagnosis [1,2]. In the right hands, ultrasonography of the proximal metacarpal/metatarsal region can serve as a valuable diagnostic tool but in the context of suspensory disease its utility is generally surpassed by high-field magnetic resonance imaging (MRI). In the case of standing low-field MRI systems valuable additional information can be gained over the sole use of ultrasonography aiding in the selection of further treatments but interpretation of signal change associated with the ligament is less straightforward. In this presentation a short overview of the relevant anatomy is given and the diagnostic imaging findings in support of the diagnosis of proximal metacarpal/metatarsal pain are discussed.

References

Further reading
Proximal suspensory desmitis is a common but extremely badly defined cause of lameness. The condition causes moderate lameness in either front limb or hindlimb [1]. Bilateral cases, particularly in the hindlimb, can present as poor performance, with loss of impulse or jumping performance. There are few localising clinical signs and the lameness is localised to the proximal suspensory ligament by nerve blocks [2]. Ultrasonography is widely used to examine the proximal suspensory ligament but there is a wide overlap between normal and disease [2]. The prognosis with hindlimb proximal suspensory desmitis is poor. The originally reported prognosis was 15% [3], and following shock wave treatment, 40% [4].

The prognosis with hindlimb proximal suspensory desmitis is poor. The originally reported prognosis was 15% [3], and following shock wave treatment, 40% [4].

Surgery for proximal suspensory desmitis was popularised by Bathe [5]. Swelling of the suspensory ligament may compress the deep branch of the lateral plantar nerve, resulting in persistent lameness [6]. Thus, a combined neurectomy and a fasciotomy, to decompress and desensitise the ligament. Good results have been reported, between 62% and 91%, [7,8]. Surgery is performed under general anaesthesia in dorsal recumbency. A linear incision is made at the level of the head of the lateral splint bone. Sharp dissection is continued through the subcutaneous tissues, and through the superficial fascia. Blunt dissection is then used along the axial margin of the lateral splint bone to isolate the deep branch of the lateral plantar nerve. The deep branch can usually only be retracted to wound level, while the lateral plantar nerve itself can be retracted several centimetres away from the surgical wound. Approximately 3 cm of nerve is resected using a guillotine technique.

The deep plantar laminar fascia is identified in the distal margins of the incision. A crescent of white tissue is identified overlying the deepest structures. This has to be transected blind, as the fascia extends from the surgical site distally. This can be undertaken using Metzenbaum scissors, but a split in the surface of the suspensory ligament is almost inevitable [7]. A custom fasciotome is manufactured by Dr Fitz, and use of this is preferred.

One study documented linear hypechoic lesions in the suspensory ligament on post operative ultrasonographic examination [7]. Another study documented significant neurogenic atrophy of the suspensory ligaments following neurectomy [9]. Finally, excellent results have been reported following neurectomy of the deep branch of the lateral plantar nerve alone [10]. Based on this information we hypothesised that plantar fasciotomy may be unnecessary, or indeed detrimental.

In August 2010, in the light of the above information, plantar fasciotomy was discarded, and neurectomy of the deep branch of the lateral plantar nerve alone was performed. This resulted in two separate but non-randomised populations. A retrospective study was conducted, to compare the success rates. Information on post operative progress was obtained by telephone questionnaire. The proportion of horses returning to previous levels of athletic activity, and to ridden activity, were compared using Fisher’s exact test.

This study included 171 horses, of which 86 (50%) had undergone plantar neurectomy alone. Follow-up information was available for 135 horses, of which 91 (67%) had returned to ridden exercise, including 63 (46%) at the same or higher level of athletic activity. Following combined fasciotomy and neurectomy, 33 horses (54%) returned to previous levels of activity, and a further 8 (13%) horses returned to ridden exercise. Following neurectomy alone, 30 horses (41%) returned to previous levels of athletic activity and a further 20 horses (27%) returned to ridden exercise. The proportion of horses returning to ridden activity was identical with or without fasciotomy, but the proportion returning to original levels of athletic use was lower without fasciotomy (41% vs. 54%), P = 0.12.

The hypothesis that fasciotomy did not alter the outcome was not rejected, but the P value was low. Other factors may have influenced the outcome due to lack of randomisation. It has been shown that horses with primary proximal suspensory desmitis, in the absence of any other musculoskeletal conditions, have a better outcome than those with concurrent conditions such as sacroiliac region pain, and particularly, straight hock conformation [3]. It is conceivable that the change of surgical procedure occurred at a time when we were encouraged by good results and had widened our selection criteria. However, we were anticipating improved results without fasciotomy, and notwithstanding statistical significance, we concluded that the results justify fasciotomy, and have reinstated this as part of our surgical protocol.

References
Ultrasonographic examination of the femorotibial joints

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Introduction

Ultrasonography is a useful imaging modality for the investigation of stifle abnormalities as it enables the evaluation of the soft tissue components of the joint together with providing information on the regularity of the bony contours and the insertion sites of ligaments. Because magnetic resonance imaging (MRI) is not a practical imaging modality for the stifle in most circumstances, ultrasound is usually the only imaging modality available to the practitioner to expand the investigation of joint pathology in the absence (or presence) of radiographic pathology. However, not all areas are accessible because of bony prominences and curved contours that can prevent optimal orientation of the transducer. Equally because of these curved contours, off-incidence artefacts are common and therefore accurate interpretation requires good technique and experience.

Medial femorotibial joint

Other than in young horses with osteochondrosis of the lateral trochlear ridge, the medial femorotibial joint compartment is the most common site of clinical pathology. The area of ultrasonographic evaluation lies between the medial patellar ligament and the medial collateral ligament. The easiest starting point is a longitudinally oriented transducer positioned immediately caudal to the medial femoral condyle and should be not confused with a meniscal tear. The transducer should then be moved in a cranio-caudal direction to identify:

- Proximal pouch of medial femorotibial joint
- Medial femoral condyle
- Medial tibial plateau
- Medial meniscus
- Medial collateral ligament.

Commonly observed pathologies

- Articular margins - the presence of osteophytes, consistent with osteoarthritis (a common consequence of many soft tissue injuries of the stifle).
- Synovial thickening in the medial pouch of medial FT joint – often secondary to chronic joint pathology or sepsis.
- Medial meniscal tears - the most commonly identified ultrasonographic pathology in this region of the joint. These are identified as anechoic defects within the meniscus (usually horizontal tears in this location) with or without displacement of the meniscus. Visualisation of a tear in this location suggests a poor prognosis similar to the arthroscopic Grade III lesions (which extend past the arthroscopic field of view of the cranial aspect of the femorotibial joint) and displacement would be considered a further negative factor in prognostication.
- Medial collateral ligament desmitis, characterised by increase in cross-sectional area and echogenic changes similar to tendons, often with enthesiopathy at its insertion sites in chronic cases.

Lateral femorotibial joint

This is a more rarely affected joint and is more difficult to scan than the medial aspect due to greater soft tissue cover. The area of ultrasonographic evaluation lies between the lateral patellar ligament and the lateral collateral ligament. The easiest starting point is a longitudinally oriented transducer positioned immediately caudal to the lateral patellar ligament. It is possible to identify:

- Conjoined tendon of lateral digital extensor tendon and perineus tertius
- Lateral meniscus
- Popliteal tendon – deep to the lateral collateral ligament and should not be confused with a meniscal tear
- Lateral collateral ligament
- Lateral femoral condyle
- Lateral tibial plateau.

Commonly observed pathologies

- Joint changes – synovial distension and osteophytes – as for the medial femorotibial joint.
- Lateral meniscal tears – similar appearance to medial meniscal tears
- Lateral collateral ligament desmitis
- Popliteal tendonitis – very rare.

Flexed stifle examination

After the standard weight-bearing scans outlined above, the stifle can be flexed (if tolerated) to evaluate the cranial ligaments of the menisci (transversely oriented transducer) and the femoral condyles (both transversely and longitudinally oriented transducer). The cloaca of subchondral bone cysts in the medial femoral condyle can easily be identified and ultrasound can be used for ultrasound-guided injection of the same. An oblique longitudinally oriented transducer can also be used to identify the cruciate ligaments although clinically significant damage to these ligaments is rarely identified with confidence.

Conclusion

Ultrasonography is a valuable additional imaging modality for investigating femorotibial joint disease although there are limitations to the regions of these joints that can be adequately evaluated. It is particularly useful for the detection of meniscal pathology, a common cause of the femorotibial joint disease in adult horses.
MRI of stifle injuries: a review of the first 100 clinical cases

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Currently, equine stifle disorders are mainly diagnosed using radiographs, ultrasonography, scintigraphy [1], computed tomography [2] and/or arthroscopy [3]. However, each of these techniques have certain limitations preventing complete imaging of osseous and soft tissue stifle structures [1]. Whereas human knee conditions are routinely diagnosed by magnetic resonance imaging (MRI), reports on equine stifle MRI are rather limited [4]. Recently though, a novel technique for routine MRI examination of equine stifles was reported by the author [5]. The purpose of this report was to: 1) describe a routine MRI scanning technique for equine stifles, 2) report typical MRI findings and 3) compare, if applicable, these results to pre-MRI radiographic, ultrasonographic and/or arthroscopic findings post-MRI. We hypothesised that equine stifle MRIs: 1) can be routinely performed on all horses independent of breed/age/gender, 2) are safe diagnostic procedures, 3) can portray all normal/diseased soft tissue/bone structures completely, 4) reveal concurrent bone/soft tissue lesions, and 5) facilitate pre-op planning for arthroscopy.

Medical records of horses that underwent stifle MRI-scanning at the Equine Hospital Aschheim since 2011 were reviewed. Animals were included if: 1) condition was localised to the stifle and 2) radiographic, ultrasonographic and/or arthroscopic findings remained without abnormalities prior to MRI scans. Patients were placed under general anaesthesia in dorsal recumbency. Limbs of interest were placed in extension into a rotating low-field MRI scanner. Prior to scanning, a flexible extremity coil was placed dorsal to the stifles. Proton density (PD, 4 mm), T1-(1 mm), T2-(4 mm) and STIR-weighted sequences (4 mm) were acquired in frontal/sagittal/axial planes followed by 3D reconstruction. Starting in 2015, X-Bone- (4 mm) and SHARC-sequences (1, 3 mm) were added to the routine examination protocol. For bilateral stifle scanning, contralateral limbs were examined in a separate anesthetic episode. Generally, bones were assessed based on STIR and cartilage/subchondral bone pathology on SHARC-/T1- and X-Bone-sequences. In contrast, PD- and T2-sequences were used for evaluating ligament/tendon/meniscal lesions and determining the duration of pathology. Among soft tissue pathologies, meniscal lesions were classified as tears or degenerations, cruciate desmopathies as degenerations and cartilage lesion as erosions. For meniscal lesions, concurrent cruciate desmo- and chondropathies were recorded. Images were evaluated by a board-certified radiologist and/or surgeon. Gender, age, breed, total anaesthesia time and MRI findings were recorded. Explorative/therapeutic arthroscopies were performed during a second anesthetic episode, if pathology was deemed accessible based on MRI findings. Arthroscopic findings or, if applicable, radiographic/ultrasonographic images obtained prior to MRI scans were compared to MRI results.

One hundred horses met inclusion criteria and bilateral imaging was performed in 5 patients. Thirty-seven mares, 50 geldings and 13 stallions (mean age 10.8 years: range 1–27 years, different breeds) underwent MRI examination. All MRI scans were successfully completed (100%) with an average anesthe-sia/MRI scanning time of 65 min (40–70 min). Typical MRI lesions included: bone oedema, subchondral bone cysts, chondropathies, cruciate/collateral/ meniscal lesions and meniscal tearing/degenerations. Frequently, concurrent bone and soft tissue lesions were observed. Re-evaluation of pre-MRI-scanning radiographs and ultrasonography failed to identify bone and soft tissue lesions retrospectively with few exceptions. Thirty-nine stifles underwent explo-ratory arthroscopy post-MRI (39%). MRI pathology was confirmed in all cases (100%). Accessible superficial lesions identified on MRI were confirmed and treated, if possible. The extent of low-grade chondropathies and synovial adhesions was more clearly delineated in arthroscopy. Generally, MRI findings were particularly useful to estimate expansion/duration of cruciate desmopathies, meniscal damage and/or subchondral bone cysts.

Magnetic resonance imaging of equine stifles has been an insurmountable obstacle due to patient size for many years. Although radiographic and ultrasonographic examinations can identify some stifle disorders, sensitivity and specificity is fairly low as compared to MRI [5]. However, they will remain the primary diagnostic tools for practical reasons. Scintigraphy could be useful to detect ongoing inflammation, but fails to reliably identify subtle pathology [1] and is subjected to strict environmental regulations. More recently, plane and/or contrast CT-studies of stifle diseases with wide-bore gantries provided more detailed insight in ligament and cartilage pathology [2]. This technique was rapidly performed, but failed to demonstrate several lesions in detail [2]. In another case series, high-field MRI of stifles was described using a wide-bore/ultra-short closed gantry [4]. However, image acquisition was strongly dependent on patient size and horses had to be measured prior to examination [4]. In contrast, our protocol allows for routine MRI examination of all stifles, independent of size, breed, age and gender [5]. Our results indicate, that low-field MRIs of stifles: 1) are safe, 2) can delineate normal and abnormal structures thoroughly, 3) reveal concurrent bone/soft tissue lesions and 4) appear superior to identify soft tissue and bone lesions as compared to traditional diagnostic modalities. Similar to human orthopaedics, MRI may develop into the ‘gold standard’ for investigating equine stifle disease. Although arthroscopy remains important for exploration and intervention, anatomical restrictions limit complete joint exploration. Certain lesions are inaccessible and thus, may be missed in surgery. Low-field MRI could be an excellent complementary tool for preoperative planning and may prevent unnecessary stiffe arthroscopy for inaccessible lesions. Therefore, a combination of low-field MRI scanning with subsequent arthroscopy may be a promising approach for a better understanding of equine stifle pathology, treatment and prognosis.

References

Arthroscopy of soft tissue injuries in the stifle: diagnosis, treatment and outcome

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Arthroscopy is a necessary part of a comprehensive examination of the soft tissue components of equine stifle joints. It is complementary to other imaging modalities, principally ultrasound, which can provide additional information regarding infrastructure. Ultrasonographic imaging windows do not produce a comprehensive evaluation of the complex of intra- and peri-articular soft tissues of the stifle joints. Direct visualisation is the most sensitive technique for evaluation of the surfaces of intra-articular structures but, unfortunately, not all surfaces are amenable to arthroscopic inspection.

Complete arthroscopic examination of the equine stifle joints requires separate approaches to the femoropatellar, cranial medial femorotibial, cranial lateral femorotibial, caudal femoral patellar, proximal caudal lateral femorotibial and distal caudal femorotibial compartments. However, in individual cases, pre-operative diagnostic techniques frequently determine that selected compartments only are evaluated. This presentation will be restricted to discussion of these identified and treated using a standard 4 mm 30° forward oblique arthroscope with horses under general anaesthesia. Use of a 1.3 mm ‘needle scope’ under sedation and local anaesthesia has been reported as a diagnostic technique.

Femoropatellar joint

Medial patellar fibrocartilage

The patellar fibrocartilage forms an extension to the patella over the medial trochlear ridge of the femur and serves as the origin for the medial patellar ligament into which it imperceptibly blends. Impact injuries, usually from jumping (or attempting to jump) fixed obstacles appear to be most common. These may, or may not, be concurrent with fractures/fragmentation of the medial pole of the patella. Injuries to the fibrocartilage may be identifiable ultrasonographically. Complete disruption disarms the medial patellar ligament but most are incomplete injuries forming intra-articular flaps of fibrocartilage. Treatment consists of removal of disrupted tissue. This generally involves sharp dissection including, in full thickness lesions, insertion of vastus medialis. The prognosis appears favourable and in the limited number evaluated with follow-up, there have been no reports of secondary distal patellar enthesopathy or fragmentation as reported following medial patellar desmotomy.

Patellar ligament injuries

The patellar ligaments are sub-synovial with respect to the femoropatellar joint which permits some evaluation of their caudal surfaces. The surface of the lateral patellar ligament frequently is traumatised by osteochondritis dissecans (OCD) lesions on the lateral trochlear ridge of the femur. Lesions are found most commonly in mature horses in work and consist of varying depths of excoriation. Removal of the torn tissue (in addition to the primary lesion) is considered to contribute to case management.

Primary lesions of the patellar ligaments are uncommon. Avulsion of the origin of the middle patellar ligament has been recognised in sporadic cases only.

Arthroscopic medial patellar desmotomy is an elegant, accurate and controlled procedure compared with open and blind percutaneous approaches.

Medial femorotibial joint

Meniscal lesions

Arthroscopy permits good evaluation of the proximal surface of the cranial horn, with some evaluation of its distal surface, a portion of the axial surface of the body and the proximal and caudal surfaces of the caudal horn of the medial meniscus. Tears of the cranial horn are most common. The severity and morphology vary from partial thickness flaps to full thickness defects which commonly result in extrusion into the joint. Involvement of the joint hinged on the cranial ligament of the meniscus. The vast majority of tears are irregular. Very few are amenable to repair so treatment consists of removal of torn tissue. Techniques used are determined by the nature and severity of the injury.

Meniscal lesions can also occur in conjunction with subchondral bones cysts of the medial condyle of the femur. These are most commonly shallow abrasions but some older horses may have further degenerative change.

From an arthroscopic perspective, meniscal degeneration can manifest as tearing, surface fibrillation or palpable changes in consistency including areas of fibrosis and/or mineralisation. Meniscal cysts have been reported but are uncommon.

Tearing/avulsion of meniscal ligaments

Injuries of the cranial ligament of the medial meniscus vary in severity from surface fibrillation to avulsions from the tibial insertion just cranial to the medial tibial eminence. Tears are usually on the caudal margin of the ligament and can extend to the cranial horn of the meniscus. In all cases, the surgical objective is removal of disrupted collagenous tissue in order to reduce synovial irritation and to promote formation of an inert scar.

Caudal cruciate ligament injuries

The femoral origin of the caudal cruciate ligament is intra-articular and visible cranially in the inter-condylar fossa axial to the medial condyle of the femur. Tearing and avulsions are identifiable but uncommon. The tibial insertion of the caudal cruciate ligament is mostly embedded within the caudal inter-articular septum. Occasionally lesions can be seen from the caudal compartment of the medial femorotibial joint but surgeons should not attempt exploration into the septum as the popliteal artery lies immediately adjacent.

The tibial insertion of the cranial cruciate ligament is sub-synovial, i.e. within the septum between medial and lateral femorotibial joints.

Lateral femorotibial joints

Meniscal lesions

Lesions of the lateral meniscus are much less frequent than medial. They are also generally less severe. The principles of treatment are identical to those applied medially.
Tearing/avulsion of the meniscal ligaments
Tears of the cranial ligament of the lateral meniscus are, like the meniscus itself, less common and normally less severe than those found medially.

Cranial cruciate ligament injuries
Partial thickness injuries of the cranial cruciate ligament can disrupt the adjacent septal tissue which separates the cranial compartments of the femorotibial joints such that, in some cases, torn fibres can be extruded into one or both joints. However, absence of such does not exclude injury. Full evaluation of the surface of the ligament necessitates removal of the adjacent septum. This is tolerated well with no identifiable adverse sequelae. Arthroscopic removal of the torn tissue appears to be contributory to case management.

NOTES
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12.00-12.20

Best practice for the treatment of osseous cyst-like lesions of the medial femoral condyle

Subchondral bone cysts in the stifle are most frequently found in the medial femoral condyle (MFC) and can cause lameness, especially in young horses [1–4]. Thoroughbreds [5] and Quarter Horses [6] are most commonly affected. Warbly bloods are less affected.

The pathogenesis of subchondral cystic lesions (SCL) in the MFC remains speculative, but trauma and osteochondrosis are commonly involved. Articular cartilage damage alone will not induce a SCL, but injuries which also cause subchondral bone damage, can result in the development of a SCL [7].

The radiographic appearance of a SCL may vary and several classification systems [8–10] have been developed to describe the radiographic shape of the SCLs. These grading systems all try to describe the shape and the depth of the SCL, the amount of subchondral bone involvement and the size of the communication between the cyst and the joint surface (cloaca).

Treatment options vary widely and many medical and surgical treatments have been recommended, with reported success rates varying between 65 and 75% in the larger case studies (>50). This reflects the difficulty in choosing the right treatment for SCLs and shows that no single effective therapeutic treatment has been found. Treatment probably needs to be adapted to the age of the horse, its use and the radiographic presentation of the SCL.

Conservative management involving box rest and intra-articular treatment of the medial femorotibial joint with triamcinolone has been used for many years and is still an option in some cases (young horses and horses with little cartilage surface damage).

In the 80s and 90s curettage of the SCL, first by arthroscopy and later by arthroscopy, was the treatment of choice. This treatment was later combined with subchondral drilling/osteostixis. Results in larger case series showed a guarded to poor return to previous performance varying from 29% successful outcome in horses older than 3 years of age to 69% in horses less than 3 years old [11]. Cyst enlargement was seen in some cases even in the absence of drilling.

It is not only the age of the horse, but also the size of the cartilage surface damage involved, that will influence the outcome [12]. Subchondral cystic lesions in the MFC associated with an articular cartilage lesion of >15 mm carry a poor prognosis, with only 30% of horses going on to start a race.

Other treatment options have been explored: cyst debridement followed by cancellous bone grafting or filling with osteochondral grafts [13] (mosaic arthroplasty); growth factor enhanced chondrocyte grafts and mesenchymal stem cells contained within fibrin glue [14]. The latter has shown better results in older horses and horses with osteoarthritis but requires advanced lab techniques not readily available to many practices.

Arthroscopic injection of corticosteroids into the fibrous tissue of the SCL of the MFC as described by Wallis et al. [9] remains a very popular and effective first line treatment. It offers similar rates of success as have been reported with debridement, but the shorter convalescence time, the ability to assess the cartilage around the cloaca and to remove loose cartilage flaps, while avoiding excessive cartilage damage and disruption of the underlying subchondral bone. If unsuccessful or only temporarily successful, the option still remains to debride the cyst with or without ‘filling up’ the SCL in a second surgery.

Very recently (2014) a new technique was published as an alternative for treatment of SCL causing lameness. It consists of placing a transcondylar screw through the SCL [10]. The authors observed a radiographical increase in bone opacity around the screw and a decrease in cyst size especially in younger horses. Lameness was eliminated in 75% of the horses but the numbers where still low (n = 20) and the follow-up was only 120 days.

In conclusion, treatments should focus on minimising cartilage disruption over the cloaca site, focus on cartilage surface repair and even preventative cartilage preservation. Ideally treatment should also focus on radiographic healing or filling up of the lesion. Debridement of a SCL with a large articular cartilage component will, especially in older horses, lead to a large imperfect fibrocartilage layer covering a weak or permanent defect in the subchondral bone plate, on the weight-bearing surface of the MFC. Older horses and horses with a long-term sport career (showjumpers and dressage horses) are more difficult to treat.

During the lecture, the different (theoretical) treatment options will be discussed briefly followed by a survey of which treatments large referral centres in Europe and the US offer to their patients in relation to the age of the horse, their use and the radiographic appearance of the SCL.

References
The pathology of navicular syndrome

Michael Schramme

Magnetic resonance (MR) imaging is now widely used in the diagnosis of equine foot lameness. It has been able to provide diagnostic information not available from other imaging techniques. Understanding of the significance of alterations in signal intensity and patterns relies on the study of pathological changes that occur in the various disease processes that affect different tissues in the foot. The purpose of this paper is to review the current histopathological knowledge of abnormalities of the navicular bone as well as the suitability of MR imaging for their identification.

The most common type of MR signal abnormality seen in the navicular bones of horses with lameness associated with navicular bone disease is STR signal hyperintensity in the spongiosa of the navicular bone with or without additional areas of T2 and PD signal hypointensity. STR hyperintensity in the spongiosa may be focal near the distal border of the navicular bone, or extend from the distal border in a vertical band along the palmar cortex to the proximal border of the bone, or spread diffusely throughout the medullary cavity [1]. In horses with chronic navicular bone disease, abnormal signal hyperintensities at the level of the palmar surface of the navicular bone are equally common as those in the spongiosa. These can be areas of subtle, focal increase, caused by synovial fluid pooling at a site of early fibrocartilage loss [2], or more extensive signal increase extending deep within the cortical bone of the flexor cortex [3].

Degenerative changes in the palmar fibrocartilage of the navicular bone occur in the distal half of the palmar aspect of the navicular bone, especially centred on the sagittal ridge, and may extend into the subchondral bone. Loss of fibrocartilage in this location is the most common lesion significantly associated with navicular bone disease and most likely represents the earliest pathology of classic navicular disease [4]. Fibrocartilage loss from this location remains difficult to identify in vivo, even with the use of MRI [2]. Progression of fibrocartilage loss may result in cortical bone erosion in the flexor cortex, and even in osteonecrosis and fibroplasia extending into the spongiosa [5,6]. Degenerative change of the spongiosa is generally only seen dorsal to extensive fibrocartilage damage. There may also be oedema, congestion and fibrosis of the narrow stroma within the spongiosa. Clinical experience with MRI in horses with foot pain caused by classic navicular bone disease provides support for the progression of lesions as outlined above.

However, there are a small number of horses with diffuse abnormalities of the spongiosa characterised by ‘bone oedema’-type signal (increased signal on fat suppressed images) but no detectable abnormalities of the flexor fibrocartilage or cortex. Post mortem examination has revealed evidence of necrosis of medullary fat cells and active remodelling of medullary trabeculae, with both osteoclastic and osteoblastic activity along trabecular surfaces. In other horses with ‘abnormal medullary fluid signal’, intertrabecular oedema and perivascular mononuclear cellular infiltration have been identified [7]. These lesions most likely have a different aetiopathogenesis than that of ‘classic navicular disease’ and may be acutely traumatic or inflammatory in origin.

In some other horses, fluid-filled, osseous cyst-like lesions have been seen in the distal aspect of the bone, apparently separate from synovial invaginations, and not associated with any detectable abnormality of the flexor aspect of the bone. Such lesions have not yet been characterised histologically and their aetiology remains speculative, but recent evidence suggests that their presence is associated with the degenerative changes in the impar ligament [8]. In recent post mortem studies, osseous fragments associated with a defect in the distal margin of the navicular bone were more common in horses with navicular disease than in age-matched controls [5–7]. Histologically, distal border fragments have variously been described as avulsion fractures, separate centres of ossification, osseous metaplasia of the impar ligament or synovial osteoma but pathological evidence elucidating their pathogenesis remains elusive. More recently it has been shown that the presence of these fragments was associated with varying degrees of damage of collagen fibres and fibroblasts in the axillary third of the impar ligament [8].

The increasing number of available pathological studies on the various tissues of the foot has helped validate the significance of MR signal variations documented with various clinical MR systems used in clinical equine practice. However, further work is needed to continue the process of elucidating the different causes of foot lameness and their pathogenesis.

References
How MRI guides my medical approach to treating navicular syndrome

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In the last decade magnetic resonance imaging (MRI) has improved massively our understanding and interpretation of navicular syndrome/palmar foot pain in the horse. Chronically, intermittently lame horses, located in the foot, without significant pathology visible on radiography used to be, before MRI, a big ‘black diagnostic hole’ in equine orthopaedics. MRI has not only differentiated in multiple diagnoses, but has also put the specificity of the different diagnostic anaesthesias, such as the palmar digital nerve block, the abaxial sesamoid block and even the intra-articular and intrabursal block, in question. Grossly, MRI divides ‘navicular syndrome’ into three major groups: hard tissue pathology, soft tissue pathology and a combination of both. In particular, the diagnosis and management of soft tissue pathology, e.g. the deep digital flexor tendon (DDFT), has had a lot of attention in the early days of equine MRI. DDFT lesions were first treated conservatively by 6 months walking exercise. Only 25% of horses were recovered to their previous level of exercise. Then surgical bursoscopy was for a short period of time the treatment of choice. Up to 60% of the horses were recovered for exercise of which 42% were to their previous level. Later and currently the highest long-term recovery rates (75%) are obtained by intrabursal steroidal medication combined with multiple months of controlled walking exercise. So the MRI journey brought us more or less back to how we managed before MRI, with the crucial distinction not only to medicate, but also to provide a time of controlled exercise and adapt the further management of the horse and the shoeing. So MRI, with the crucial distinction not only to medicate and with which product, but more if after medication the horse can resume working exercise sooner or later. In the group of mainly hard tissue pathology, without (yet) significant soft tissue involvement, such as generalised increased STIR signal in the navicular bone medulla, several treatments have been tried (and ‘rejected’). Intra-articular/intra-bursal steroidal medication is still a valuable symptomatic treatment with very high short- to mid-term recovery numbers, compared to the more exotic anecdotally and poorly documented other treatments. Surgical drilling of the navicular bone hasn’t gained many followers. The response to regenerative medication such as stem cells, PRP and ACS (IRAP) is poorly documented on large groups of horses. Nevertheless they might be of value in the long-term management of the sporting career of the horse. The use of bisphosphonates has gained a lot of attention and is widely spread in equine orthopaedics and thus also in the management of navicular syndrome. As long as a firm distinction in the different causes of increased STIR signal (‘bone-oedema’) is not possible on the image, e.g. inflammation vs. cell necrosis, evaluation of the results is difficult, not to say impossible. Hypothetically people can even argue whether routinely administering bisphosphonates is actually not potentially worsening the pathological process, preventing the osteoclasts fulfilling their remodelling healing function. Maybe we need to try to promote (medically) osteoclastic activity, combined with rest, in the idea that we consider the ‘end stage’ of a bad navicular bone to be fully sclerotic on radiography.

Further reading


Calcium dobesilate and clodronic acid: new treatments for navicular disease?

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Magnetic resonance imaging (MRI) has improved the diagnosis of foot pain in horses originating from the area of the navicular bone (NB) because this imaging technique enables the clinician to differentiate soft tissue from bony lesions. Pathological lesions of the NB can be identified in the absence of radiographic changes and with no detectable abnormalities of the flexor fibrocartilage or cortex, but with diffuse abnormalities of the medulla characterised by increased signal in fat suppressed images [1]. These MRI findings could be interpreted as early changes of NB disease and may reflect a variety of pathological processes including fibrosis, necrosis, bone oedema or abnormal trabecular modelling [2].

It has been hypothesised that impaired venous drainage causes venous hypertension in the navicular bone marrow resulting in intraosseous hypertension and bone oedema [3,4]. Alternatively, the accumulation of osmotically active proteins in the subchondral tissue leads to a compartment syndrome within the navicular bone, which is characterised by increased tissue pressure, acidosis, pain and a vicious cycle of progressive pathological changes. The degenerative processes within the compartment are triggered by a switch from aerobic to anaerobic metabolism locally. Surgical procedures have been explored to decompress the medullary cavity of the navicular bone in sound horses [5]. An experimental study revealed that drilling the bone reduced excessive intraosseous hydrostatic pressure due to lowered perfusion resistance and improved local blood circulation. However the direct decompression effects are short-lived due to the rapid healing of the drill channels.

Biphosphonates (BP) have been used for similar bone pathologies in horses. The main pharmacological action of biphosphonates is to inhibit bone resorption; they cause osteoclast apoptosis and disrupt intercellular trafficking of proinflammatory mediators. Biphosphonates are used to treat humans with diseases such as osteoporosis and Paget’s disease [6].

The best known BP in equine medicine is tiludronate (Tildren®). A double-blinded, placebo-controlled study showed some positive effects of tiludronate at the 1.0 mg/kg bwt dose [7]. Major drawbacks of this study are the low number of horses and the incomplete characterisation of the source of lameness. Tiludronate had a significant effect on reduction of bone resorption in horses that were immobilised in a full limb fibreglass cast during 8 weeks suggesting that tiludronate has the ability to prevent osteoclast activity [8]. Tiludronate is injected systemically at 1 mg/kg bwt in horses. In an effort to reduce cost and minimise systemic side effects such as colic, intravenous regional limb perfusion (IVRLP) has been tested using 0.5 mg and 50 mg of tiludronate. Both concentrations did not cause an inflammatory reaction in synovial structures of the digit compared to placebo, but efficacy was not assessed in this study [9].

Recently, disodium clodronate (Oosphos®) has been introduced to the American market for the treatment of navicular disease. Clodronate is administered intramuscularly in a single dose of 1.4 mg/kg bwt (maximum dosage per horse: 900 mg). One multicentre field study included 146 horses with palmar foot pain (AAEP score ≥2) and radiographic signs of navicular disease. The treatment group (n = 86) received clodronate and the control group (n = 28) saline. Treatment success was defined as improvement of the primarily affected limb by at least one AAEP grade on Day 56 after treatment. Ten horses of the treatment group had clinical signs of discomfort or nervousness, or experienced cramping (mild colic) immediately post treatment. All horses recovered shortly after treatment. The success rate in the clodronate group was 74.7% compared with 3.3% in the control group. This study is part of the approval process and is sponsored by Dechra Ltd, Stoke-on-Trent, UK.

Anecdotally, there may be benefit from use of tiludronate [10,11] or clodronate [12] in horses with subchondral bone injury. Biphosphonates may help to normalise metabolism in bone injuries characterised by abnormal absorption and formation, but this has probably no detectable effect on pressure dynamics in bone oedema.

Calcium dobesilate (Calcium 2,5-dihydroxybenzene sulfonate) has been used to treat high protein oedema in humans and there are anecdotal reports of clinical effects using the drug in navicular disease in horses. The suggested mode of action is a macropage-driven removal of osmotically active proteins, which has been described in models of lymphoedema in rats. Calcium dobesilate is a synthetic venoactive drug with a variety of biochemical functions such as inhibition of serotonin, bradykinin, free radicals and histamine induced capillary permeability, inhibition of prostaglandin and thromboxane synthesis, reduction of experimental lymphoedema and intralymphatic pressure, increased lymphatic flow, decreased angiogenesis, and it also reduced albumin leakage.

In a recent experimental study on an osteoarthritics model in rabbit knees, the intermediate pressure dynamics and joint characteristics were investigated. In this model calcium dobesilate had a detectable effect on pressure dynamics in the subchondral bone of osteoarthritic joints [13].

There are anecdotal reports of positive clinical effects of calcium dobesilate on horses affected by navicular disease in the absence of adverse effects of the drug. Benzbypore, a chemically very similar and similarly acting substance to calcium dobesilate (without a pyrone ring) has been used to treat subchondral cyst-like lesions in horses. Twelve of 19 horses with subchondral cyst-like lesions returned to full athletic function after oral administration of benzbypore for 4 months. No side effects were reported [14].

Advances in MRI diagnosis in the foot suggest different aetiopathogenesis for navicular disease, but there is a lack of targeted treatment options for specific pathological processes affecting the navicular bone. Twelve horses with lameness due to increased signal intensity in fat suppressed images in the medulla of the navicular bone were treated with calcium dobesilate and lameness and signal intensity in the navicular bone was monitored 2 and 4 months after diagnosis [1]. All but one horse improved clinically and significant reduction of the signal intensity in the fat suppressed images in the navicular bone occurred. Further research is required to confirm these promising results.

References

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What is the current best algorithm for treatment and outcome of DDFT injuries in the foot?

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The increased use of both high-field and low-field magnetic resonance imaging (MRI) in equine practice over the last decade has allowed equine clinicians to demonstrate that injuries of the deep digital flexor tendon (DDFT) are a common cause of foot lameness in the horse [1].

Four different types of lesion are recognised in the distal portion of the DDFT, namely core lesions, dorsal fraying and fibrillation, partial and complete parasagittal splits and insertional lesions [2–6]. Lesions of the DDFT occur most commonly at the level of the navicular bone and proximal aspect of the navicular bursa, less commonly at the insertion of the DDFT to the distal phalanx and least commonly at the level of the proximal interphalangeal joint and proximal phalanx [7,8]. Core lesions predominate at the level of the proximal interphalangeal joint and proximal phalanx, whereas dorsal splits or fibrillation and parasagittal splits occur more frequently at the level of the navicular bone and proximal recess of the navicular bursa [7]. Lesions may be the primary cause of lameness although they commonly occur in conjunction with degenerative changes or injuries to other structures in the foot.

Whilst the widespread use of MRI in equine practice has increased the ability of equine clinicians to diagnose DDFT lesions, and our understanding of their pathogenesis, treatment regimens lags behind. Generally it has been considered that the most important factor in the treatment of injuries of the DDFT in the foot is the need for prolonged rest. Rest for core lesions and parasagittal splits should consist of stall or small pen confinement for at least 6–12 months with low-grade maintenance exercise consisting of daily in-hand walking for up to 60 min on a slowly ascending regimen. Longer lay off may be required for more severe lesions. However, retrospective studies of horses with primary digital DDFT lesions treated conservatively with rest for at least 6 months have been discouraging with only 25–28% returning to their previous level of athletic function. Between 38 and 62% of horses suffer persistent or recurrent lameness [9,10]. Horses with complete splits or core lesions of the DDFT were significantly less likely to return to some level of athletic activity than horses with dorsal border lesions [10]. There was no difference in outcome between lesions distal to, proximal to or at the level of the navicular bone [9]. Vanel et al. [11] reported that no horses with hyperintense lesions on T1-GRE sequences in the DDFT greater than 30 mm in length or over 10% tendon cross-sectional area returned to their previous activity level.

Regardless of how horses are treated, remedial foot trimming is important in horses with all types of DDFT lesions to correct or maintain good dorsalplanar and lateromedial foot balance, maintain heel mass by ensuring loading of the frog and to shorten the toes to ease breakover. Remedial farriery with appropriate shoes to optimise the position of breakover and provide support in the heel region is advisable in most horses. A foot-pastern cast with a heel wedge or shoes with raised heels can be applied during the first 6 weeks of convalescence to reduce the strain in the healing DDFT [12].

As a consequence of the poor outcome with rest alone, a number of additional or alternative therapies are in use, including injection of corticosteroids into the digital flexor tendon sheath or navicular bursa [13,14], application of extracorporeal shock waves [15], intrabursal or intralesional injection under computed tomography (CT), radiographic or bursoscopic control with acellular urinary bladder matrix, the vascular stromal fraction of fat, bone marrow-derived mesenchymal stem cells, platelet-rich plasma or bone marrow aspirate concentrate [15–20], inferior check ligament desmotomy [21] and bursoscopic debridement of accessible tendon lesions [18–20].

Bell et al. [14] reported the results of using corticosteroid injections into the navicular bursa in horses with lesions of the DDFT diagnosed by MRI. Lameness was abolished for at least 3 months in 14 of 21 horses (66%), while 7 other horses remained lame after medication of the navicular bursa with triamcinolone acetonide and hyaluronic acid. However, the effect of corticosteroids in the presence of tendinopathy is controversial. Lameness invariably recurs [13,22] and accelerated exacerbation of existing tendon lesions may lead to rupture [23,24]. It has been proposed that corticosteroid injection in or around a tendon induces collagen necrosis that can influence the elasticity and strength of the tendon. Thus whilst intra-bursal injection may offer short-term resolution of lameness which might allow a horse to complete a season or to compete in a particular event it is otherwise difficult to recommend. At present the optimal treatment and method of administration for equine DDFT lesions unsuitable for surgical debridement is controversial. However, encouraging results have been reported following bursoscopic debridement of tendon lesions that communicate with the dorsal border of the DDFT within the navicular bursa [20]. The authors suggested that the absence of an intrinsic mechanism for debridement and healing of torn collagen fibres in a synovial environment results in persistent synovial irritation, inflammation and lameness. Debridement of torn, extruded tendon fibres with a synovial resector suppresses synovial inflammation and promotes intrinsic repair mechanisms. Smith and Wright [20] reported 92 horses that had injuries within the bursa and DDFT injuries were identified in 98% of bursae. Of those examined with magnetic resonance imaging (MRI), 56% had combination injuries involving the DDFT and navicular bone. Sixty-one per cent of horses became sound and returned to work and 42% returned to previous performance. Evaluation of case variables on outcome measures however identified that horses with extensive DDFT tears were significantly less likely to be classified as returned to work (54%) compared with those with small tears (92%) and less likely to return to work at previous levels of performance (25%) compared with those with DDFT injuries alone (60%). Bursoscopy does not facilitate lesion management in every case. There is limited room for instrument triangulation and tendon lesions that extend distal to the proximal half of the navicular bone become increasingly inaccessible [18,25].

Lesions unsuitable for surgical debridement can be injected with biological agent [18]. Several different rationally have been proposed for intralesional injection of therapeutic biological compounds in tendon and ligament injuries in horses but there is still limited evidence for their beneficial effects in the DDFT [15,17,18,26]. The indication for intralesional injection at different stages of healing in an injured tendon may vary markedly. Injection into a focus of degenerative matrix meets...
little resistance and results in the injectate being contained within and adequately dispersed throughout the lesion. Injection into a fibrous scar however, may disrupt matrix repair and force apart native tendon fibres thereby causing more damage [27]. Recent information suggests that the distinction between acute and chronic lesions may be facilitated by the use of intravenous MRI or intra-arterial CT contrast [16,28]. Intrallesional injections have been performed with assistance of CT or radiographic imaging [17,26] or bursoscopy/tenoscopy to aid positioning of the needle [18]. Intrallesional injection may also be substituted by intrabursal injection of mesenchymal stem cells. In a limited number of cases, Schramme [27] reported favourable experiences with both intrallesional and intrabursal injection of autologous bone marrow-derived mesenchymal stem cells.

Palmar digital neurectomy (PDN) has been advocated and used for the management of horses with digital DDFT tendinopathy. Gutierrez-Nibeyro et al. [30] reported the results of a retrospective study of 50 horses that underwent PDN for the management of chronic foot pain. Horses with pre-existing core or linear lesions of the deep digital flexor tendon (DDFT) had significantly shorter periods of lameness resolution after surgery than horses with dorsal border lesions of the DDFT or other foot lesions. They concluded that horses with core lesions or parasagittal lesions of the DDFT are poor surgical candidates for PDN as these horses are at risk of progressive damage of the DDFT once they regain athletic activity.

In conclusion, the current best treatment for tendinopathy of the DDFT in the foot with a core lesion or full-thickness split is a 6-12 month programme of rest and controlled exercise with corrective foot trimming and remedial farriery. In horses with damage to the dorsal surface of the DDFT in the navicular bursa, outcome can be improved by bursoscopic debridement of torn tendon fibres. Further evaluation of the use of biological therapeutic compounds is justified based on the proposed degenerative aetiopathogenesis of tendinopathy.

References

Introduction
While the promise of regeneration has centred on the use of embryonic or embryonic-like cells because of their ability to generate every tissue in the body, the development of stem cell therapies in the veterinary field has involved undifferentiated stem or progenitor cells recovered from a variety of mesenchymal tissues, most commonly adult bone marrow and fat. Generally, differences between these products are most marked when comparing products where the preparation protocol differs. Thus there are large differences in the nature of the cells produced between those products that are ‘minimally manipulated’ (e.g. many of the fat-derived cell products; neat bone marrow and ‘BMAC’ [bone marrow aspirate concentrate]) and those with enriched stem cell products where culture is employed. The latter is more homogeneous, at least when defined by stem cell surface markers. A number of experimental and clinical studies have shown effectiveness for these therapies but there have been few studies that compare the clinical effectiveness between different products so it is not possible to state one treatment is ‘better’ than another, although in the light of these variations, it is likely that the defining characteristic of a stem cell, the presence (or absence) of which is critical in conferring therapeutic success to a population, will be essential for therapeutic effectiveness, but this has yet to be determined satisfactorily.

Where should they be used:
a) Tendon and ligament injury
Tendon naturally heals (re pairs) well but the scar tissue formed in this repair is functionally deficient compared to normal tendon, which has important consequences for the animal in terms of altered limb mechanics, reduced performance and a substantial risk of re-injury, in spite of a multitude of treatments that have been proposed. Regenerative medicine offers the prospect of restoring normal structure and function to an injured organ and thereby resulting in a successful restoration of neoplastic transformation. In racehorses, the re-injury rate was also unaltered between these two studies. Outcome figures [4]. The re-injury rates were generally lower with shorter interval between injury and implantation and with greater numbers of cells.

b) Soft tissue injuries
The role of stem cells in the regenerative response to soft tissue injury is less well understood. In the light of these variations, it is likely that the defining characteristic of a stem cell, the presence (or absence) of which is critical in conferring therapeutic success to a population, will be essential for therapeutic effectiveness, but this has yet to be determined satisfactorily.

Where should they be used:
c) Bone
Bone growth and repair are complex processes that involve the interaction of various cell types and growth factors. Stem cells have been shown to play a crucial role in bone regeneration, with osteoprogenitor cells being particularly important. These cells have the ability to differentiate into osteoblasts, which are responsible for bone formation, and chondrocytes, which can differentiate into cartilage. The use of stem cells in bone regeneration has shown promise in various applications, including the treatment of bone defects, fractures, and degenerative bone diseases.

The successful restoration of normal structure and function to an injured organ may require the use of stem cells, which have the potential to differentiate into a variety of cell types and can be used to regenerate various tissues. The role of stem cells in the regenerative response to soft tissue injury is less well understood compared to bone.

Conclusion
The use of stem cells in regenerative medicine is a rapidly advancing field, and their potential applications in various medical conditions are being explored. However, further research is needed to better understand the mechanisms of stem cell action and to develop effective therapeutic strategies. The use of stem cells to regenerate tissues is a promising area of research, and continued investigation is essential to advance our understanding of this field.

References
While the above evidence only relates to the treatment of superficial digital flexor tendon injuries, it is logical to conclude that they may also be effective for the treatment of other tendon and ligament injuries where there is a contained area of disruption, although there is limited clinical evidence in these other injuries. Intra-tendinous tendon marginal tears carry a guarded prognosis within tenoscopic or bursoscopic debridement and so present a potential additional use for MSCs. However, there are currently no reports of effectiveness for the treatment of these injuries although this is currently being trialled at the Royal Veterinary College.

b) Joint disease

When tested in an equine OA model, injection of MSCs resulted in a significant improvement in PGE2 level with bone marrow derived MSCs and a significant increase in TNFalpha level with fat derived MSCs but with no other significant effects on other more clinically relevant parameters [6]. Consequently the conclusion was that they could not be recommended for the treatment of ‘simple’ osteoarthritis. This has, however, not prevented their widespread use with anecdotal reports of success and more recent publications have suggested better clinical benefits [7].

One particular exciting publication assessed the efficacy of intra-articularly administered MSCs in an experimental meniscectomy model in a large animal model (the goat) [8]. This demonstrated both a reduction in severity of subsequent osteoarthritis and a degree of meniscal neogenesis not seen in controls. Consequently there has been much interest in using MSCs for the treatment of problematic meniscal injuries in horses which carry a poor prognosis (e.g. 6% for grade III lesions [9]). Recently a publication has supported this hypothesis with apparent improved effectiveness of MSCs in naturally-occurring meniscal injuries [10]. This author considers their use for the treatment of grade III meniscal tears, identified ultrasonographically or arthroscopically, where a stable stifle is present.

A third use in joints is for incorporation with a bone substitute for the filling of subchondral bone cysts arthroscopically where anecdotal reports suggest they can be effective.

When should they be used?

The sole criterion for the application of a cell therapy to tendon or ligament injury is the presence of a contained lesion. This will tend to fill in with fibrous tissue over time which will make the lesion less injectable. Given that the current belief that much of the benefit of MSC implantation is likely to be by immunomodulation of the repair process, it is logical that early implantation would provide the best outcome. This has been supported by clinical studies which have suggested better outcome with earlier implantation. The need for culture means that the shortest interval would have suggested better outcome with earlier implantation.

Hence caution is advised in their use and it is likely that further regulatory hurdles will exist to govern their use.

Conclusions

These findings suggest that MSCs can have a significant benefit in the treatment of over-strain tendon injuries where there is a contained lesion. There may be additional uses within synovial cavities (e.g. joints, tendon sheaths, and bursae) although conclusive evidence is still lacking. The future use of allogenic cells could increase the popularity of MSCs because of ease of use, reduced costs and optimised timing of treatment.

References


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Investigating the role of inflammation in tendinopathy

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Introduction
Tendinopathy is a frustrating and challenging clinical problem. Whilst exercise, ageing, and genetics are cited as important contributing factors to the development of injury [1–4], an incomplete understanding of the pathogenesis of injury impedes the development of efficacious new therapies.

Inflammation: what is the evidence?
A growing body of evidence suggests that inflammation is a key factor in the pathogenesis of human and equine tendinopathy [5,6]. Studies of pathologial equine superficial digital flexor tendons (SDFTs) have demonstrated inflammation is highly active at the cellular level, after the clinical signs including heat, pain and swelling of the tendon have subsided. Characterisation of cells in pathological equine SDFTs has shown an abundance of macrophages in the regions corresponding to core lesions. Analogous to wound healing processes in the skin, the phenotype of these macrophages in damaged equine SDFTs changes throughout the course of tendon healing. Macrophages in early disease show a pro-inflammatory phenotype where as a transition to an anti-inflammatory/pro-fibrotic phenotype occurs with established disease [5].

A recent study investigating inflammation signatures in human rotator cuff tendinopathy highlights the plasticity of inflammation throughout the different pathological stages (Dakin et al. 2015, unpublished data). In this study, inflammation was characterised using biomarkers representative of the revised classification system for signalling and activation pathways in macrophages [7]. Activation pathways included inflammation (Interferon and NFkB), fibrosis (STAT-6) and resolution pathways (glucocorticoid receptor). A switch in inflammation signature was observed between tendinopathic (earlier disease with intact tendons) and torn tendons with striking similarities to pathology of equine SDFTs [5].

Mechanisms for sustaining chronic inflammation
Inflammation stimulates a series of events broadly termed ‘resolution’ that promote restoration of the damaged tissue to its normal state [8,9]. A repertoire of pro-resolving lipids and proteins are concerned with the timely resolution of inflammation to prevent prolonged or inappropriate tissue damage [8,10]. Chronic inflammation is thought to develop due to dysregulated or inadequate resolution of inflammation [11,12]. Whilst resolution has been well developed in experimental murine models of systemic inflammation, it is not well studied in naturally occurring inflammatory conditions. However, levels of a pro-resolving protein FPR2/ALX were found to be increased in samples of early stage equine tendinopathy compared with normal tendons [5]. This is further supported in samples from pathological human shoulder tendons, whereby increased expression of pro-resolving proteins occurred with tendinopathic compared to normal and torn tendons (Dakin et al. 2015, unpublished data). Collectively, these studies suggest that injured tendons do mount a resolution response to inflammation. However, activation of these pro-resolving pathways is not sustained or may be insufficient, leading to failure of resolution of inflammation, which may drive chronic inflammation and fibrosis.

Conclusions
Preventing the development of chronic inflammation holds the key to promoting improved functional repair of tendon tissue. Until potential new therapies to moderate tendon inflammation become clinically available, it is prudent to treat with a short course of anti-inflammatory drugs in the acute phase after injury.

Acknowledgements
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References
Degenerative joint disease is a common cause of lameness and reduced athletic function in horses. In the past there was an increasing interest in the use of regenerative therapies such as platelet-rich plasma (PRP) and mesenchymal stem cells (MSCs) for the treatment of osteoarthritis. The use of equine allogenic MSCs has been reported for the treatment of osteoarthritis in several joints [1,2]. In agreement with others [3,4], it has been demonstrated to be clinically safe to use allogenic MSCs in equine joints without any indication of an increased immune response in comparison with autologous MSCs. For the present study, cells were isolated from the peripheral blood (PB) and characterised as MSCs, as described by Dominici in 2006 [5]. Since it has been reported that frozen PB-MSCs do not lose their characteristics [6] and to enhance standardisation of the biologicals, MSCs with or without chondrogenic induction and platelet-rich plasma (PRP) were prepared from the same donor horse (tested without chondrogenic induction). Horses in the PRP group (Group 1) initially (6 weeks post injection) received an average score of 3.4, which was higher than for the MSC treated group (Group 2). By combining both PRP and MSCs (Group 3) the initial average score was significantly increased. Subsequently, the average score of the PRP treated group decreased to 2.6 at one year after the treatment, indicating that the effect was short-lived. The initial score of 3.0 in Group 2 was the lowest for all the treatment groups, due to one non-responder. The average score for Group 2 increased to 4.4 at 6 months, and decreased to 4.2 at one year after the treatment. Horses in Group 3 had a higher initial score of 3.6 that increased to an average score of 4.2 at one year post injection, likely attributed to the long-term effects of the MSCs. The clinical score was highest in the group with chondrogenic induced MSCs and PRP and gradually improved over time (Group 4). Indeed, the initial score of Group 4 was 4.4 and increased further to 4.8 from 6 months to one year post injection. Nevertheless, the difference between both combination treatments was not statistically significant. Therefore, both treatment groups were compared in a larger group of 30 horses [1], but no significant difference was found, although 73% of the horses received an evolution score of 4 or more in the group with chondrogenic-induced MSCs and PRP vs. 53% in the group with native MSCs and PRP. The combined treatments were significantly better than PRP alone and scored considerably better than MSCs alone.

In a second study, the use of native MSCs in combination with PRP and the use of chondrogenic-induced MSCs in combination with PRP was evaluated in distal interphalangeal joints (DIPJ), proximal interphalangeal joints (PIPJ), fetlock joints and stifles. In the fetlock group, 89% of the horses in the chondrogenic induced MSCs group returned to work, vs. 86% in the native MSC group. In the DIPJ group this was 83% vs. 82%. For the PIPJ group a higher percentage of horses returned to work after treatment with chondrogenic induced MSC treatment (100%) when compared to native MSC treatment (60%). In the short term (6 weeks) more horses returned to work after treatment with chondrogenic induced MSCs in comparison with horses treated with native MSCs in the fetlock (73% vs. 41%), DIPJ (53% vs. 38%) and PIPJ (61% vs. 36%). Overall, in the short term a higher percentage of horses in the chondrogenic induction group went back to work (73% vs. 41%). In the stifte group 80% of the horses returned to work in the long term (18 weeks), whereas 73% of the horses treated with chondrogenic induced MSCs returned to work in the long term. Taken both allogenic treatments together, 75% of the horses returned to work, which is very similar to a previous study which reported a return to work in 76% of the horses at 24 months after treatment with autologous native MSCs and arthroscopy. This was significantly higher than horses treated with arthroscopy alone (60–63%) [7].

In conclusion, there is some evidence of a clinical improvement in horses with degenerative joint disease after treatment with MSCs. The results are similar after treatment with autologous and allogenic MSCs and no adverse affects were noted.

References
Platelet-rich therapies are being used increasingly in the treatment of musculoskeletal soft tissue injuries such as ligament injuries and tendinopathies. They are appealing in providing a relatively economical source of autologous growth factors and cell rich fractions. They can be used as the sole treatment or as an augmentation procedure such as following surgical repair.

Blood is collected from the patient and the platelet rich plasma (PRP) is produced by centrifugation or a filtration-recovery system to concentrate the platelets, generally greater than two to four times that of blood. Platelets are a natural source of growth factors including platelet derived growth factor (PDGF), transforming growth factor-β (TGF-β) and vascular endothelial growth factor (VEGF). These factors have demonstrated in vitro and in vivo animal models to improve tendon healing [1–6]. When the platelets degranulate these factors are released promoting tissue repair and influencing the reactivity of vascular and other blood cells in angiogenesis and inflammation [7]. As PRP clots on exposure to the basement membrane of cells in damaged tissue a fibrin scaffold forms allowing cell migration into the injury and the described growth factors are retained at the site of injury. The principal disadvantage of PRP is the mixture of growth factors it delivers; many of these are associated with scar formation.

The critical question for all therapies is their efficacy in the clinical arena. This requires randomised control trials which are lacking in the equine arena. A Cochrane systematic review of the use of PRP in musculoskeletal injuries in humans has been performed [8]. These reviews represent the highest standard of clinical evidence. This review included data from 19 single centre trials with 1088 participants. They compared PRP with placebo, autologous whole blood, dry needling or no platelet-rich therapy. Clinical conditions trialled included rotator cuff tears (arthroscopic repair), elbow epicondylitis, anterior cruciate ligament (ACL) reconstruction, patellar tendinopathy and Achilles tendinopathy. No improvement in short- or long-term function was found in PRP treated groups compared with non-PRP treated groups. There was a marginal reduction in short-term pain in some conditions following PRP treatment and no evidence of an increased risk of adverse effects. They concluded that overall there is currently insufficient evidence to support the use of PRP for treating musculoskeletal soft tissue injuries. However the authors did concede that the current evidence base on which to decide whether to use PRP for treating musculoskeletal injuries is weak with only a low number of single centre studies reporting a variety of outcome measures, many of which were not directly relevant to clinical outcomes.

The use of PRP-enhanced scaffolds for cartilage repair in animals has also been assessed and compared to other similar biologically augmented cartilage regeneration techniques in humans [9]. This study concluded that there was a beneficial effect on the articular cartilage repair process in animals and humans based on macroscopic, histological, and biochemical analysis and based on clinical outcome scores, respectively. However, comparison between studies was difficult because of the large variability in PRP preparation and administration.

A further study reviewed PRP in orthopaedic therapy equine and human musculoskeletal lesions [10]. In the 123 studies reviewed beneficial effects of PRP were observed in 46.7% of the clinical studies, while the absence of positive effects was observed in 43.3%. Poor study design was a common feature of equine clinical trials. Despite the majority of equine studies yielding positive results, the human clinical trials’ results failed to corroborate these findings. In both species, beneficial results were more frequently observed in studies with a high risk of bias. They concluded that the use of PRP in musculoskeletal lesions, although safe and promising, has still not shown strong evidence in clinical scenarios.

**Conclusion**

Despite a number of studies suggesting a clinical benefit of the use of PRP most of these are poorly designed and have a high risk of bias. There is increasing evidence that it has little benefit in the treatment of musculoskeletal injuries but due to the wide variability in preparation and administration robust scrutiny of its efficacy remains difficult.

**References**


Diagnosis and Treatment of Colic
Chaired by Chris Proudman
Sponsored by The Horse Trust

08.30–08.50
Diagnosis and management of the colic patient: what can be achieved in the field
Debra Archer
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Introduction
The majority of colic episodes that occur in practice are medical in nature and resolve spontaneously or following medical therapy. However, 7-9% of horses with colic will require surgical management or euthanasia [12] and early identification and referral of these cases at an early stage, prior to deterioration in systemic parameters, has important consequences for post operative survival [3]. Therefore a thorough and systematic approach to evaluation of the colic case in the field is important.

History and Initial examination
Information about signalment and management of the horse, prior history of colic and recent changes in management may provide clues regarding the possible cause of colic [4]. Initial examination should include observation of the horse and appraisal of the horse’s surroundings. Heart rate (HR) should be determined prior to the administration of medications that may alter this (e.g. alpha, agonists, butylscopolamine/hyoscine). Heart rate provides a good measure of the horse’s systemic status and acts as a baseline enabling response to therapy to be monitored. Respiratory rate and effort, rectal temperature, intestinal borborygmi (gut sounds), mucous membrane colour and moistness, pulse quality, temperature of the extremities and digital pulses should also be assessed.

Rectal examination
Rectal examination can provide valuable diagnostic information and assists monitoring response to treatment (e.g. progressive resolution of an impaction). These benefits greatly outweigh the risks of rectal tearing and most horse owners accept that this is an important part of the colic examination. Vet, handler and horse safety must be considered and administration of sedation and/or or spasmolytics may be required if the horse is straining excessively or is fractious.

Nasogastric intubation
Passage of a nasogastric tube is diagnostic (net >2 l significant) and therapeutic (e.g. enteral fluid administration in horses with primary colonic impactions). In the horse with gastric distention this confirms the likely diagnosis, can prevent gastric rupture and reduces the degree of pain associated with gastrointestinal distention.

Other diagnostic tests
Abdominocentesis can be performed easily in the field and gross visual assessment of peritoneal fluid together with assessment of peritoneal total protein (TP) and lactate using a refractometer and portable lactate analyser can provide valuable diagnostic information. This will be discussed further in the next lecture. Abdominal ultrasonography is frequently performed in clinic settings and can be performed in the field if suitable equipment is available. This can be useful in identifying distended small intestine, particularly in the more cranial parts of the abdomen. If a portable lactate meter is available, systemic lactate can be also be measured. Blood samples can be obtained for measurement of other relevant haematological (PCV, WBCC, TP) and biochemical parameters once back at the practice.

Response to analgesia and medical therapy
Non-response to analgesia or recurrence of colic signs remain key indicators of the need for potential surgical intervention. In horses exhibiting mild signs of colic, phenylbutazone or NSAID/spasmolytic medications (e.g. Buscopan compositum®) are frequently indicated. Alpha, agonists/opiates (e.g. butorphanol) may be considered in horses with more severe colic signs. Flunixin meglumine is a potent analgesic and this together with its antiendotoxic properties make it a useful analgesic. However it should be used with caution in horses with mild/moderate signs of pain where the diagnosis is unknown and where referral for surgery is an option. In these situations it is essential that owners appreciate the significance of ongoing signs of colic pain, even if less severe than initially. Medical therapy in the field may be limited by lack of facilities and appropriate patient monitoring (e.g. in horses requiring i.v. fluid therapy). In horses with primary large colon impactions, enteral fluid therapy is effective [5] and boluses of 4–6 l of oral fluids can be provided at frequent (e.g. 4 hourly intervals) until the impaction resolves. More intensive medical treatment/monitoring and surgery will be required where cases fail to respond to initial treatment/show signs of clinical deterioration.

Communication with the owner and ongoing monitoring of the horse
One of the benefits of managing the colic patient in a clinic setting is the ability to perform ongoing monitoring and frequent veterinary reassessment; this can be difficult when treating colic cases in the field. Different owner types, previous experience of colic and opinions about management of colic should be considered when communicating with the horse’s owner/carer [6]. It is essential to give clear instructions about the signs to look for (e.g. looking for feed, recurrence of signs of colic, defaecation) and how the horse should be managed following the colic episode (e.g. when feed can be reintroduced). It may be sensible in some cases to get owners to call back at a set time (e.g. 2 h) following initial examination to decide whether repeat assessment is necessary.
required or not. Where the horse responds to medical therapy it is worth discussing the potential cause of the colic episode to rule out/treat preventable causes that may result in colic recurrence [8] (e.g. high parasite burdens, poor dentition).

References

Diagnosis and management of the colic patient: advanced techniques

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Diagnosis and management of the colic patient, at least on an emergency basis, should focus on the need for surgical intervention vs. the likelihood of a favourable outcome with medical management. Obtaining a definitive diagnosis prior to surgery is not necessary in most cases. With the increasing costs associated with patient care, every attempt should be made to successfully manage the horse medically. That being said, pursuit of surgery in horses with a strangulating lesion should not be delayed. The goal should be to intervene with surgery sufficiently early that the bowel is viable and a resection is not necessary. This involves a team approach by the horse owner/caregiver, field service veterinary staff at the referring hospital, and the attending veterinary surgeon. History and physical examination remains the cornerstone of colic patient evaluation. The most important determining factor as to whether a horse with signs of colic requires emergency surgery is the degree or persistence of pain and the response to initial medical management. The next most important is the owner’s willingness and ability to pursue surgical treatment. In many instances it is readily apparent that the horse has a surgical lesion; however, some horses are less demonstrative of pain and some owners need more definitive information that surgery is necessary. In these cases more advanced techniques, such as abdominocentesis/peritoneal fluid analysis and abdominal ultrasonographic examination are indicated.

Abdominocentesis/peritoneal fluid analysis

Abdominocentesis can be performed aseptically in a location to the right of the ventral midline using an 18 gauge needle or a teat cannula [1]. Peritoneal fluid can be evaluated based on its colour, clarity and volume as well as the nucleated cell count (NCC), total protein (TP) and lactate concentration. Note that TP and lactate concentration can be measured using a point-of-care refractometer or lactate meter [2,3]. Normal peritoneal fluid is yellow, clear, and small volume (<10 ml) is usually obtained. The normal NCC is <10 x 10⁹ cells/L (and in most horses <5 x 10⁹ cells/L) and TP <25 g/L. Serosanguineous peritoneal fluid, particularly if it is a large volume, is strongly associated with the need for surgical treatment.

Peritoneal fluid lactate concentration has recently received a lot of attention in the veterinary literature and can be useful for determining the need for surgery. Normal peritoneal fluid lactate concentration is <1 mmol/l and peritoneal fluid:plasma lactate concentration ratio >1 is suggestive of a strangulating obstruction [3,4]. In one study, horses with a strangulating obstruction had a peritoneal fluid lactate of 8.45 mmol/l and nonstrangulating obstruction of 2.09 mmol/l [4]. However, gross appearance of the peritoneal fluid was also useful for distinguishing a strangulating from a nonstrangulating obstruction. Serial peritoneal fluid lactate concentration was a good predictor for differentiating horses with a strangulating from a nonstrangulating lesion; an increasing peritoneal fluid lactate concentration had a high odds ratio for predicting horses with a strangulating lesion [5]. It is important to recognise that in many of these studies, there are no horses with enteritis, colitis or peritonitis, and the interpretation of peritoneal fluid lactate concentration in horses with these diseases has not been investigated.

Abdominal ultrasonographic examination

Abdominal ultrasonographic examination can be useful when examining the horse with colic [6]. However, as with any ancillary test the value of the results are dependent on the skill of the operator and the experience of the clinician interpreting the findings. Abdominal ultrasonography is best used as a diagnostic tool rather than ultrasonographic findings being part of the minimum data base for horses with colic. Findings should be interpreted in conjunction with other clinical findings. Recently, a procedure called fast localised abdominal sonography of horses (FLASH) has been described and topographical areas evaluated included [7]: ventral abdomen; gastric window (left); spleno-renal window (left); left middle third of the abdomen; duodenal window (right); right middle third of the abdomen; cranial ventral thorax just caudal to the triceps muscle to detect pleural effusion. The normal duodenal, jejunal, caecal and colon wall thicknesses are <3 mm. The normal stomach should be less than 7.5 mm thick. A small volume of anechoic peritoneal fluid is considered normal.

Types of clinical situations in which ultrasonography can be useful include:

• Identifying an area of peritoneal fluid accumulation for abdominocentesis
• Evaluating peritoneal fluid volume and character
• Identifying dilated loops of small intestine
• Identifying intraluminal sand
• Differentiating caecal from right dorsal colon impaction
• Diagnosis of an intussusception
• Evaluating the size of the stomach and wall thickness
• Diagnosing large colon displacements (and volvulus).

Decision making

While these diagnostic tools can be particularly useful, care must be taken with the interpretation of findings and all the information available to the clinician should be considered when making a decision about the need for surgery.

References

Surgical management of colic: what the client and referring vet can expect

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The primary aim of the initial evaluation of the horse affected with acute colic is to attempt to distinguish horses with mild/uncomplicated disease processes from those with potentially life-threatening diseases or those requiring intensive therapy. Referral of the colic case to an equine hospital may be required to permit further evaluation and monitoring, surgery and/or intensive care.

The initial assessment of the horse with acute colic on the farm is fraught with difficulties, even for the most experienced equine clinician. Distracted owners, absence of competent lay assistance, and inadequate facilities for handling and restraint are just a few of the problems that the vet may encounter. An accurate diagnosis of the cause of acute colic may be difficult in such circumstances. However, the primary vet should not be concerned about the inability to reach a specific diagnosis in all cases. Careful assessment and appropriate management of acute colic cases are of much greater importance than reaching a specific diagnosis. Indeed, in many cases of acute colic, a specific diagnosis of the case will never be reached.

The past few decades have seen dramatic improvements in survival rates of horses undergoing surgical treatment for many diseases causing colic. However, despite this, many horses with intestinal ischaemia and other surgical diseases of the abdomen still die in spite of surgical intervention. A delay in making the decision to refer the case can represent one of the most critical factors that impacts upon the chances of survival. Early referral is therefore of vital importance, and the primary vet needs to address the question and discuss with the owner whether or not the horse should be referred as a matter of priority.

The decision to refer a horse with acute colic should be regarded separately to the decision to perform surgery. In some cases, the diagnosis of a surgical lesion may be made at the initial assessment of the patient, and immediate referral must, therefore, take place. However, in many other cases, the decision to perform surgery is only made after re-assessment of the case over time and after evaluating the response to medical treatment. By the time that the decision to perform surgery is reached in such cases, the horse should already be located at the surgical facility so that surgery can be undertaken immediately. It is imperative, therefore, that referral of such cases should have taken place before the final decision to undertake surgery is reached.

Referral of a horse with acute colic should never be regarded as unnecessary, even if the horse recovers without surgery. Early transport of horses in abdominal pain to a surgical facility does not constitute a decision to perform surgery; it serves only to transfer the horse to a location where it can be re-assessed (using further diagnostic procedures that might not be available in the field) and where immediate surgery can be undertaken as and when deemed necessary. The surgeon is the most qualified person to decide whether or not surgery should be performed. The referring vet need not feel embarrassed or inadequate if the surgeon decides that surgery is unnecessary – most owners will be only too pleased to learn that their horse does not require major (and expensive) surgery. The owner of the horse should also be made aware that referral does not necessarily mean that the horse will require surgery; however, the owner should be prepared for this eventuality and must be prepared to cover the associated costs of surgery and aftercare.

Factors which are helpful in determining the need for referral include:
• Signalment
• Geographical location
• Medical history (especially relating to previous episodes of colic)
• Management and deworming history
• Severity of pain and progression of colic since its onset
• Faecal production
• Response to medical therapy
• Results of physical examination
• Haematocrit (PCV) and total plasma protein (TPP) estimations
• Results of nasogastric intubation
• Results of rectal examination
• Appearance of peritoneal fluid.

The decision to refer the horse affected by acute colic is frequently made as a result of a combination of factors rather than one single observation. Some of these factors include:
• Severe unrelenting pain
• Absence of response to analgesics
• Rapid recurrence of pain following administration of analgesics
• Persistently elevated heart rate (especially over 60 beats/min)
• Progressively rising heart rate
• Positive rectal findings
• Large quantities or persistence of gastric reflux
• Persistently reduced or absent borborygmi
• Serosanguinous peritoneal fluid with increased total protein and nucleated cell count
• Exudative peritoneal fluid indicating peritonitis
• Progressive cardiovascular deterioration with rising PCV (>55%), TPP, injected or cyanotic mucous membranes, and prolonged capillary refill time (>2 s)
• Progressive abdominal distension
• Profuse watery diarrhoea
• Recurrent bouts of colic over a period of days or weeks, especially if the frequency of bouts or severity are increasing
• Chronic colic persisting >24 h where no diagnosis has been reached.

The decision of where to refer a colic will, to some extent, be dictated by geography and the availability of surgical centres in that location. However, an equine hospital with a good reputation for colic surgery and intensive care, as well as the presence of adequately trained and qualified personnel is desirable. Regular communication between the referral centre and the referring vet and owner are important considerations. Estimates and regular updates about the on-going costs of treatment should also be expected. Prior to referral, owners should be given advice about likely costs of medical or surgical treatment; this should enable them to consider their options prior to arrival, which will speed up the decision-making process once the horse has been evaluated and treatment options presented. They should also, if possible, be given advice about potential complications and the required aftercare should the horse require surgery.
Horses presenting with colic or clinical signs of abdominal pain, represent a substantial component of the cases presented to veterinary surgeons [1]. Vets and horse owners need to be aware of the risk factors for colic, both to help reduce the incidence of the disease and to recognise which horses are most at risk.

Risk factors can be broadly divided into four main categories: horse factors (including age, breed and sex), environmental factors (including season, weather, and geographical location), management factors (including feeding, housing, watering and exercise regimes), and owner factors (including number of carers and their experience).

Identifying risk factors for colic is not straightforward: the evidence for specific risk factors is often inconsistent between different studies [2,3]. The type of colic is also important – some risk factors are common across different types of colic, whereas others may be specific to particular diseases [4,5]. Finally, different risk factors may interact or influence each other, resulting in complex multivariable interactions.

A systematic review involves a systematic search of databases of publications, review of publications against inclusion and exclusion criteria, evaluation of study design and methodology, and consolidation of study findings (including meta-analysis where appropriate). A systematic review of risk factors for equine colic identified 32 published studies relating to specific diseases causing colic, and 33 studies relating to clinical signs of abdominal pain (across a range of different causes of colic).

The 32 published studies on specific diseases researched 17 different conditions, including epiploic foramen entrapment, descending colon disease, grass sickness, gastric ulceration, ileal impaction, simple colonic obstruction and distension (SCOD) and cyathostomiasis.

The 33 studies relating to clinical signs of abdominal pain (across a range of different causes) consisted of 5 cohort studies, one nested case-control in cohort, 13 case-control, 4 cross-sectional and 10 case series. The best study designs for evaluating risk factors are cohort and case control studies. Assessment using the JBI-Mastari critical appraisal tool identified 11 key studies [2,3,5-13].

Definitions for each risk factor varied between studies (e.g. different age categories), as did study methodologies and therefore meta-analysis was not possible. Horse factors identified as significant included age, breed, sex, use of horse, behaviour/temperament, and previous history of colic/surgery, but the findings and significance varied between different studies. Age was significant in 8/10 studies which evaluated it, and older horses (with variable categorisations) were at increased risk in 5 of these. Previous history of colic or colic surgery were identified as significant risk factors in 5/5 studies which evaluated this. A large range of management factors were identified across the 11 studies, including type of feed, access to water, access to pasture, change in feed, change in housing and anthelmintic administration, again with much variation in the categorisation and assessment of these factors. A recent (<2 weeks) change in diet was significant in 2 studies, and a recent change in housing was significant in 2/4 studies which assessed this risk factor.

The systematic review highlighted the need for:

- Multi-centre international studies – 8/11 studies were based in US, 2/11 in UK, and 1/11 in Europe
- Standardisation and use of similar categories to enable outcomes to be combined and consolidated
- Open access publication of methods, including questionnaires/recording forms, for transparency and repeatability
- Research which spans the wider population of horses – 17 of the 33 studies were based in referral hospitals.

The development of methodologies to pool and analyse ‘big data’ means that this is becoming achievable [1]. As a profession, we need to recognise the value of working together, sharing data and gathering evidence across the different types of equine practice.

References

Colic – What is the Evidence?

Chaired by Celia Marr
Sponsored by the University of Liverpool

10.30-10.50
Post operative analgesia of colic patients

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For the purposes of this presentation, the term colic is used in its most typical manner, i.e. pain originating from gastrointestinal dysfunction or disease. An increasing number of equine practices and hospitals are performing colic surgeries in horses. One of the challenges of colic surgery is dealing with the aftercare of the patient including the horse's analgesic requirements.

Although it is hoped the primary cause of colic has been corrected during surgery, horses are likely to still be in pain during the post operative period due to trauma associated with surgery, endotoxaemia/systemic inflammatory response syndrome (SIRS), as well as complications such as anastomosis remodelling, ileus, adhesion formation and peritonitis. The range of potential causes of post operative pain provides challenges for those dealing with these cases. Whilst equine vets are pretty adept at identifying specific pain behaviours associated with colic, it is worth noting that we may be less able to identify more subtle and nonspecific pain behaviours which are exhibited by horses after abdominal surgery [1]. A discussion on post operative pain assessment and pain scoring in horses is outside the scope of this presentation but see [2,3] for further reading.

With respect to the range of potential causes of post operative pain in colic horses and the different underlying mechanisms of nociception, transduction and transmission and modulation of pain; it is worth noting that much of the experimental evidence for the efficacy of different analgesics for visceral pain in horses relies on distension models (e.g. [4]), which may not be good models for some causes of post operative pain in colic patients.

There are a limited number of drugs available to treat pain in horses and the list is reduced further if various restrictions such as licensing are taken into account. At present, the most commonly used analgesic agents for post operative colic patients include nonsteroidal anti-inflammatory drugs (NSAIDs), opioids, α₂ agonists, lidocaine and ketamine.

Nonsteroidal anti-inflammatory drugs are the most widely used analgesic/anti-hyperalgesic drugs in horses; their effectiveness is due to their anti-inflammatory effects as many causes of pain are linked to inflammatory processes. NSAIDs are also reported to have a range of adverse effects in horses such as gastrointestinal ulceration, inhibition of gut mucosal healing in vitro models and renal tubular necrosis [5]. There seem to be some differences between some NSAIDs regarding the profile of their side effects but flunixin meglumine remains the most commonly used NSAID for visceral pain in horses. Flunixin is not only efficacious in relieving visceral pain, such that many horses with abdominal pain will recover completely with one dose (1.1 mg/kg bwt), but is also effective at ameliorating the pain and cardiovascular dysfunction associated with endotoxaemia/SIRS, which may be important during the post operative period.

Opioids have not been used as widely in horses compared to other species due to fears about adverse effects on gut motility and excitement. However, these side effects may be agent or dose specific or have no more clinical relevance than side effects from other widely used drugs (e.g. α₂ agonists) [6]. Thankfully, opioid use is now becoming accepted as part of the peri-anaesthetic analgesic regimen in many hospitals. Butorphanol is licensed for use in horses and provides moderate visceral analgesia in some models [7]; adverse side effects such as excitement, often seen after single intravenous bolus are less apparent when butorphanol is administered as a continuous infusion [8], although this approach is expensive in terms of drug cost, other case cost savings were identified [8]. Morphine has been shown to provide visceral analgesia in a caecal distension model [9] and has been shown to improve recoveries from anaesthesia in surgical cases [10]. Morphine has seemed to suffer the most ‘infamy’ regarding inhibitory effects on gut motility leading to colic, yet a multi-centre prospective study into post anaesthetic colic failed to show any link between morphine use and post anaesthetic colic [11]. Morphin remains the main opioid analgesic used in all post operative patients in our hospital.

The analgesic effects of α₂ agonists are well documented in horses [12]. However, they also have potent cardiovascular and gastrointestinal motility side effects and as such they should be used judiciously in post operative colic patients. It may be that the use of intravenous infusions of α₂ agonists may provide analgesia whilst ameliorating some of the side effects but this approach has not been evaluated in conscious horses with abdominal pain. We currently utilise intramuscular bolus of romifidine to provide α₂ agonist analgesia in some of our post operative colics.

Lidocaine, administered as an intravenous infusion is widely used in horses for its analgesic and anti-inflammatory properties [13]. Administration of lidocaine in post operative colic patients has been shown to have beneficial effects on small intestinal size [14] and survival [15]. It should be noted that prolonged administration of lidocaine infusions may result in accumulation of the drug [16] and risk adverse side effects, especially as concurrent administration of some drugs (e.g. flunixin) reduce plasma protein binding of lidocaine.

Ketamine is the most commonly used intravenous anaesthetic agent in horses and is well known to have analgesic effects at anaesthetic doses. Whilst ketamine has been shown to have somatic analgesic effects at sub-anaesthetic doses in anaesthetised [17] and conscious horses [18], there are currently no studies showing any visceral analgesic effects at these doses.

Clinical experience tells us that in horses with moderate or severe post operative pain, a single analgesic agent is rarely sufficient to provide pain relief and a multi-modal approach is often necessary. Unfortunately there are very few studies into the efficacy and safety of multi-modal approaches in post operative colic patients and clinicians should be vigilant for potential side effects (e.g. gut motility and excitement).
Lastly, nonpharmacological approaches may of course be beneficial in some cases. Obvious examples include specific procedures such as nasogastric reflux for ileus or hot-packing for thrombophlebitis, but it is also likely that other activities such as grooming may improve the demeanour of the horse.

References
Perioperative antimicrobials

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Perioperative antimicrobial drugs (AMD) have had an insurmountable positive impact on human and veterinary surgery. Antimicrobial drugs have relatively few side effects, are cost-effective, and are, in general, effective at preventing infection. So why shouldn’t we administer AMDs just in case our surgical patients may need them and until we think that it is ‘safe’ to stop them? There are several reasons. The first and most simple reason is fiscal responsibility – unnecessary use of any medication in the perioperative period increases the cost of surgery making it unaffordable for some horse owners. Complications, while uncommon, can occur including antimicrobial-associated colitis, which can be rapidly fatal. Supportive care for horses with antimicrobial-associated colitis can amount to several thousands of dollars. That being said, the more pressing evidence of the emergence and impact of resistance in equine patients. Hospitalisation and AMD administration were shown to increase resistance to antimicrobial agents and multidrug resistance of Escherichia coli in equine faeces as well as Staphylococcus aureus on the skin of horses [2–5]. Today more than ever responsible AMD use is necessary (see BEVA PROTECT ME toolkit). Inappropriate AMD use has been shown in human hospitals to contribute to patient morbidity and cost of treatment [6].

What is appropriate perioperative AMD use and what is the evidence?

Antimicrobial drugs should never replace atraumatic and aseptic surgical technique. Halsted’s principles of surgery should always be adhered to. Because the majority of colic surgeries are considered clean-contaminated, prophylactic AMD use is indicated. What, therefore, is considered appropriate prophylactic AMD use?

The major areas where AMD use is generally deemed inappropriate include timing of administration, excessive duration of prophylaxis, and inappropriate selection of AMD. Antimicrobial drugs should be administered such that their serum and tissue drug levels exceed the minimum inhibitory concentration (MIC) for the organisms likely to be encountered for the duration of surgery. Peak concentrations should be achieved during surgery. In order to achieve these goals, AMDs should be administered within 60 min of beginning surgery and if the duration of surgery is longer than twice the half-life of the AMDs re-dosing is necessary. Administration of AMD at the completion of surgery is ineffective. Antimicrobial drug prophylaxis beyond skin closure (or >24 h post-operatively) is unnecessary. First-line AMDs at an appropriate dose rate should be used for prophylaxis.

One of the biggest controversies among surgeons is the duration of AMD prophylaxis. Prolonged AMD use is typically the most common reason for noncompliance to prophylactic AMD use guidelines in human hospitals [6]. There are several studies from human hospitals that have shown no benefit to administering AMDs beyond the initial perioperative period including abdominal surgery [6–9]. Similarly, studies from our hospital have also shown no increase in infection post laparotomy in horses receiving AMD during the immediate postoperative period compared to prolonged use [10]. Antimicrobial drug use beyond the initial perioperative period (>24 h) is considered therapeutic and in most cases should be based on diagnosis of infection, bacterial culture and sensitivity, and whether the infection is likely to resolve without AMD therapy.

Are post operative pyrexia and high concentrations of acute phase proteins useful for early diagnosis of infection?

It is important to recognise that pyrexia is not necessarily associated with post operative infection and mild pyrexia in the early post operative period is not an indication for continuing AMD administration. Infection, however, was associated with horses developing a fever >39.2°C, with the time to peak fever >48 h post operatively, and the fever duration longer than 48 h [10]. Similarly, serum amyloid A (SAA) and fibrinogen increase post operatively in most horses and their usefulness for determining the need for therapeutic AMD use is unsubstantiated.

References


NOTES
Management of the incision site

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Although closing the surgical incision is only a small part of performing an exploratory laparotomy for the investigation of colic, successful healing of the incision is important for horses to return to athletic function. It has been shown that those horses that develop surgical site infections (SSIs) have an increased morbidity and duration of hospitalisation [1], and are more likely to develop incisional hernias [1]. Incisonal healing is also frequently used as a gauge by owners of the success of the overall surgical procedure, as it is the only part visible to them.

The prevalence of developing an SSI varies greatly between studies, ranging from 4% [1] to 27% [2] for a single laparotomy, although the wide variation can be partly attributed to the difference in classification of SSI within the studies. Repeat laparotomies have a higher reported rate of development of SSI.

Early studies identified specific surgical procedures that would increase the likelihood of developing an SSI, including: manipulation of the large intestine [3], enterotomy and resection [4], and taking horses back to repeat laparotomy [15].

Later studies have looked at both intraoperative and post operative factors that may affect the incidence of a horse developing an SSI, including: location of incision [6], suture pattern [7,8], suture type [9,10], antimicrobial regimen used [11], and the use of abdominal bandages [12]. The use of intraoperative culture results as a predictor of the development of SSIs has also been investigated [13].

Overall, the factors identified as increasing the likelihood of developing an SSI included: a large intestinal lesion [3]; intestinal resection [4]; use of polydioxanone 910 in closure of the linea alba [10]; application of a stent for recovery [11]; and the use of an abdominal bandage [12].

Although many pre-, intra- and post operative factors have been identified that may contribute to the occurrence of post operative incisional complications, the majority of studies are retrospective case series with low case numbers, and some report conflicting findings. The number of prospective, randomised clinical trials performed investigating the influence of specific factors has increased, although inconclusive results and low case numbers remains a problem. No one study has so far been able to generate sufficient numbers to identify what one, if any, factor is the most important in preventing a horse developing an SSI. In order for this to be achieved, multi-centre studies, where comparable techniques and protocols are used, is required to identify what is important.

References

Management of post operative ileus (POI)

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Introduction

Post operative ileus (POI) constitutes a significant post operative complication in horses with a reported prevalence in the range of 10–50% of colic cases and a reported mortality rate between 13 and 86%, the range of which may partly reflect the variation in diagnostic criteria (e.g. amount of reflux) used to define the condition. Potential risk factors for the development of POI include: elevated preoperative heart rate and packed cell volume, increasing age, amount of preoperative reflux, increased duration of anesthesia, and small intestinal surgery particularly involving resection.

The classical view of POI was that it involved an early phase that consisted of inhibition of motor activity mediated through neural reflexes. It is now clear that there is also a clinically-relevant prolonged inflammatory phase to POI.

Much has been learned in avoiding POI in humans, including avoidance of starch in gloves, optimised post operative fluid and electrolyte therapy, early feeding, selective use of nasogastric decompression, modification of pain management strategies, as well as attempts at chemical means to reduce adhesion formation. Strategies used in combination as part of fast-track multimodal treatment plans for human patients may lead to a decrease in the time to return to normal intestinal function and shortened hospital stay.

Treatment and management of equine POI

The mainstays of treatment and management include: nasogastric decompression, replacement and maintenance of fluids and electrolytes, control of the effects of endotoxaemia, control of infection, effective pain management, attempts to reduce inflammation and prokinetic therapy. It is important to consider attempts to try to reduce the incidence or severity of POI by instituting some therapies intraoperatively and early in the post operative period.

Electrolyte supplementation of intravenous fluids

Many clinicians in their fluid therapy protocols may supplement calcium and potassium. Calcium supplementation (optimally by measuring ionised calcium levels) may be helpful in improving outcome in colic cases; however some urge caution on the supplementation of calcium in horses with endotoxaemia due to the evidence from laboratory mammals of calcium administration causing an increase in mortality in cases of endotoxic shock.

Anti-inflammatory drugs

With the increasing evidence for the important role of inflammation in POI, it is no surprise that anti-inflammatory treatment is of benefit. There is significant variability in the choice and dose of NSAIDs used depending on availability and spectrum of action. Although flunixin meglumine appears to be the most commonly chosen NSAID in the management of equine POI patients [1], there are little objective data in the scientific literature to support its preferential choice.

Feeding and nursing

Early feeding is highlighted as a priority in human POI cases and there is an increasing move towards feeding equine patients earlier. If feeding is not feasible, even measures such as tying a hay net outside the stall appear to have some merit. Also, early hand-walking post operatively is advocated by many clinicians.

Prokinetic drugs

There is considerable use of prokinetic therapy in the management of equine POI; however, there is not a ‘one size fits all’ option and accordingly the supportive therapy described above remains a mainstay of treatment. Surveys of clinicians show that the most commonly chosen drug is lidocaine [1,2]. Other commonly used drugs include metoclopramide, erythromycin and bethanechol. Some of the literature and clinical perceptions of lidocaine are conflicting. Malone et al. [3] showed that intravenous infusion of lidocaine improved the clinical course in 32 reflux cases and horses suffering from obstructive ileus have beneficial prokinetic actions. Torfs et al. [4] showed that prophylactic use of lidocaine (immediately post operatively) reduced the incidence of POI and that lidocaine treatment improved survival. Classically lidocaine has been considered a prokinetic agent but there is increasing evidence that it may be having its beneficial effects via alternative mechanisms, such as anti-inflammatory and effects on smooth muscle membranes.

Repeat surgery

An area of debate in the management of POI relates to the decision of whether and when to perform a repeat laparotomy. The decision to perform an early repeat laparotomy in cases continuing to reflux carries the advantages of both permitting decompression of the small intestine, which may have therapeutic benefits, and checking for the presence of and potentially resolving a mechanical obstruction. In contrast, there is evidence in that the survival rate for horses requiring relaparotomy is reduced and the complication rate high.

Conclusion and future directions

Despite the ongoing debate with regard to both the clinical definition of equine POI and the optimal management of this condition, there is increasing acceptance that inflammation plays a key role in its pathophysiology. The various treatment options available are largely aimed at addressing the clinical consequences of POI or attempting to pharmacologically manipulate the motility of a dysfunctional bowel. Targeting the inflammatory response continues to be a major focus of research aimed at the development of such novel pharmacological approaches.

References


Further reading


Nutrition of the surgical colic patient

Alex Dugdale

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Despite our attempts to improve patient survival through focusing on cardiovascular support, analgesia, ileus-prevention/treatment etc., very little research has focused on post operative nutritional management of horses that present with acute abdominal crises warranting emergency surgical intervention. Current ‘recommendations’ are mostly based on personal (although usually ‘expert’), experience and opinion.

What’s the problem?

Healthy horses can tolerate 2–3 days of food deprivation and enter a state of simple starvation or protein-energy malnutrition. During simple starvation, glycogen stores are utilised first and then gluconeogenesis gets underway; but neuro-endocrine mechanisms spare protein catabolism at the expense of lipolysis, such that fat becomes the main source of gluconeogenic precursors and energy. Insulin hypersensitivity develops as blood glucose concentration falls. Keto-adaptation occurs in humans but the production of ketones is limited in horses. Overall, with simple starvation, the basal metabolic rate is reduced to eke out the body energy stores for as long as possible.

In contrast, stressed starvation (whereby systemic disease/illness/surgery etc. exacerbate the effects of reduced intake, through the effects of cytokines and neuro-endocrine mechanisms), results in a maladaptive response, including a hypermetabolic/hypercatabolic state, peripheral tissue insulin resistance and an inability to limit protein catabolism. Although glycogenolysis also occurs initially, gluconeogenesis remains fuelled mainly by protein catabolism because the use of fat is limited by insulin resistance. A rapid loss of protein from muscle (skeletal, cardiac and smooth), and visceral tissues ensues, promoting physical weakness, poor tissue repair/healing and increased morbidity (e.g. infections). Sodium and water retention, possibly secondary to decreased activity of cell membrane sodium pumps, accompany stressed starvation and may mask early weight loss.

Energy, protein, vitamin and mineral requirements for horses post abdominal surgery are unknown; and will differ between individuals depending upon the extent of the pathology/endotoxaemia, invasiveness of the surgery, (i.e. the degree of the stress response and inflammatory response) and any pre-existing malnutrition. In humans, morbidity and mortality are linked to nutritional status and pre-existing malnutrition is common in patients undergoing abdominal surgery for cancer.

Stable confinement post-op reduces energy requirements for locomotion and, if nil-per-os, these animals will also have lower energy requirements than horses prehending, masticating, swallowing, digesting, fermenting, absorbing and assimilating food. Sedentary, stable-confined horses are said to have energy requirements of c. 130–150 kJ DE/kg BM/day (c. 30–35 kcal DE/kg BM/day); and, if not eating, their energy requirements will be lower, at c. 100 kJ DE/kg BM/day (c. 24 kcal DE/kg BM/day). This may, however, be somewhat offset by increased energy demands imposed by the stress of the disease process itself and surgery/anaesthesia.

Protein requirements are suggested to be of the order of 1–2g crude protein/kg BM/day. Adequate energy is required for protein assimilation/synthesis. If energy is lacking, protein deamination and oxidation take precedence, which may increase blood urea. There should be -625–1250 kJ non-protein energy/g nitrogen (150–300 kcal/g nitrogen), but this ratio also depends upon the nutritional status of the patient, i.e. the more catabolic the patient, the more energy-dependent is the protein-sparing effect.

Nutritional support FAQs

When?

No equine evidence on timing: but most authors agree that intervention – with enteral and/or parenteral nutritional support - is warranted if horses are not able to ingest at least 50% of their daily requirements for 48–72 h; and possibly sooner for malnourished horses (that is, those with pre-existing protein-energy malnutrition). Early (day of surgery) parenteral nutrition provision (75 kJ/kg/day; 0.5 g/kg protein/day), improves clinical benefits in one equine study. Early enteral nutrition, within 24–48 h of surgery, may help to blunt the effects of stressed starvation and may reduce morbidity and mortality in people, but many people requiring GI surgery are already in a malnourished state pre-op, which itself increases morbidity and mortality. The situation may be different for horses. Anastomotic strength and diameter are improved with early enteral nutrition, but impaction at anastomotic sites remains a valid concern in horses whose diets are fibre-based.

How much?

Little equine evidence: but provision is generally started at 25–50% of estimated requirements and, if tolerated, is increased over ‘a few days’ to meet 80–100% of estimated requirements. Failure to deliver at least 25% of daily requirements in critically ill humans has been associated with significantly worse morbidity (infections) and mortality. Monitoring effectiveness is important, but how? Body mass varies with hydration status, fluid retention and gut fill. BCS/muscle scoring? Blood biomarkers (e.g. albumin, pre-albumin, acute phase proteins, minerals, vitamins and redox markers, NEFA, TAGs, bilirubin, urea, creatinine) generally unreliable, although some trends may be useful.

Route?

Mixed evidence, much human: enteral probably best (maintains structural and functional integrity of gut), and usually cheaper but may not always be possible. Although ‘trophic enteral feeding’ (provision of 20% of estimated daily requirements) can result in very similar outcomes to ‘full feeding’ (provision of 80% of estimated daily requirements) in critically ill people, partial parenteral nutrition is increasingly being used to supplement enteral feeding, at an earlier stage of hospitalisation, to improve outcomes. Total parenteral nutrition may, however, be required in some cases and requires careful monitoring for hyperglycaemia, hyperlipidaemia, liver function, etc.

With what?

Limited equine evidence for both enteral and parenteral. Parenteral nutrition is based around glucose, amino acids and lipid solutions ± vitamins and minerals. Lipid-containing...
parenteral nutrition is contraindicated in hyperlipaemic animals. Enteral nutrition fibre-based; what place prebiotics and probiotics?

Where next?
Nutritional supplementation will not completely reverse the increased catabolism seen with stressed starvation but should ameliorate it. Recent focus has been on attenuating the metabolic response to stress, preventing oxidative cellular injury and favourably modulating the immune response (‘immuno-nutrition’) ...to reduce disease severity, complications and length of hospital stay and improve outcomes. To this end, much interest has focused on inclusion of pharmaco-nutrients such as arginine, glutamine, cysteine, taurine, increasing the ratio of branched chain to aromatic amino acids, increasing the provision of short and medium chain fatty acids instead of long chain, providing especially omega-3 fatty acids, ribonucleotides, anti-oxidants (including vitamins and trace minerals), and targeting mitochondria with e.g. co-enzyme Q10.

NOTES
When to undertake relaparotomy

Debra Archer

Why undertake relaparotomy?

Relaparotomy (RL) is undertaken in 8.2–10.6% of horses that have undergone laparotomy for treatment of acute gastrointestinal disease [1–3]. It is more frequently required in horses that initially presented with strangulating small intestinal lesions (63%) and strangulating large intestinal lesions (20%) compared to other lesions [4]. Risk factors for RL include epiploic foramen entrapment (OR 4.23, 95% CI 1.43–12.39, P = 0.016) and post operative ileus (POI) (OR 3.88, 95% CI 1.51–9.97, P = 0.008) [5].

When and how should it be performed?

Indications for RL include: persistent or recurrent post operative pain, POI or persistent reflux >48–72 h, mechanical obstruction at an anastomosis, progressive deterioration of intestinal viability/peritonitis, correction of surgical errors, incisional complications including colic associated with incisional breakdown and abdominal haemorrhage [2,4]. Findings at RL may be related to the original surgery (e.g. adhesion formation) in 43–51% of cases, progression of patient disease (e.g. continued ischaemic necrosis, POI) in 16–36%, recurrence of the original lesion (e.g. LC displacement) in 15–19% and unrelated lesions (different lesion identified) in 6–13% of horses [1,3]. Lesions most frequently involved small intestine (63%), or caecum 22% in one study [2] and resulted in intestinal resection in 21% of cases in another study [4]. Intraoperative euthanasia was performed in 21–22% of horses in 3 studies [1,2,4].

As in human medicine, it is difficult to make specific guidelines about optimal timing of RL, where required. In humans with abdominal sepsis (which includes ischaemia and necrosis of intestine) the outcome is generally considered to be more favourable when re-intervention is performed at an early stage, although currently there remains no data to support this [6]. In horses in which RL was performed during initial hospitalisation, median duration between first surgery and RL was 2.5–3 days [2,4]. Relaparotomy should be considered in horses with progressive deterioration in clinical parameters prior to development of marked systemic compromise. Careful patient monitoring and use of diagnostic imaging such as ultrasonography is important in high risk horses and the clinical threshold for undertaking RL may be reduced in these cases.

In two studies, RL was performed through the original ventral midline laparotomy incision in 99% [4] and 89% [2] of cases. This surgical approach is supported by a recent study [7] which demonstrated that there are no differences in healing, inflammation, infection, tissue necrosis and tensile strength between horses undergoing repeat ventral midline laparotomy compared to a right ventral paramedian laparotomy. The latter surgical approach was also found to have histologically less mature incisional apposition.

Outcome following laparotomy

Complications that may result in death or euthanasia following RL include recurrent ileus/colic, equine grass sickness (in the UK), systemic inflammatory response syndrome (SIRS), peritonitis and colitis [2,4]. Incisional complications are common; incisional infection occurred in 68% of horses in one study and 12/35 horses (32%) developed incisional hernias/dehiscence. Mair and Smith [2] reported incisional drainage in 43%, incisional infection in 14% and jugular vein thrombophlebitis in 19% of RL cases. This is consistent with a previous study [8] in which incisional hernias were 12 times more likely to develop in horses following >1 laparotomy.

It is difficult to make direct comparisons about survival between some studies due to different criteria regarding when RL was performed relative to the initial laparotomy. Whether euthanasia was performed during RL should also be taken into account when assessing mortality rates as if this was undertaken partly on economic factors, this introduces various biases. Taking horses that survived following anaesthesia for RL, short-term survival (survival to hospital discharge) is around 51–65% [1,2,4] and of horses discharged from the hospital in one of these studies [4], 71% were alive >3 months and 58% alive >6 months following RL.

References


NOTES
Complications of intestinal anastomoses
Tim Greet
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Small intestinal anastomoses are now routinely performed in equine patients with a relatively high success rate. Nevertheless the surgical and post operative medical management of strangulating small intestinal disease still represents one of the more challenging situations in equine surgical practice.

This presentation will deal with complications associated with small intestinal resection and anastomosis and detail the author’s approach to minimising these problems. In particular, assessment of intestinal viability, the critical role of decompression and a practical and effective technique for sutured end-to-end anastomosis and stapled side-to-side anastomosis will be described. Post surgical management of complications will be briefly described.

The take home messages from the presentation are:
1) Always decompress the intestine before assessing viability.
2) Patience is important in allowing ‘unstrangulated’ intestine to recover and before making a decision as to whether resection is necessary.
3) Clinical judgement is still the most effective way to determine intestinal viability.
4) Continuous suturing is a rapid and effective method for anastomosis.
5) Care must be taken in handling the mesentery especially of foals.
6) Adopt a logical approach to haemostasis of mesenteric vessels.
7) Appropriate post operative medication and support is helpful in avoiding ileus.
Large abdominal incisional hernias are usually repaired by implanting synthetic mesh. Although the right and left margins of most abdominal incisional hernias can be apposed with sutures, thus avoiding implantation of a mesh, small gaps can usually be found in the abdominal wall after the repair has healed (authors’ experience). Techniques for implantation include placing the mesh retroperitoneally to avoid contact between the viscera and the mesh. Placing the mesh retroperitoneally, however, is often difficult, and creating defects in the hernia sac exposes the mesh to viscera. We have found that placing the mesh subcutaneously, after the margins of the hernial ring have been apposed, is associated with fewer complications and is easier to perform compared with techniques in which the mesh is placed retroperitoneally.

The horse is fasted for 24 h and is administered antimicrobial therapy and a nonsteroidal anti-inflammatory drug before being anaesthetised. The horse is positioned in dorsal recumbency, and the ventral aspect of the abdomen is prepared for aseptic surgery. The hernial ring is identified, and a straight cutaneous incision is created on the midline that extends 6–8 cm beyond the cranial and caudal limits of the hernial ring. The incision is extended through subcutaneous tissue, the hernial sac is isolated from surrounding tissue, and the abdominal tunic is exposed for about 6 cm circumferentially around the hernial ring by using sharp and blunt dissection. The hernial sac is inverted into the abdomen, and the right and left margins of the hernial ring are apposed with preplaced, inverted cruciate sutures of doubled 5-metric, absorbable, synthetic, monofilament suture using a hernia or kidney needle.

A synthetic mesh (i.e. nylon, polypropylene, or polyester), the length of which corresponds to or slightly exceeds the length of the hernia, is folded in half and placed over the sutured ring. One edge of the folded mesh is sutured to the abdominal tunic with simple-interrupted sutures of 3.5-metric, absorbable, synthetic, monofilament suture. The other side of the folded mesh is sutured to the underlying abdominal tunic using the same suture material preplaced in a Mayo pattern to produce tension on the mesh and reduce tension on the sutured hernial ring when the sutures are tightened. Excess mesh is removed, and second and third rows of simple-interrupted sutures are placed through the mesh and underlying tunic medial to the first rows of sutures on each side of the sutured hernial ring. Excess skin is excised, and subcutaneous tissue is closed in two layers using 3.0-metric, absorbable, synthetic, monofilament suture placed in a simple-continuous pattern, and the cutaneous incision is closed with staples or sutures. A bandage is applied to the abdomen after the horse recovers from anaesthesia. Skin staples or sutures are removed about 14 days after surgery. The horse is confined to a stall for about 45 days, during which time it can be walked freely.

We have used this technique of repairing incisional hernias on more than 70 horses with few complications. One horse was subjected to euthanasia because it fractured a radius during recovery from anaesthesia. Two developed infection at the surgical site, requiring removal of the mesh, one after experiencing a confirmed allergic reaction to a nylon mesh. A weaning temporarily developed clinical signs of peritoneal inflammation after intestine was inadvertently penetrated with a needle during surgery, as evidenced by a particle of feed attached to a suture inserted to close the hernial ring. Sutures used to close the abdominal wall of this horse were placed using a swaged-on, taper point needle, rather than a hernia or kidney needle. We have not encountered other reported complications of hernia repair, such as recurrence, visceral adhesions, and tearing of the internal abdominal oblique muscle [1,2].

Incisional herniation is a complication experienced by 6–17% of horses undergoing emergency celiotomy [3,4] and is usually associated with infection at the surgical site [5]. The incidence of post operative complications associated with retroperitoneal placement of mesh, such as tearing of the internal abdominal oblique muscle and incisional drainage, is relatively high [2]. Closing the hernial ring prior to implanting a mesh strengthens the repair, and based on our experience and that of others [6], placing the mesh subcutaneously, rather than retroperitoneally, makes mesh repair less difficult. Suture material used to secure the mesh should be absorbable so that if infection or an allergic reaction at the surgical site does occur, the mesh can be more easily removed. Using a hernia or kidney needle to close the hernia ring decreases the likelihood of penetrating a viscus with a needle.

### References

14.10–14.30

Comparative focus: management of the acute abdomen in humans

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No abstract submitted
Less commonly-performed abdominal surgeries

Jim Schumacher

Department of Large Animal Clinical Sciences, University of Tennessee, Knoxville, Tennessee 37996, USA

Flank approach to the abdominal cavity with the horse standing

The flank approach to the abdominal cavity can be used when general anaesthesia is impractical because of financial constraints imposed by the owner or because facilities in which to perform surgery with the horse anaesthetised are not available. For the flank approach, a 15- to 20-cm incision is made through the skin and subcutis in the centre of the paralumbar fossa, parallel to the last rib, and centred over the internal abdominal oblique muscle with the horse sedated after desensitising the proposed site of incision with local anaesthetic solution. The external abdominal oblique muscle is split in the direction of the cutaneous incision, and the internal abdominal oblique and transversus abdominis muscles are split in the direction of their fibres to expose the retroperitoneal fat and peritoneum, which are torn with a finger to expose the abdominal cavity. Procedures that can be performed through a flank approach to the abdominal cavity, with the horse standing include ovariectomy, cryptorchidectomy, and laparoscopic-assisted surgeries, such as nephrectomy and obliteration of the nephrosplenic space. The internal and external abdominal oblique muscles, subcutis and skin are each closed separately with interrupted or continuous sutures. Closing the peritoneum and transversus abdominis muscle is difficult and not necessary.

Closing the superficial inguinal ring

The superficial inguinal ring must be closed when the vaginal ring is so large that it allows escape of intestine, either because it has been stretched to extract an abdominal testis during an inguinal approach or because it is congenitally enlarged. The vaginal ring can be closed laparoscopically to prevent evisceration, but if laparoscopic closure of the vaginal ring is impractical, the superficial inguinal ring must be closed. If, after removing a testis through the vaginal ring, no more than the tips of two fingers can be inserted through the dilated ring, no measures need be taken to prevent evisceration, but if the ring has been dilated beyond this diameter, the superficial inguinal ring should be sutured. The ring is most easily sutured by using heavy, doubled or continuous sutures. Closing the peritoneum and subcutis and skin are each closed separately with interrupted or continuous sutures. Closing the peritoneum and transversus abdominis muscle is difficult and not necessary.

Ovariectomy through a colpotomy

Ovariectomy through a colpotomy is usually reserved for bilateral removal of non-tumourous ovaries. This approach is relatively inexpensive because it is performed with the mare standing, and can be performed quickly because the incision is left unsutured. The mare can be allowed unrestricted exercise sooner using this approach than with ovariectomy performed using other approaches. A major disadvantage of ovariectomy by colpotomy is that the mesovarian is crushed and transected blindly with a chain écraseur, making detection of excessive intra-abdominal haemorrhage difficult. A faecal ball can be mistaken for an ovary and removed, resulting in septic peritonitis, or a section of the mesocolon can be inadvertently removed if the ovary is grasped through the mesocolon as the chain of the écraseur is applied to the mesovarian. A complication of colpotomy itself is fatal haemorrhage caused by perforation of a uterine artery. Because of these disadvantages, ovariectomy is no longer commonly performed with an écraseur through a colpotomy, but by using proper technique, complications can be avoided.

To perform ovariectomy through a colpotomy using an écraseur, the perineum, vestibule and vagina are cleaned for aseptic surgery and desensitised by administering caudal epidural anaesthesia. Epidural anaesthesia also prevents the mare from defaecating during surgery. With a gloved hand holding a scalpel blade, a stab incision is made at the fornx of the vagina, at the 1- to 2-o’clock position, about 2.5 cm lateral and dorsal to the cervix. The stab incision should extend only through the submucosa. The stab incision is spread by using a hemostat and fingers until an opening is created that can accommodate 4 fingers. Loose fascia and peritoneum are torn with a finger, and the hole into the abdominal cavity is enlarged to accommodate an arm. The pedicle of each ovary is desensitised by injecting local anaesthetic solution into it using a long needle inserted into the abdomen through the colpotomy or by applying sterile gauze, tethered to a string and saturated with local anaesthetic solution, to each pedicle for 5 min. The écraseur, the chain of which is secured over the hand of the surgeon, is inserted through the colpotomy into the abdomen. The ovary is grasped, and the chain is slipped over the hand of the surgeon to encircle the ovarian pedicle. The surgeon should be certain that the structure encircled is an ovary and that intestine has not entered the loop of chain before the chain is slowly tightened. The chain is tightened until it severs the pedicle, permitting the ovary to be extracted through the colpotomy. The surgeon should ensure that the ovarian pedicle is not stretched while it is being crushed and severed. The same procedure is performed on the contralateral ovary. The surgeon should ensure that his hand has passed beneath the colon to access the left ovary and is not grasping the ovary through the mesocolon. A Castlick’s vulvoplasty should be performed, if the mare has poor perineal formation, to prevent pneumovagina. Typically, the incision in the vagina is left unsutured. Some surgeons recommend leaving the mare tied for 3 days to prevent the mare from becoming recumbent thus avoiding evisceration. The mare can be returned to work after being confined to a box for 3–5 days.
Challenges in Colic Diagnosis and Post Operative Care

Chaired by Tim Greet
Sponsored by the University of Liverpool

15.40–17.00

Panel: Neil Townsend, Tim Mair, John Keen and Louise Southwood

The experienced panel of surgical and internal medicine specialists will engage in interactive discussion of the management of pre- and post operative colic patients.

NOTES
EGUS – where are we now? Highlights from the ECEIM consensus statement

B.W. Sykes, Michael Hewetson*, R.J. Hepburn, N. Luthersson and Y. Tamzali
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Terminology
The committee recognises that the terminology for equine gastric ulcer syndrome requires clarification and proposes that the following nomenclature be used: Equine Gastric Ulcer Syndrome (EGUS) would remain as a general all-encompassing term to describe erosive and ulcerative diseases of the stomach, however the committee proposes that the terms Equine Squamous Gastric Disease (ESGD) and Equine Glandular Gastric Disease (EGGD) be added and that emphasis should be placed on clearly distinguishing the affected region of the stomach when communicating research and clinical findings. Within ESGD, both primary and secondary disease is recognised. Primary ESGD, the more common of the two forms, occurs in predisposed animals with an otherwise normal gastrointestinal tract. In contrast, secondary ESGD is likely to occur in animals with delayed gastric outflow secondary to an underlying pathophysiological mechanism. The pathophysiology of EGGD remains to be elucidated and as such further sub-classification of lesion type is not possible at this point in time. In lieu of this, the committee recommends the use of descriptive terminology with a clear distinction of the anatomical region affected and the gross appearance of the lesion (Fig. 1).

Clinical signs
The committee concludes that a wide range of clinical signs may be present in individual cases of EGUS, with inappetance and poor body condition the most prevalent at a population level. Although inconsistent, effects on behaviour are not uncommon. Likewise, it is recognised that EGUS may result in poor performance; however given the numerous factors that potentially contribute to poor performance other differentials need to be considered. Whether differences in clinical signs are observed between ESGD vs. EGGD is unknown at this point but warrants investigation.

Table 1: Grading system for ESGD

<table>
<thead>
<tr>
<th>Grade</th>
<th>Squamous mucosa</th>
</tr>
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<tbody>
<tr>
<td>O</td>
<td>The epithelium is intact and there is no appearance of hyperkeratosis</td>
</tr>
<tr>
<td>I</td>
<td>The mucosa is intact, but there are areas of hyperkeratosis</td>
</tr>
<tr>
<td>II</td>
<td>Small, single or multifocal lesions</td>
</tr>
<tr>
<td>III</td>
<td>Large single or extensive superficial lesions</td>
</tr>
<tr>
<td>IV</td>
<td>Extensive lesions with areas of apparent deep ulceration</td>
</tr>
</tbody>
</table>

The clinical relevance of the different manifestations of glandular disease are yet to be well evaluated but variation in the histological appearance of glandular lesions, that can also be appreciated endoscopically, has been reported. Considering this; at present the committee does not recommend that these different appearances be reflected in a hierarchical grading system such as that used for ESGD. In lieu; terminology describing the presence/absence, anatomical location, distribution and appearance of lesions as outlined in Figure 1 should be used.

---

**Fig 1:** Proposed terminology for describing erosive and ulcerative diseases of the horse’s stomach.

- **Equine Gastric Ulcer Syndrome (EGUS)**
  - **Primary ESGD**
    - Associated with intensive management in animals with otherwise normal gastrointestinal tracts
  - **Secondary ESGD**
    - Occurs secondary to delayed gastric emptying resultant from other disease states

- **Equine Glandular Gastric Disease (EGGD)**
  - **Anatomically**
    - Cardia
    - Fundus
    - Antrum
    - Pylorus
  - **Descriptively**
    - Focal/Multifocal/Diffuse
    - Mild/Moderate/Severe
    - Flat and haemorrhagic/Raised and fibrinopurpurative/Depressed ± blood clot/Depressed and fibrinopurpurative
Pathophysiology
A variety of management factors have been demonstrated to contribute to the development of ESGD. All of these factors share the common trait that they increase the exposure of the squamous mucosa to acid. In contrast, the pathophysiology of EGGD is poorly understood. Whereas ESGD results from exposure of mucosa unaccustomed to acidity, EGGD is believed to result from a breakdown of the normal defence mechanisms that protect the mucosa from acidic gastric contents. In humans, *Helicobacter pylori* and NSAIDs are the predominant factors that contribute to breakdown of this protective layer, and as such, current research in the horse has so far, focused primarily on these two mechanisms. To date however, evidence for bacteria as a direct, causative agent in EGGD is lacking. Similarly, although NSAIDs have the potential to cause EGGD in individual animals they are unlikely to be a significant contributor to the prevalence of disease at the population level.

Treatment and prevention
Consistent with the mantra ‘no acid, no ulcer’, it is the committee’s opinion that acid suppressor therapy is indicated in the management of both ESGD, for which its efficacy is well documented, and EGGD, regardless of the failure to identify an underlying cause as of yet. Furthermore, in line with the profession’s obligations for responsible stewardship of antimicrobials, it is the committee’s opinion that the widespread use of antimicrobials in the treatment of EGGD is not justified until their efficacy is appropriately documented. Treatment recommendations for ESGD and EGGD are summarised in Tables 2 and 3 respectively.

<table>
<thead>
<tr>
<th>Table 2: Treatment recommendations for Equine Squamous Gastric Disease</th>
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<tbody>
<tr>
<td><strong>Primary recommendation</strong></td>
</tr>
<tr>
<td>Omeprazole Buffered formulations – 4 mg/kg bwt <em>per os q. 24 h</em></td>
</tr>
<tr>
<td>Enteric coated granule formulations – 1 mg/kg bwt <em>per os q. 24 h</em></td>
</tr>
<tr>
<td>Plain formulations – 4 mg/kg bwt <em>per os q. 24 h</em></td>
</tr>
<tr>
<td><strong>Treatment duration</strong> – 3 weeks</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>Table 3: Treatment recommendations for Equine Glandular Gastric Disease</th>
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</thead>
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<tr>
<td><strong>Primary recommendation</strong></td>
</tr>
<tr>
<td>Omeprazole Buffered formulations – 4 mg/kg bwt <em>per os q. 24 h</em></td>
</tr>
<tr>
<td>Enteric coated granule formulations – 1 mg/kg bwt <em>per os q. 24 h</em></td>
</tr>
<tr>
<td>Plain formulations – 4 mg/kg bwt <em>per os q. 24 h</em></td>
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<tr>
<td>plus</td>
</tr>
<tr>
<td>Sucralfate – 12 mg/kg bwt <em>per os q. 8 h</em></td>
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NOTES
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Imaging the liver: what more can we do?

Mary Beth Whitcomb

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The liver is often evaluated as part of a full abdominal ultrasound examination but may be the primary focus in horses with elevated hepatic enzymes [1]. Horses with hepatic abnormalities may also have normal liver enzymes or nonspecific signs of inflammation [2]. In such cases, clinicians should resist the temptation to dismiss abnormal liver ultrasound findings as clinically insignificant. Biopsy may be useful to rule out liver disease.

A low frequency (2–5 MHz) transducer is necessary for hepatic ultrasound in the adult horse. A rectal or microconvex transducer is insufficient because it can only penetrate to 5–10 cm. Clipping, washing and ultrasound gel produce the best images. Alcohol saturation can be used in thin coated horses. Scanning depth should be adjusted frequently to enhance superficial and deep hepatic imaging. An abdominal program/preset should be selected and time-gain-compensation controls adjusted for deep cavity imaging.

The right liver lobe (RLL) is visible ventral to the lung margins in the right 8-15th ICS in many but not all horses. The RLL is considered enlarged if it extends to or beyond the costochondral (CC) articulations. The left liver lobe (LLL) is visible caudal to the heart in the left cranioventral abdomen (left 7-10th ICS) and extends from the ventral lung margins to the CC articulations. The latter often inhibits visibility of LLL margins, and visibility beyond the CC articulations may be found in horses without hepatic pathology. The normal LLL is hypechoic to the adjacent spleen. It is generally located superficial to the spleen but is occasionally situated deep to the spleen in which case liver margins will appear falsely rounded.

Ultrasoundographic abnormalities include hepatomegaly, rounded margins, changes in echogenicity (usually increased), decreased fine vascular markings (FVM), biliary/vascular fibrosis/inflammation, hepatoliths, biliary distention and evidence of abscessation or neoplasia. Hepatomegaly and rounded margins are found with multiple disease processes, including hepatitis, cholangiohepatitis, obstructive cholelithiasis and neoplasia. Decreased FVM is a subtle finding where the liver appears dense and similar in echotexture to the spleen. Although nonspecific, decreased FVM is a significant finding that is often overlooked and may be the lone abnormality in horses with primary liver disease, including those with pyrrolizidine alkaloid toxicity.

Obstructive cholelithiasis is a well-known, albeit infrequent, disorder [3,4]. Hepatoliths are variably echoic and produce weak to strong acoustic shadows. The obstructive hepatolith may not be visible, but a ‘parallel channel sign’ is often evident due to dilated bile ducts adjacent to portal veins. Biliary or vascular inflammation or fibrosis is a nonspecific finding that occurs with many hepatic disorders. This creates multiple small hypechoic parallel lines scattered throughout hepatic parenchyma. These may cast shadows and should not be confused with hepatoliths. Incidental granulomas can produce a similar ‘starry sky’ pattern and are differentiated from hepatoliths by their extrabiliary location [5]. Hepatic abscesses can range from focal to coalescing, hypechoic or hypechoic areas within the liver [2,6]. Although uncommon, hepatic neoplasia may create a diffusely heterogeneous appearance, although discrete metastatic or primary tumours have been reported [1,7].

Ultrasound-guided (USG) biopsy is often necessary to differentiate between hepatic pathologies. Blind liver biopsies are not recommended because adequate tissue may be lacking at published anatomic landmarks, thereby increasing the risk for gut or lung penetration [8]. Ultrasound-guided biopsy is indicated in horses with a strong suspicion for hepatic disease regardless of the source of information. Ultrasoundographic abnormalities can be found without elevated liver enzyme or vice versa [2,9]. Although post-procedure haemorrhage is infrequently reported, clotting profiles are often recommended [10]. Either liver lobe can be sampled, but the RLL is usually selected in horses with nonspecific clinicopathological or ultrasound findings [11]. Site selection should consider the amount of visible liver, lesion location and surrounding vital structures. Biopsies are performed using sterile technique after marking the biopsy site and placement of a lidocaine bleb and stab incision to reduce needle drag. Needle throw must be considered with automated biopsy instruments. A slight dorsal to ventral needle trajectory is easiest but a ventral-to-dorsal approach may be beneficial in horses with suboptimal hepatic visibility. Two samples for histopathology and culture are often obtained. In suspect cases of abscessation, aspiration often yields superior samples; however, biopsy is recommended if purulent material is not obtained.

References

NOTES
Getting the most from a liver biopsy

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Liver failure in the horse frequently results in recognisable signs due to inability of the liver to perform its diverse functions. These signs include depression, weight loss, anorexia, poor performance, photosensitisation, diarrhoea, icterus, oedema, pruritus, coagulopathy, polyuria/polydipsia and central and peripheral neural dysfunction (including bilateral laryngeal paralysis, disorientation, ataxia, blindness, headpressing, circling, yawning). However, liver disease is much more prevalent than liver failure, and many horses with liver disease are subclinically affected or have mild, vague signs. Since there is a poor prognosis anticipated once clinically overt liver failure is present, there is a convincing argument for thorough investigation of cases of liver disease when identified in horses showing few or no clinical signs rather than waiting until the liver is obviously dysfunctional.

Investigation of liver disease in horses needs to meet three aims; (i) to confirm the presence of liver disease, (ii) to characterise the type of disease present to guide treatment selection and (iii) to provide prognostic information. Histopathological analysis of liver biopsy remains the best technique to answer these points.

Practical considerations
Transabdominal ultrasound should be used to guide liver biopsy; the site selected will depend on the absence of large blood vessels, width of liver tissue and rarely, presence of focal ultrasonographic abnormalities. Given the widespread availability of diagnostic ultrasound in equine veterinary practice in current times, undertaking liver biopsy without ultrasound guidance is not easily justifiable.

Human studies report a reduced incidence of sample fragmentation (particularly in portal areas with marked fibrosis) when automated firing devices were compared with hand-operated Tru-cut biopsy devices. This has not been verified in equine liver biopsy sampling at this time, but given the ease of use of automated firing devices, it might be a worthwhile investment for those regularly performing liver biopsies. Since humans often report abdominal pain following percutaneous liver biopsy, routine systemic doses of analgesics ought to be administered at the time of biopsy.

Sample variability
Liver biopsy is regarded as a valuable ante mortem test in human patients with chronic active hepatitis. Historically, there was an assumption that since liver disease of this type was diffuse, the biopsy site and size were not of great importance. However, recent human studies report sampling variability associated with portal areas but not hepatic parenchyma; the degree of portal pathology is underestimated in small biopsies [1]. This inaccurate grading of the pathology was overcome when ≥10 complete portal tracts (wholly surrounded with parenchyma) were analysed.

A prospective study has been undertaken evaluating sampling variability in multi-site simultaneous ultrasound-guided liver biopsies from clinical cases at Liphook Equine Hospital. The results were broadly similar to the human literature; no intra- and inter-biopsy variation was detected in terms of irreversible pathology, predominant type of inflammatory cell infiltrate, or degree of haemosiderosis. When portal areas were evaluated, significant intra- and inter-biopsy variation was detected in (i) fibrosis score and (ii) number of perportal inflammatory cells. No single biopsy contained more than ten complete portal tracts; when two randomly selected biopsies from each patient were selected 63% contained more than ten complete portal tracts, and when three biopsies were selected 93% contained more than ten complete portal tracts.

This study is ongoing but these results indicate variability in portal tracts but not hepatic parenchyma in multiple simultaneous liver biopsies from equine patients, and that single liver biopsies are unlikely to contain enough portal tracts to overcome this sampling variability. There did not appear to be any influence of sample site when histological grade of left vs. right-sided biopsies were compared. This study suggests that when taking liver biopsies from horses with a suspected hepatopathy, and a uniform ultrasonographic appearance, it may be prudent to take multiple biopsies, but the anatomical location of the biopsies is unlikely to be of importance. Possible adverse effects of liver biopsy include haemorrhage, colic, peritonitis, pneumothorax and pleuritis; there was no incidence of these adverse effects when multiple simultaneous biopsies were taken.

Histopathological analysis
Causes of liver disease in horses include infectious (viral, clostridial, bacterial cholangiohepatitis), toxicosis (mycotoxins, pyrrolizidine alkaloids, iron), hepatic lipodisosis, chronic active hepatitis, choleithiasis, amyloidosis, neoplasia, abscessation, and endotoxaemia. Categorisation of the exact cause of liver disease is often not achievable from histopathological analysis of liver biopsy in horses. However, certain characteristic pathological patterns may guide specific therapy such as lymphocytic portal infiltration warranting glucocorticoid treatment, and severe haemosiderosis requiring phlebotomy and a thorough diet review to minimise iron ingestion. A diagnosis of cholangiohepatitis (predominant neutrophilic infiltrates in portal areas) appears to be an infrequent diagnosis in liver biopsies from horses according to several UK studies, so the blanket treatment of suspected liver disease cases with oral antimicrobial therapy prior to performing liver biopsy (i.e. without histological evidence) is questionable.

A histopathological prognostic scoring system has been validated in horses [2]. This system has weighted scores for fibrosis, irreversible cytopathology, inflammatory infiltrate, haemosiderin accumulation and biliary hyperplasia that yield an estimation of likely survival to at least six months post biopsy. Recently, this prognostic scoring system was re-evaluated with a new cohort of UK horses from two referral institutions. This study demonstrated the ongoing validity of this scoring system for estimating short-and long-term survival [3].

References
Equine coronavirus – an emerging enteric pathogen of adult horses
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Coronaviruses are members of the Coronaviridae family, all of which are single-stranded, positive-sense, nonsegmented, enveloped RNA viruses responsible for enteric, respiratory, hepatic or neurologic disease in a variety of mammalian and avian species. Equine coronavirus (ECoV) is classified within the Betacoronavirus genus, along with bovine coronavirus (BCoV), porcine haemagglutinating encephalomyelitis virus, mouse hepatitis virus, rat coronavirus (sialodacryoadenitis virus), and certain human coronaviruses. ECoV has been recently associated clinically and epidemiologically with outbreaks of pyrogenic and enteric disease in adult horses in Japan, and anorexia, lethargy and fever in the United States.

Epidemiological information on ECoV is sparse at this time and there are only a few case reports available in published and non-published preliminary observations. For example, the first outbreak of ECoV in horses was reported in 2007 in Japan and confirmed by virus isolation and detection of ECoV in faeces. The consistently observed presence of clinical signs compatible with ECoV infection (anorexia, lethargy and fever), and detection of ECoV in faeces by qPCR. The percentage of asymptomatic horses during an outbreak of ECoV has been reported. Although clinical disease is apparent in 25% and 18% of the horses, respectively. Gastrointestinal signs are generally preceded by systemic signs of anorexia and fever. In 3% of infected horses, signs of encephalopathy, such as circling, head pressing, ataxia, proprioceptive deficits, nystagmus, recumbency and seizure have also been reported. Although clinical disease is apparent in ECoV infected horses, one needs to take into account that some horses remain asymptomatic after infection. Asymptomatic infection is defined as lack of clinical signs and detection of ECoV in faeces by qPCR. The percentage of asymptomatic horses during an outbreak of ECoV has been observed to range between 11% and 29%.

The ante mortem diagnosis of ECoV relies on the presence of clinical signs compatible with ECoV infection, haematological changes suggesting of an acute viral disease, the exclusion of common enteric diseases and molecular detection of ECoV in faeces. The consistently observed haematological abnormalities observed with ECoV infection are leukopenia due to neutropenia and/or lymphopenia.

Biochemical parameters may be unremarkable, but elevation of total and indirect bilirubinaemia due to partial or complete anorexia, electrolytes changes consistent with enterocolitis, transient elevation of liver enzymes, and renal parameters have been observed in some of the cases. It is judicious to measure ammonia in horses with suspected ECoV infection and concurrent signs of encephalopathy. Historically, the detection of ECoV has relied on either electron microscopy, antigen-capture ELISA or viral isolation from the faeces. All these detection modalities lack sensitivity, especially if viral particles are not present in sufficient numbers. Quantitative PCR (qPCR) for the detection of ECoV has supplanted many conventional virological assays, mainly due to its short turn-around time, high through-put capability and increased analytical sensitivity and specificity. The overall agreement between clinical status and PCR results for ECoV is over 90% based on recent outbreak investigations. Infected horses can shed ECoV up to 14 days.

In adult horses, the pathogenesis of ECoV has recently been described in three equids. The ECoV infected equids displayed severe diffuse necrotising enteritis with marked villus attenuation, epithelial cell necrosis in the tips of the villi, neutrophilic and fibrin extravasation into the small intestinal lumen, as well as crypt necrosis, microthrombosis, and haemorrhage. ECoV was detected by qPCR in small intestinal tissue, gastrointestinal content, and/or faeces, and coronavirus antigen was detected by immunohistochemistry and/or direct fluorescent antibody testing in the small intestine of all cases.

Most adult horses with clinical ECoV infection recover spontaneously in a few days without specific treatment. Horses with persistent elevated rectal temperature, anorexia and depression are routinely treated with anti-inflammatory drugs for 24–48 h, as long as their hydration status is maintained. Horses with colic, persistent depression and anorexia and/or diarrhoea are treated more intensively with fluid and electrolyte therapy, nasogastric intubation or parenteral administration of polyionic fluids until clinical signs have resolved. The prevention of ECoV infection should focus on the implementation of routine management practices aimed at reducing the likelihood of introducing and disseminating ECoV at any horse-based premise (boarding facility, show ground, veterinary hospital). Due to the highly contagious nature of ECoV, any horse Developing or presenting with significant fevers, anorexia and depression with or without enteric signs (colic, diarrhoea) should be strictly isolated until a diagnosis is secured. Such an approach can prevent the later quarantine of an entire horse population should ECoV infection be diagnosed subsequently. Equine coronavirus is susceptible to common disinfectants including sodium hypochlorite, povidone iodine, chlorhexidine gluconate, phenols, quaternary ammonium compounds, accelerated hydrogen peroxide and peroxygen compounds.
High dose radiation (HDR) therapy – a new treatment option?

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Radiation therapy, namely the use of ionising radiation, as a treatment modality for solid tumours was first described in the horse using the isotope radium (Ra-226) in the early 1900s. Over the past century, there has been comparatively limited development of clinical radiotherapy for horses compared with the advances made in other areas of veterinary medicine partly because the clinical need is relatively low, as young to middle aged horses suffer from far fewer forms of neoplasia than other companion animals or humans, and partly because of the significant expense incurred in developing and building facilities designed to safely treat horses with ionising radiation, and the health and safety implications of handling radioactive sources within such a facility.

Brachytherapy (the source is applied directly to the target tissue, in either an interstitial or an ‘in contact’ manner) and teletherapy (the source remains remote from the target tissue) are the two main options applicable to the horse, with brachytherapy being performed more commonly, given that it is often suitable for treatment of cutaneous neoplasia in the horse, and can be performed in standing, sedated patients within minimally adapted clinical examination rooms, rather than requiring general anaesthesia and a lead lined bunker to house a linear accelerator. By far the most frequently used brachytherapy source in veterinary medicine is the unstable isotope of iridium, iridium-192 (Ir-192). The largest case series published using iridium brachytherapy detailed 445 horses with peri-ocular sarcoids treated over a 25-year period [1]. In this case series, thin iridium-192 impregnated stainless steel wires or strings of iridium seeds were implanted directly into the sarcoid via guides, and sutured in place and left in situ for a variable period of 2–6 days defined by the activity of the wire or seeds on Day 1, with the aim of delivering a total dose of between 45–65 grays of radiation directly into the implanted tissue over this time. With this technique, the short source-object distance allows for a high dose of radiation locally, with less damage to surrounding tissues. A resolution of peri-ocular sarcoids was seen in 98% of cases in this study, which further validated the use of Ir-192 in this population of horses with sarcoids. The disadvantages of using Ir-192 wires or seeds are primarily health and safety related in that clinicians have to handle the radioactive source during placement, and additional support staff are also exposed to a level of radiation whilst holding the horse during wire placement. The horse must stay at the hospital in an isolation facility for the duration of the treatment, and during this time there is the risk of dislodgement of the radioactive wires due to rubbing or loosening of the sutured wire. There are known instances of inadvertent ingestion of a dislodged iridium wire by horses, resulting in prolonged hospitalisation until the radioactive material was passed in faeces and fully accounted for.

Because of the health and safety concerns for personnel during handling of Ir-192 wires and seeds, high dose radiation therapy (HDR) has largely replaced the use of ‘low dose’ Ir-192 wires and seeds in the medical profession. HDR therapy is the medical term for the provision of radiation therapy using a remote ‘after loading’ technique where an iridium-192 source of high activity (>12 Gy/h) attached to a motorised guide wire and contained within a lead chamber can be remotely guided by computer to exit the chamber and pass along connecting catheters to transiently dwell within a pre-placed catheter system within a patient’s tumour. The dwell sites within the catheter system and the dwell times at each site can be pre-planned in order to deliver a specific volumetric dose of radiation (termed a ‘fraction’). The dwell times can be set to match the treatment times and allow for sufficient time for the tissue to recover from the radiation. HDR therapy is delivered remotely by computer controlled systems making it less invasive than interstitial (or ‘in contact’) techniques such as iridium seeds or wires. The major advantages of HDR therapy include:

- Remote control of treatment delivery
- Precise tumour targeting
- Lower risk of normal tissue damage
- Higher tumour control rates
- Lower treatment time
- Reduced cost to client

Table 1: Comparison of brachytherapy techniques

<table>
<thead>
<tr>
<th>Facilities</th>
<th>Cost to client</th>
<th>Patient isolation</th>
<th>Planning/preparation time</th>
<th>Dose delivery time</th>
<th>Treatable cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ir-192 wires or seeds HDR therapy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clinic with EA licence for sealed source and locked lead lined storage cupboard</td>
<td>High cost to client and low availability of Ir-192 wires and seeds</td>
<td>Required for 3–7 days</td>
<td>Comparatively quick to prepare patient and place wires</td>
<td>3–7 days</td>
<td>Limited by size and location of tumour</td>
</tr>
<tr>
<td>Clinic with EA licence for sealed source and padlocked and alarmed steel cage to contain HDR machine</td>
<td>Moderately high cost to client, availability currently limited to two European centres</td>
<td>Not necessary</td>
<td>Relatively quick to place catheters, image tumour but time consuming to plan treatment</td>
<td>Approx 3–7 min per fraction dependent on source activity</td>
<td>In theory no size limit of tumour, less limit of location also</td>
</tr>
</tbody>
</table>

HDR therapy remains widely available in Europe but is currently limited to two European centres. There is a need for the development of international guidelines to ensure the safe and efficient delivery of HDR therapy for both veterinary and human applications. The primary advantage of HDR treated is the ability to deliver a precise radiation dose to very small defined tumours, which is relevant to the treatment of equine cutaneous neoplasia.
throughout the tumour over a very short treatment time. Multiple fractions are usually administered, daily or weekly. By utilising cross-sectional imaging during the planning process, a far more accurate treatment plan for each tumour is possible than with direct Ir-192 wire or seed placement, due to the ability to identify the tumour volume more accurately. The relationship of the tumour to adjacent sensitive tissues is better understood and manipulation of dose gradients, the contours of the tissue volume to be treated, and the total doses at prescribed treatment perimeters are all possible using the planning software, all of which minimise exposure of sensitive tissues such as the cornea, lens and retina to radiation in cases of peri-ocular tumours.

There is obvious application of the technique to various forms of cutaneous neoplasia, including peri-ocular sarcoids in the horse, but, in addition, more invasive tumours within the sinuses, maxilla and mandible may be treatable provided placement of a catheter system is possible. The technique is not limited to the head region and tumours of the external genitalia and limbs may also be amenable to treatment, providing an alternative to external beam radiation therapy (EBRT) and the risks and costs associated with multiple general anaesthetics necessary for EBRT treatment protocols in the horse.

Reference


Further reading

Melanoma – where are we and what does the future hold?

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Melanoma is a common, variably infiltrative and potentially malignant neoplasm affecting almost exclusively adult (mean age 13 years) grey horses [1]. Many horses die for unrelated reasons without their melanomas ever causing any problems. Consequently for many years veterinary surgeons have taken a view of benign neglect unless the melanomas are extensive, ulcerated or compromise the horse’s welfare due to local enlargement, invasion, or internal distant metastasis. Prevalence rates as high as 80% in the grey horse population have been reported with claims that 2 in 3 tumours will eventually become malignant [1]. Of the 4 types of melanoma described (melanocytic nevus, discrete dermal melanoma, dermal melanomatosis and anaplastic malignant melanoma) the vast majority of cases involve the dermal forms [2]. Typical sites involved are the anal, perineal, genital (prepuce and penile shaft), parotid salivary glands, lip commissures, and the ventral aspect of the tail. All dermal melanomas run the risk of enlarging or progressing to more diffuse and extensive infiltrative melanomatosis [1,2] and this knowledge is increasingly directing veterinary surgeons toward earlier and move aggressive intervention including surgical excision, if possible. Indeed the historical mantra that no treatment for a melanoma is required unless the tumour is affecting function and that melanomas should not be interfered with surgically as there is a significant risk of subsequent rapid progression and/or recurrence would appear to have little or no reliable data to support such a conservative approach. Once even a slow growing melanoma is affecting function, treatment often becomes increasingly more complex, costly and less effective. Currently in horses, there is little or no data available assessing either simple qualitative histological indicators of malignancy such as high frequency nuclear atypia and/or cell de-pigmentation or indices of proliferation such as mitotic index and frequency of cellular Ki-67 expression as described in dogs [3].

A change in attitude to melanoma management rather than advances in therapy per se has stimulated a much more proactive approach in their management. Indeed early complete surgical excision of small lesions is often tolerated curative but development of new lesions is common.

Long-term follow-up data on horses treated by any technique are limited but as well as surgical excision, laser ablation, cryotherapy, local chemotherapy, both radiation tele- and brachytherapy and immunomodulation have been reported. All of the above treatment modalities have been used with success in small numbers of cases.

Clinicopathological observations suggested equine melanoma should be amenable to immunological manipulation [4]. Early reports of tumour regression following purported inhibition of activation of suppressor T cells by cimetidine were very encouraging [5] but a later retrospective owner questionnaire efficacy study indicated a 33% response rate [6]. Experience in practice suggests that some horses will respond favourably, but case selection is difficult and the response rate is low.

An uncontrolled autogenous vaccine trial initially reported tumour regression in 11 of 12 horses [4] but these results were not confirmed. Although complex, a regime of an autologous vaccine and intralesional IL-2 and hGM-CSF produced marked tumour regression in a single horse [7].

A great deal of interest has been stimulated by clinical trials in horses using the xenogeneic plasmid DNA vaccine encoding human tyrosinase, licensed for use in canine melanoma (Oncept; Merial) [8]. Melanocytes containing melanin-producing melanosomes are stimulated to proliferate by a number of glycoproteins including tyrosinase. The construct was shown to elicit tumour antigen-specific reactivity [9] and unpublished data from preliminary clinical trials suggested a clinical benefit in two-thirds of cases. However despite widespread use of the vaccine, a recent trial showed that dogs that received the vaccine did not achieve a greater progression-free survival, disease-free interval or median survival time than dogs that did not receive vaccine [10]. However a more recent study combining DNA vectors encoding eqIL-12 and eqIL-18 as well as two human proliferation glycoproteins (GP100 and tyrosinase) showed that modest tumour regression was mediated by eqIL-12 and eqIL-18 rather than GP100 and tyrosinase [11].

References

NOTES
There have been a limited number of published studies investigating the success and recurrence rates of laser surgery for equine skin tumours. Carstanjen and colleagues [7] reported the results of CO2 laser therapy of single or multiple sarcoids in 60 animals (44 horses, 13 donkeys, 2 mules and one pony). Recurrence (minimum follow-up of 6 months) was observed in 23 (38%) cases. Animals with new sarcoid manifestations with or without recurrence of sarcoid were observed in 35 cases (58%). Donkeys showed a significantly lower recurrence rate than horses. Martens and colleagues [8] compared surgical excision (conventional or CO2 laser), cryotherapy and local BCG vaccination in 95 horses with sarcoids. A successful outcome was reported as: cryosurgery 11/14 (79%), BCG 18/27 (71%), conventional excision 18/22 (82%) and laser 20/28 (71%). Another retrospective study (9) assessed the outcomes (minimum follow-up of 6 months) of 32 horses with cutaneous masses treated by CO2 laser excision; these included sarcoïds (15 horses), other tumours (11 horses) and non-neoplastic masses (6 horses). Five sarcoïds and 2 squamous cell carcinomas recurred; 7 (21%) horses had complications associated with wound dehiscence. Kemp-Symonds [10] reported a disease-free state in 15/16 horses with peri-ocular sarcoïds treated by CO2 laser surgery with adjunctive photodynamic therapy after one year. Compton and colleagues [11] reported a recurrence rate of 1.31 sarcoïds per 10 horse years following diode laser surgery of 290 sarcoïds in 73 horses.

References
Mitomycin C (MMC) is an antibiotic isolated from Streptomyces caespitosus. The drug is an alkylating agent with cytotoxic effects on cells including the cross-linking of DNA. Although DNA alkylation can occur at any stage of the cell cycle, the biological consequences are more severe during DNA synthesis. In addition, under aerobic conditions, as occurs predominantly in ophthalmic use, MMC can react with oxygen to generate free radicals, causing cytotoxicity via lipid peroxidation, and DNA and protein damage. In ophthalmic use, MMC has also been shown to inhibit cell migration, extracellular matrix production and fibroblast transformation, giving MMC anti-fibrotic and anti-scarring properties.

There are currently three main indications for MMC in equine medicine:

- **Anti-scarring agent:** MMC is used extensively in human ophthalmology as an anti-scarring agent in a wide range of ocular surgeries, including glaucoma filtering surgery, dacryocystorhinostomy, etc. The author has used MMC following nasolacrimal punctual surgery to prevent early scarring and closure of newly created ostias.

- **Ocular squamous cell carcinoma (SCC):** MMC can be used as an adjunctive treatment following surgery or in some cases as sole therapy. Typically it is applied as a 0.04% solution every 6 h in rounds of 7 days of treatment, followed by 7 days without. MMC has also been used intraoperatively, although early use before epithelialisation of the surgical lesion has been associated with an increased number of complications. Potential complications include blepharitis, conjunctivitis and ulcerative keratitis. Recurrence rates following treatment for ocular SCC in horses vary in the literature from 11.9% (if radiation therapy is used) to 66.7%. Recurrence rates when MMC is used range from 25% to 15%. MMC related changes may persist in ocular surface epithelium for at least 8 months following MMC therapy. Used as topical application, MMC allows treatment of the entire ocular surface, including the conjunctival fornices, and may reach and destroy subclinical disease and prevent new tumours arising elsewhere on the ocular surface.

- **Treatment of certain skin tumours:** MMC has been used for the treatment of periocular sarcomas with very favourable results for nodular and fibroblastic lesions. Two courses of injections one week apart are usually necessary, with each course consisting of 5 intralesional injections administered every other day, although slow release formulations are also possible. Its use has also been anecdotally reported for the treatment of melanomas and squamous cell carcinomas where surgical removal is not possible.

Due to the cytotoxic properties of MMC, safety precautions have to be taken during the preparation and handling of the drug. The drug should only be prepared in an exhaust safety cabinet and personal protection devices should be worn when handling it. In addition the drug should be disposed of only in an appropriate container for chemotherapeutic agents.

**Further reading**


The pathophysiology of (lone) atrial fibrillation

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Introduction
Lone atrial fibrillation (AF) is a re-entry atrial tachyarrhythmia, found in the absence of other (detectable) cardiac pathology, especially in large breeds. It consists of a rapid, chaotic, self-sustaining electrical activation of the atria at a ‘rate’ of 300–500/min. Due to the high vagal tone, the atrioventricular (AV) node blocks most of these impulses and the final ventricular rate remains normal at rest.

How does AF start: triggers...
Atrial fibrillation occurs when both a trigger to start the arrhythmia and a substrate to maintain it, are present. AF is induced by one or more atrial premature beats, a rapidly firing focus or small re-entry sites (spiral waves or rotors) that initiate (macro) re-entry. In human patients, pulmonary vein myocardial sleeves are the main source of ectopy, and recently these have also been identified in horses. Strenuous exercise with elevated left atrial pressures in horses (more than in other species), may lead to a higher burden of atrial stretch-related premature beats.

How does AF perpetuate: the substrate...
Once initiated, the perpetuation of AF depends on the substrate, the atrial myocardium. Factors in favour of AF are a large atrium, short refractory period, dispersion of refractoriness, slow conduction velocity and structural obstacles or lesions (fibrosis) [1]. High vagal tone, large atria and a short refractory period in relation to its size, makes the equine atria an almost perfect substrate to maintain AF.

Occasionally, AF is short-lived and terminates spontaneously, usually within the first 24–48 h, which is called paroxysmal AF, occasionally seen in slowly finishing Thoroughbreds. Probably strenuous exercise triggers initiation of AF by stretching the atrial myocardium, leading to atrial premature beats and electrophysiological changes that are exacerbated by electrolyte disturbances, while the myocardium is not well suited for maintenance of AF due to its size, electrophysiological properties and structure.

In the vast majority of horses, however, once initiated, AF does not terminate spontaneously because of the size and properties of the atrial myocardium. In addition, experimental work has shown that immediately after AF occurrence, shortening in refractory period (electrical remodelling) and loss of contractile function (contractile remodelling) occur, both leading to further stabilisation of the arrhythmia. As a result, AF generally becomes permanent AF very quickly after its onset and progressive remodelling prevents it from ever terminating spontaneously.

What is the impact on cardiac function at rest?
During AF there is no coordinated atrial activation because of the rapid and chaotic electrical activity. In addition, within days to weeks after initiation of AF, atrial contractile function itself is almost completely lost, a process which appears reversible after restoration of sinus rhythm. Loss of atrial contractility is not related to clinical signs at rest because passive filling is sufficient to maintain cardiac output.

Ventricular rhythm becomes irregular (irregular AV conduction) but the high vagal tone blocks most of the atrial impulses and maintains ventricular rate normal at rest.

What is the impact on cardiac function during exercise?
During exercise, atrial contribution to ventricular filling becomes more important and loss of atrial contractility may affect performance. More importantly, exercise results in a predominantly sympathetic tone, whereby the AV node will suddenly conduct too many pulses to the ventricles, resulting in a disproportionate tachycardia during exercise. Heart rates well over 250/min are often encountered during exercise which negatively affects cardiac output.

Clinical presentation
Horses that have atrial fibrillation without underlying cardiac lesions usually present with a history of reduced performance at high level exercise (e.g. racehorses). Epistaxis may occur during exercise. Occasionally, a brief period of ataxia, distress or even collapse may be observed during fast work. Because of the influence on performance, diagnosis is often made in an early stage. In jumping or dressage horses, AF results in moderate or subtle effects during fast work. Because of the influence on performance, diagnosis is often made in an early stage. In jumping or dressage horses, AF results in moderate or subtle effects during fast work.
Conclusion
Atrial fibrillation is initiated by atrial premature beats and quickly becomes permanent. It results in loss of atrial contractile function and disproportionate ventricular response rate but may also lead to broad QRS tachycardia and ventricular dyssynchrony. Although well tolerated in horses at rest, AF is not a benign rhythm in competition or racehorses.

References
Quinidine sulphate: friend or foe?

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Introduction
Since the development of transvenous electrical cardioversion (TVEC), quinidine cardioversion (QC) has become the ‘poor cousin’ of atrial fibrillation (AF) treatment, despite more than 60 years of successful use. The concern for idiosyncratic and toxic adverse reactions has discouraged some equine clinicians from using the drug in some or all cases of AF. However, quinidine can be used both safely and effectively with appropriate patient selection, a standardised treatment protocol, careful monitoring, and advanced planning on how to treat arrhythmias that may arise during treatment.

Patient selection
Cardioversion should be considered for horses with AF duration >48 h, who are exercise intolerant, have rapid ventricular response rates at rest, inappropriately elevated heart rates during exercise, concurrent wide QRS/ventricular ectopy during exercise, and/or experience repeated episodes of exercise-induced pulmonary haemorrhage (EIPH) while in AF. Sale prospects and children’s mounts may also be considered as candidates for cardioversion. Cardioversion is not recommended for horses with congestive heart failure, severe myocardial dysfunction or severe valvular regurgitation. Determining the best method for cardioversion (TVEC or QC) requires knowledge of the chronicity of AF, the details of previous quinidine treatment attempts including treatment schedule and adverse advents, the presence or absence of underlying heart disease and any comorbidities. Horses with lone AF between 48 h and 4 months’ duration and without relevant comorbidities can be treated with either TVEC or QC. The method chosen in these cases may depend more on relative cost of procedures, availability of cardioversion catheters or the ability to monitor quinidine concentrations, or pre-existing bias of the clinician or owner. The presence of chronic (>4 months) or unknown duration AF, mild to moderate valvular regurgitation or atrial enlargement typically prolongs the treatment time needed for successful QC, thereby increasing both the cost and chances of adverse events. TVEC may be a better choice in these cases, although if TVEC is not available QC should still be considered. It is important to note that there is no difference in the long-term maintenance of sinus rhythm between TVEC and QC, although there is a higher risk of immediate recurrence of AF with TVEC.

Standardised treatment
Erratic administration of quinidine may result in treatment failure at best and toxic concentrations at worst. Horses that have ‘failed’ quinidine cardioversion have often had non-standard treatments. A standard treatment protocol for quinidine sulphate includes administration of 22 mg/kg bwt via a nasogastric tube every 2 h for 4 doses and then switching to every 6 h until converted, an adverse event occurs or owner ends treatment due to financial reasons. Horses with recent onset atrial fibrillation (<2 months) commonly convert to sinus rhythm between the third and fifth doses. Because quinidine absorption can be variable from horse to horse a small percentage of horses will become toxic with the fourth q. 2 h dose and some will require a fifth q. 2 h dose to reach therapeutic concentrations. Having the ability to obtain quinidine concentrations with rapid turnaround time (within 1 h) greatly enhances the ability to tweak treatment protocols for individual horses and safely perform QC. In cases where quinidine concentrations cannot be obtained, it is not recommended to give a fifth q. 2 h dose.

Monitoring the patient
Continuous telemetric monitoring of horses undergoing QC is critical for rapid recognition and treatment of tachyarrhythmias. Combining digital telemetry and remote viewing software can permit frequent if not continuous ECG monitoring. It is expected that horses receiving quinidine will become dull/depressed and most will eventually stop eating and drinking. Neurological signs indicate toxicity and should be distinguished from hypotension. Nasal oedema has also been associated with toxicity although it can also occur without toxicity if the horse keeps its head lowered. Diarrhoea and laminitis are rare complications that tend to occur in patients receiving quinidine for several days or with a history of gastrointestinal disease.

Emergency treatment of arrhythmias
Cardiac tachyarrhythmias during QC are usually idiosyncratic. Having a plan for the treatment of arrhythmias (drugs available and dosages calculated) prior to starting QC is strongly recommended. Quinidine increases conduction through the AV node and rapid AF is a common finding during treatment. AF rates of 100–130 beats/min can be tolerated for short periods of time and rate control can be reserved for sustained rapid AF or for horses with clinical signs due to paroxysms of rapid AF. Intravenous digoxin and/or a beta blocker should be available for rate control. Quinidine administration should be discontinued if ventricular arrhythmias are identified. Magnesium sulfate is the treatment of choice for Torsades.

Treatment pearls
The use of a test dose of quinidine is a hold-over from the early days of QC and is no longer considered necessary. It is not unusual for horses to go from AF to atrial flutter during the course of QC and quinidine administration should be continued until conversion to NSR has occurred. Atrial flutter with 2:1 conduction (often at an atrial rate of 110–120 and a ventricular rate of 5–60) can be mistaken for NSR if careful ECG evaluation is not performed. Discontinuing treatment during atrial flutter or not recognising 2:1 atrial flutter are possible reasons for reports of quinidine failure or early recurrence of AF.

Draught horses frequently have mildly elevated resting heart rates (60–80 beats/min) while in AF. Pre-treatment with digoxin or a beta blocker can be considered in these cases, although successful cardioversion can occur without it. Educating draught horse owners about the signs of AF and the importance of early recognition and treatment can aid in keeping treatment costs and adverse events to a minimum.

Accessory pathways (AP) are rare causes of AF in the horse. Because the P-R interval is absent in AF, the diagnosis cannot be made via ECG until the horse is converted. Increased resting heart rates in non-draught breeds with AF and/or the presence of frequent wide QRS complexes should alert the clinician to the possibility of an AP. Quinidine is an acceptable treatment for AF due to an AP, although digoxin is contraindicated, at least theoretically. APs can increase the risk for sudden death (independent of quinidine administration).
Introduction
Lone atrial fibrillation (AF) treatment success depends on AF duration and ectopy, size, electrophysiological properties and structural properties of the atria. Because of the more pronounced effect on performance, racehorses often present with shorter AF duration compared with Warmbloods or other breeds. Atrial fibrillation can be converted to sinus rhythm by administration of drugs, such as quinidine sulphate or amiodarone, or by transvenous electrical cardioversion (TVEC). TVEC is believed to be more efficacious than quinidine and is often successful in quinidine refractory cases.

TVEC procedure
For TVEC, in the standing horse, two cardioversion catheters are inserted through a sheath in the jugular vein [1]. Near the tip, these catheters possess a shock electrode with a large surface area in order to limit local current density during shock delivery. Catheters with lumen are available to allow pressure monitoring as an aid during catheter placement. Catheters are advanced towards the right heart. Under ultrasound guidance, the first catheter is inserted through the right atrium (RA) and right ventricle (RV) into the left branch of the pulmonary artery (PA), about 25–30 cm beyond the valves. Special attention should be paid to the fact that the catheter tip should not get a curved-back position in the PA. This is best monitored on ultrasound from the left hemithorax. Also radiography can be applied to check catheter position. The second shock catheter is inserted in the right ventricle. Some horses present temporary (usually seconds up to 2 min) asystole after shock delivery due to complete atrioventricular block [2]. Therefore, a third pacing catheter is inserted into the right ventricular apex and can be used for temporary right ventricular pacing [3] during anaesthesia. Indeed, in human patients, a long pause in ventricular rhythm is known to be associated with an increased risk of initiation of ventricular tachycardia or fibrillation.

When all catheters are in place, general anaesthesia is induced while the horse is supported in a sling. During anaesthesia, catheter positions are confirmed by ultrasound. The shock catheter that was positioned in the right ventricle is now gently pulled back until the catheter tip is exactly between the tricuspid valve tips, while attempting to curve the shock coil towards the right atrial free wall, away from the atrial septum. The right ventricular pacing catheter is connected to a temporary pacing unit and its position is adapted in order to achieve consistent ventricular capture at 0.5 ms and 5 V pulses. Both cardioversion catheters and a surface ECG are then connected to the biphasic defibrillator, which is operated in synchronous mode. In synchronous mode, the defibrillator detects the R wave of the ECG and will automatically deliver the shock exactly on the R wave when the button is pressed. Synchronous shock delivery with correct detection of the R wave is vital: when the defibrillator wrongly identifies the T wave as an R wave and delivers a shock on a T wave, induction of fatal ventricular fibrillation is very likely. Therefore, position of the surface electrodes must be changed at all times until T wave detection disappears. Fifty Joules incremental shocks are applied starting at 150 to 360 J, with attempts being made to minimise total energy delivered. Most horses convert between 125 and 250 J with an impedance of 25–50 Ohm. If cardioversion is not achieved, catheter position may need to be adapted. Alternatively, shock delivery after administration of an antiarrhythmic drug, such as amiodarone, usually results in successful cardioversion. After successful cardioversion, anaesthesia is continued for at least 10 min to monitor for atrial ectopy as these might result in immediate or early recurrence of AF. If there is a high burden of atrial premature beats amiodarone might be administered. Instead, sotalol treatment before TVEC may be useful to reduce early recurrence of AF. After the cardioversion procedure, catheters are gently withdrawn and the horse is allowed to recover.

TVEC results at Ghent University
Over the years, catheter design and cardioversion technique has improved which has led to a reduced number of shocks, decreased energy demand and increased success rate. With the currently available catheters (TVEC electrode catheters, Gaeltec, UK), successful cardioversion was achieved in 98% of the TVEC procedures (1 of 57 procedures failed), with a median number of shocks of 2, a median maximal energy of 200 J and an impedance of 29 Ohm. Ninety per cent of these horses were Warmbloods with chronic AF and 8 of the successfully converted horses were referred because previous quinidine sulphate treatment had failed. In one of the successful cases, electrical cardioversion was only achieved after amiodarone had been administered during anaesthesia. The one failed case did get amiodarone but could not be converted. One horse required temporary ventricular pacing because of a 1.5 min period of asystole. Six horses received amiodarone immediately after successful TVEC because of the presence of multiple atrial premature contractions. Twenty-two horses had received sotalol treatment before the TVEC procedure to reduce the risk for immediate recurrence of AF. Long-term recurrence rate was 32% (18 of 57 treatments).

(Dis)advantages of TVEC
Major advantages of the treatment include the very high success rate and avoiding toxic side effects of medical treatment. The disadvantages are the requirement of general anaesthesia and specialised equipment which results in a higher cost. The procedure also needs experienced operators that are familiar with cardiac catheterisation and ultrasound-guided catheter positioning.

References
What does the future hold for the horses after AF: what is the prognosis?

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After successful cardioversion of atrial fibrillation (AF), most horses can return to full athletic activity. However, follow-up is needed for evaluation of atrial function and for monitoring atrial arrhythmias or AF recurrence. Evaluation of atrial contractile function can be performed using 2D echocardiographic indices or tissue Doppler measurements of atrial myocardial velocity. Especially after long duration AF, atrial contractile function is impaired due to AF-induced myocardial remodelling and improves slowly over the first days to weeks after cardioversion [1,2]. A 24 h ECG recording shortly after cardioversion often demonstrates atrial premature depolarisations (APDs). Atrial premature depolarisations are known to be able to trigger AF. However, the exact importance of APDs on recurrence and the best timing to perform the 24 h ECG recording remain to be determined [3].

Atrial fibrillation recurrence occurs in 15-40% of horses after successful cardioversion [4-9]. This large variation in recurrence rate can be explained by differences in study set-up and study population. Atrial fibrillation recurrence requires a trigger (APD) and a vulnerable substrate, the atrial myocardium, which is able to maintain AF due to its large size, electrophysiological characteristics and structural properties. Higher recurrence rates have been associated with longer duration AF and atrial electrophysiological properties, which can be explained by atrial remodelling during AF [5,9]. Larger atrial size, underlying cardiac disease such as valvular regurgitation or frequent atrial premature beats and atrial tachycardia are also considered poor prognostic indicators [3]. In human medicine, atrial contractile dysfunction after cardioversion has been described as a predictor of sinus rhythm maintenance [10]. A recent large multi-centre study on AF recurrence in horses aimed to determine whether echocardiography at 24 h after cardioversion could be used to predict AF recurrence [11]. Signalment, AF history, cardiac comorbidities such as valvular regurgitation, treatment method and administration of drugs at or after cardioversion were included as additional potential prognostic factors. The recurrence rate at one year after cardioversion was 39% (32/82 episodes) in horses with a first AF episode and 43% (47/110 episodes) overall. Approximately half of the recurrences occurred within 4 months after cardioversion. The factors associated with recurrence were previous unsuccessful treatment attempts and mitral regurgitation in horses treated for a first AF episode, and previous AF and low left atrial fractional area change when the last AF episode of all horses was considered. It remains to be determined whether echocardiography at a later time point after cardioversion would provide more prognostic information. However, persistent left atrial dysfunction could indicate irreversible atrial remodelling and therefore a higher risk of recurrence [3].

Little scientific evidence is available regarding the prevention of AF recurrence. An adequate period of rest is advised. Ideally, the horse should not be exercised until atrial contractile function is restored and post conversion arrhythmias have disappeared. The period of rest can therefore range from one week for horses with short-duration lone AF to one month or longer for horses with long-duration AF [3]. Regarding the administration of drugs or supplements to prevent recurrence, evidence from human or experimental animal studies is often extrapolated to horses. In order to suppress atrial arrhythmias, several anti-arrhythmics have been described such as sotalol, propafenone, amiodarone and phenytoin. Long-term administration of ACE-inhibitors or vitamin C has also been suggested. Oral potassium chloride supplementation is advised in horses administered furosemide before racing or in those with low fractional urinary potassium excretion. The use of furosemide, sodium bicarbonate and thyroid hormones should be avoided as this could induce arrhythmias [3].

In conclusion, evaluation of left atrial function and cardiac rhythm is indicated after successful treatment of AF. The vast majority of horses are able to return to their previous level of performance after cardioversion. Repeated rhythm monitoring remains necessary to confirm maintenance of sinus rhythm.

References
HALL 1c
FRIDAY 11th SEPTEMBER

Cardiology Panel
Chaired by Lesley Young

15.30–17.00
Panel: Annelies Decloedt, Mark Bowen, Gunther van Loon and JoAnn Slack

The panel will discuss current areas of controversy within the field of equine cardiology with a focus on atrial fibrillation.

NOTES
Dealing with the acyclic mare

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Introduction
Failure to cycle is a relatively common issue in broodmares, and the desire to produce early foals means that there is often considerable pressure to rapidly restore cyclicity. Acyclicity may be suspected on the basis of behaviour, i.e. prolonged absence of behavioural oestrus. More often, acyclicity is suggested by the findings of a gynaecological examination, and confirmed by follow-up examination(s). Signalment and breeding, medical and competitive history can be very useful in helping distinguish between potential physiological, iatrogenic and pathological causes, and in deciding on appropriate ancillary tests to identify underlying pathology or determine how best to resolve the problem.

Specific problems in young mares
Young mares fresh out of competition may have issues relating to their previous use that delay or inhibit ovarian activity; these range from low body-fat reserves to the effects of pharmaceuticals used to treat injury or aid performance, such as GnRH vaccination to ameliorate oestrous behaviour. While most mares vaccinated against GnRH resume cyclicity within a year, young mares are more prone to prolonged (2 years) or irreversible anoestrus [1]. Another important, if uncommon, differential diagnosis for ovarian inactivity continuing into the physiological breeding season in a maiden mare, is a chromosomal abnormality such as Turner’s syndrome (XO). Poorly developed tubal genitalia in a >3-year-old mare are suggestive of a chromosomal abnormality, but definitive diagnosis requires karyotypic examination, as will the rare androgen insensitive (XY) ‘mares’ that present with grossly female genitalia, but internal testicles.

Problems in older mares
Old mares ‘suffer’ from a depletion of the ovarian follicle pool leading to irregular cycles characterised by long inter-ovulatory intervals and slow follicle development; however, complete senescence-related cessation of ovarian activity is unusual before 25 years of age. It is also believed that pituitary pars intermedia dysfunction (PPIID) can result in acyclicity as a result of disturbed prolactin and gonadotrophin release. While proof that PPIID causes acyclicity is lacking, it is worth considering as a contributory factor in middle-aged mares with no other obvious cause of anoestrus.

Acyclicity despite reproductive activity
Not all mares examined for apparent acyclicity are reproducitively quiescent. In mares that were bred at the end of the previous season but diagnosed barren or that failed to deliver an embryo, unexpected pregnancy should be ruled out. Thereafter, careful examination of the ovaries and tubular genitalia may help identify other conditions that can interfere with normal cyclicity such as a granulosa-theca cell tumour (GTCT), a persistent corpus luteum (CL) or an anovulatory haemorrhagic follicle (AHF). A persistent CL or mature AHF will secrete progesterone and therefore increase uterine and cervical tone, and can be lysed by administration of a PGF2α analogue. However, PGF2α analogue administration may predispose to AHF formation [2] and should be used sparingly in mares that suffer repeated AHFs. Repeated luteinised anovulatory follicle formation can also result from persistent endometrial cups (PECs), an uncommon condition that should be considered when there is a history of Day 35-150 pregnancy loss. Persistent endometrial cups are sometimes visible ultrasonographically, but definitive diagnosis requires hysteroscopy during which PEC ablation can be attempted.

Seasonality
Undoubtedly, the most common ‘cause’ of acyclicity is attempting to breed early in the year before day-length has increased sufficiently to enhance gonadotropin release and initiate cyclicity. Early breeding is the ‘norm’ in Thoroughbred and Standardbred breeding and, accordingly, management techniques have been developed to optimise the likelihood of early cyclicity. Chief amongst these is the use of artificial lighting to simulate longer days; a period of >35 days of >16 h light a day or, more precisely, the absence of any single period of >8 h continuous darkness, is the best stimulus to early season cyclicity. Since little more than 10 lux is required to suppress pineal activity, sufficient lighting can be provided by floodlights in small paddocks or by (preferably blue) light reflected onto the eye via a custom designed ‘mask’ [3]. Another powerful trigger to cyclicity is body condition; well-fed mares either cycle all year around or have a relatively short anoestrus. Supplementary lighting and feed are especially important in young maiden mares in which the natural onset of cyclicity tends to be later, and should also be borne in mind for foaling mares; indeed, the incidence of ‘lactational anoestrus’ can be reduced by keeping foaling mares under lights. Finally, exposing mares to pheromonal cues, e.g. by housing them with a stallion, will also accelerate the onset of cyclicity [4].

Pharmacologically stimulating cyclicity
It is notoriously difficult to pharmacologically induce cyclicity in mares during deep winter anoestrus, although success has been reported using up to 10 days of frequent or continuous GnRH analogue administration or repeated (recombinant) equine FSH. It is easier to hasten progress through the ‘transitional phase’ when follicles develop but fail to ovulate. In mares with a follicle >20 mm, 10 days of progesterone priming will both advance the onset of ovulatory cycles and increase the sensitivity of the first subsequent large follicle to hCG. Dopamine antagonists (e.g. domperidone, sulpiride) stimulate an increase in circulating prolactin concentrations (more effective following oestrogen-priming) and kisspeptin analogues enhance gonadotropin release, but neither has yet been proven to reliably induce cyclicity.
References


Managing prepubic tendon rupture
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Prepubic tendon (PPT) ruptures are a life-threatening condition of the mare in late gestation [1]. They should ideally be differentiated from abdominal wall (AW) ruptures or hernias; however, differentiating the two conditions is not always clinically possible. They may be categorised together as body wall defects.

The abdominal wall is made up of the external and internal abdominal oblique muscles and their aponeuroses, the transversus abdominis and rectus abdominis muscles. Any or all of these muscles may be involved in tears. In some instances of AW rupture, the gastrointestinal viscera and uterus can lie subcutaneously.

The PPT runs along the pectin of the pelvis from one iliopectineal eminence to the other. It is comprised of the linea alba and the insertion of the rectus abdominis muscle and is the origin of the pectineus (running from iliopectineal eminence to the pelvic symphysis) and gracilis muscles. Complete rupture of the PPT leads to complete loss of support to the ventrolateral abdominal wall.

Draught breeds [1] and Standardbreds [2] appear over-represented. There may be a genetic predisposition in Egyptian Arabs [3]. It is more common in older multiparous mares. Conditions that predispose to the condition are trauma, twin pregnancy and hydrops (hydramnion or hydrallantois) [4,5].

Mares with abdominal wall tearing are often colicky, but reluctant to move or lie down. They show a progressive ventral or ventrolateral oedema. The progression of oedema can vary greatly. On occasion a palpable defect in the abdominal wall is present, or abdominal contents can be seen directly under the skin.

Mares with PPT rupture are also distressed, painful and reluctant to move. They often demonstrate a more severe ventral oedema which progresses quickly. The flank area is poorly defined. As the pelvis is no longer in alignment with the spine they demonstrate lordosis and elevation of the tubera ischia and tailhead [1]. The mammary gland may have an abnormal conformation with the teats pointing cranially and blood exiting the front orifice of each teat.

Both conditions can generally be diagnosed by clinical signs. It may not be possible to differentiate AW tearing from PPT rupture. Ultrasonography is useful to confirm muscular defects with accompanying haematoma formation, to detect underlying hydrops and to determine fetal viability.

Decision making in the management of these conditions is not straightforward. Factors that must be considered are the systemic status of the mare, rate of progression of clinical signs, gestational length and the relative importance of the mare or foal.

In cases in which the mare is systemically unwell, has uncontrolled pain and a gestational age of <320 days, survival of both mare and foal is unlikely.

• If the mare and foal have little economic value, euthanasia is warranted
• If the foal is valuable a terminal C-Section can be performed but there is a very low likelihood of a viable neonate [4].
• If the mare is valuable, abortion of the foal (with assisted delivery) should be considered. Abortion of late stage pregnancies can be carried out with daily administration of PGF2α (10 mg) or cloprostenol (250 μg) [6].

In cases in which the mare is stable and pain is controllable, and has a gestational age >320 days, the aim is to provide supportive care and allow fetal maturation with the aim of saving both mare and foal. Foal survival has shown to be higher where supportive treatment is used in preference to intervention [2]. Supportive treatment consists of:

• Stall rest
• Abdominal support (elastic bandages, commercial belly bandages, canvas slings)
• Pain relief (nonsteroidal anti-inflammatories, opioids, CRls of lidocaine or butorphanol)
• Broad spectrum antimicrobials
• Progestin therapy (0.044–0.088 mg/kg bwt alrenogest)
• Dietary management; reducing the bulk of the diet and providing laxatives.

Close monitoring is required. Mares should be examined frequently for changing cardiovascular parameters and readiness for parturition. Frequent monitoring of the fetus (repeat ultrasonographic examinations and electrocardiographic monitoring via telemetry) is required.

Owners should be warned that despite providing supportive treatment, rapid progression of signs with catastrophic rupture and death may occur.

In cases in which supportive treatment has been successful and the mare reaches parturition, assisting parturition is essential as the mare will have little to no ability to contract her abdomen.

In cases in which clinical signs progress, despite supportive care, and where the status of the mare and/or foal deteriorate, the clinician needs to decide whether to allow conservative management to proceed (with the risk of a catastrophic body wall tear progressing) or whether to intervene (with the risk of delivery of a premature foal). Interventional management consists of induction of parturition or an elective caesarean section.

In an ideal scenario, one would minimise the risk of a premature and nonviable foal by inducing parturition only when appropriate, based on fetal readiness for birth. Criteria for successful induction of parturition include; gestational length >330 days, relaxed sacrosciatic ligaments, relaxed cervix, appropriate changes in mammary secretions (increased calcium >10 mmol/l, inversion of sodium and potassium; usually around 30 mmol/l) [7].

However, in reality, if the status of the mare and foal are deteriorating, induction may need to be performed prior to this stage. If it is judged that the mare can survive for 4–5 days, daily administration of 100 mg of intramuscular dexamethasone can be initiated; this regime results in a shorter gestational length, with advanced fetal maturity, in healthy mares [8]. Clearly the benefits of this regime need to be outweighed against the risks of sudden death in these mares.

In instances in which parturition must be immediately induced, oxytocin is the drug of choice [9,10]. A regime of 10 iu i.v., repeating as needed in 20–30 min, has been shown to be safe and efficacious.

If the mare survives a prepubic tendon rupture, re-breeding is not advised. Some abdominal wall defects are candidates for surgical repair [5] through direct suturing or with prosthetic mesh (performed 3–4 months post foaling). Embryo transfer, where possible should be encouraged as an alternative to re-breeding.
Manufacturers' addresses

aCM Hernia Heal Belt; CM Equine Products, Norco, California, USA
bBoa; Re-wrap Pro Veterinary Products, Paris, Kentucky, USA

References


Preparing transported semen of problem stallions

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There are great individual differences in semen quality of stallions – and even more so in the tolerance of sperm to cooling or freezing. In most western European countries, the majority of trotter and riding mares are inseminated with cooled transported semen, although the pregnancy rates (PR) are often lower compared to fresh semen insemination (AI). Some stallions have such poor sperm quality that acceptable PRs are not achieved using routine semen preparation methods. In the handling of semen for shipment, rigorous control of temperatures and hygiene is very important. Cooling and storage stress sperm which do not tolerate these conditions if they have been mistreated during semen processing.

Seminal plasma

It is well known that the presence of seminal plasma (SP) is detrimental to the maintenance of sperm motility, viability and fertility. Therefore, the proportion of SP is reduced by dilution of semen. The optimal amount of SP during semen storage is <20%, and thus, the recommended extender: semen ratio is 4:1. The optimal sperm concentration during storage is from 25 to 50 x 10⁶/ml, and therefore dilution ratio 4:1 requires sperm concentration of at least 125 x 10⁶/ml. Even with this concentration the total volume of semen dose may become too large, if the progressive motility is low. Large volumes do not affect fertility of mares but most disposable transport containers can accommodate only 40 ml.

The SP effect during storage depends also on stallions: some stallions possess SP that even after a short exposure decreases sperm motility, viability and fertility. In case of ‘toxic’ SP or when the sperm concentration is low, SP has to be removed or the proportion substantially reduced. Some other stallions produce ‘good’ SP which, if exchanged between stallions, improves the maintenance of motility during storage.

Semen concentration methods

Semen collection with an open-ended vagina allows the collection of the first sperm-rich fractions only; by doing so the sperm concentration is easily doubled. In addition, gel is avoided and there are very little bacteria, since semen is collected directly from urethra. Even stallions shedding Pseudomonas can be used if there is no growth in the urethra. However, approximately 20–30% of sperm is lost in the last ejaculate fractions.

The newest method is filtering of sperm (SpermFilter®). Depending on how much fluid is left in the filter the semen may be concentrated 2- to 3-fold. However, filtering of a large volume ejaculate using the recommended 1:1 dilution with extender takes a long time. The manufacturer recommends that each stallion has its own filter, but they can be washed and used 10 times.

If the sperm concentration is very low, semen has to be centrifuged. After centrifugation, the majority of supernatant is removed and the sperm pellet is mixed with extender. Sperm losses depend on centrifugation forces: the higher the speed the better the sperm recovery rate, e.g. the use of 400 x g and 20 min results in about 30% of sperm being lost, whereas with 1000 x g and 5 min the loss of <10% of sperm cells is expected. With higher speeds the sperm may be damaged, but this can be overcome by using cushion fluid on the bottom of the centrifugation tube.

Storage temperature and extenders

Stallion semen is best preserved if the semen is cooled slowly to about 5°C. The majority of semen transport containers maintain the temperature between 5 and 10°C for 24 h in normal ambient temperatures. However, already a 3-h cooling results in decreased sperm longevity in the mare’s genitalia. The explanation for the lowered PRs after cooled semen AI in practice may be a too long interval between AI and ovulation (>24 h). The sperm of some problem stallions may be oversensitive to cooling which reduces sperm longevity.

For stallions producing semen sensitive to cooling the use of higher temperatures during shipment may be tried. Good results have been reported in the temperature range of 15 and 20°C using INRA-96® extender. INRA-96® extender works as well in all temperature ranges between 5 and 20°C. It is highly effective in the control of bacteria and yeasts in the semen. Abundant microbial growth has been shown to decrease sperm motility. For problem stallions, different extenders can be tested, e.g. Botu-Semen has been advocated for ‘bad coolers’.

In a Styrofoam box, the temperature between 15 and 20°C is maintained in normal ambient temperatures for 24 h if the cooling device is kept overnight in the refrigerator instead of the freezer. It seems that in stallions of high fertility the higher temperature may decrease PRs of mares whereas in some stallions with low fertility the opposite effect can be achieved.

Sperm selection

Selection of sperm by density gradient centrifugation has been used for a long time to get small numbers of very good sperm for in vitro fertilisation techniques in humans. Equipure® was the first equine product which was able to separate cells with differing specific gravities into different layers. It was followed by Androcoll-E® which is based on a single layer centrifugation (SLC) technique. It was scaled-up to allow large volumes of semen, such as whole stallion ejaculates, to be centrifuged in 50 ml Falcon tubes. The idea is to get high quality sperm to the AI dose by selecting motile, viable, morphologically normal sperm with good chromatin and intact plasma membranes. By doing so, viruses and bacteria can also be excluded from the AI dose.

Androcoll-E®-centrifugation also removes SP thereby improving sperm motility, viability and fertility during storage. Single layer centrifugation-treated spermatozoa retain their motility, viability and chromatin integrity longer during storage than non-treated sperm. This technique is particularly suitable for stallions which produce low quality sperm and lots of dead sperm which is often associated with low sperm concentration and motility. Deep horn Al can be applied if the yield of good sperm remains low.

Androcoll-E®-treatment results in extra costs and it takes about half an hour to do, but its use is justified in problem stallions.
The aged maiden mare: increasing your chances of success
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Introduction
The aged maiden mare is primarily a sport-horse issue that arises because dressage and showjumping mares are not allowed, and often not able, to compete at the highest levels until they are 7 years old. Moreover, injury permitting, sport-horse mares can continue to compete at an elite level until their mid to late teens. In short, an elite dressage, showjumping or eventing mare’s competitive career will often extend beyond her years of optimal fertility. Given that owners and/ or breeders are likely to want to produce progeny from proven performers, this presents a dilemma. Some owners anticipate the possible conflict by producing foals or foals from embryos from mares when they are 3–4 years old, and still at an early stage of their training. Indeed, committed breeders may continue to use mares as embryo donors throughout their competitive career; however, while some mares will readily produce embryos without any noticeable effect on performance, others appear to struggle with the dual demands and either yield disappointing numbers of embryos or suffer a drop in performance level. Certainly, riders often complain that elite mares are disturbed by the various hormonal manipulations and accompanying examinations required for insemination and embryo recovery. For this reason, the recent development of ovum pick-up and intracytoplasmic sperm injection to a commercially viable means of producing foals is being followed with interest within the sport-horse world; oocyte recovery can be performed as an outpatient procedure with no requirement for preparatory oestrous cycle manipulation and followed by only 1–2 days of rest or reduced training intensity. Nevertheless, a large number of mares are still presented for breeding in their mid- late teens either as maidens, not having ever given birth to a foal, or not having produced a foal for many years.

The aged maiden mare syndrome
When presented for breeding for the first time after years of athletic competition, mares can display a range of issues relating either to their advanced age or the fact that they have never previously been bred or given birth. Some may also still be ‘competition fit’ and need time to relax and accumulate body-fat. The archetypal reproductive ‘abnormality’ of the ‘aged maiden mare’ is a long, fibrotic cervix that relaxes poorly even when the mare is in optimal oestrus. This is primarily a factor of the mare not having recently produced a foal, and is also encountered in older mares that have been used exclusively for embryo transfer or that have had an extended break from breeding. For mares that need to be covered naturally, it is possible that cervical relaxation will be insufficient to allow intrauterine ejaculation and/or passage of an adequate number of sperm into the uterus. This can be addressed by topical application of PGE preparations (preferably PGE2) to enhance cervical relaxation, and ‘reinforcement breeding’ (i.e. collecting the semen deposited in the vagina and introducing it into the uterus using an AI catheter). The poorly relaxed cervix also presents a significant obstacle to the uterine drainage required to clear the inflammatory response to mating or insemination. This can generally be managed adequately by digitally dilating the cervix during a post-breeding (usually 4–12 h later) examination for ovulation and fluid accumulation, combined with uterine lavage and administration of ecbolics to assist uterine evacuation. In the authors’ experience, it is rarely necessary to augment treatment with topical PGE2.

Maiden issues
When examining older maiden mares, it is important to remember that they have no breeding track record and, therefore, may have undiagnosed congenital anomalies or problems normally diagnosed in 3–4 year olds. They may also be slow to start cycling at the start of the year because of low fat reserves, or treatments received during their competitive career. The lack of body fat may also predispose them to poor perineal conformation, adding an extra predisposition to pneumovagina and persistent post mating endometritis.

Old mare issues
Similarly, being a maiden does not exempt a mare from the degenerative changes associated with age. These will include chronic endometrial fibrotic degeneration (endometrosis), which may or may not be accompanied by the development of endometrial cysts. The cysts may be visible ultrasonographically and, if they are large, numerous or likely to be missed diagnosed as a pregnancy can be removed by diathermy or Nd:YAG laser treatment during hysteroscopy. However, if the intention is for the mare to remain pregnant and produce her own foal, it is more relevant to take an endometrial biopsy to examine the degree of degeneration and give an indication of the likely ability of that mare to carry a foal to term. Although endometrial fibrosis is essentially irreversible, the problem can be circumvented by using embryo transfer, when permissible. The uterus of the older mare may also be poorly contractile and less able to expel inflammatory products following breeding, again requiring additional support in the form of ecbolics or uterine lavage.

Other issues related to ageing that may compromise fertility and should be considered, despite the mare being a maiden, include PPID, slow or irregular cyclicity as a result of depleted follicular reserve, occlusion of the oviduct with fibrin plugs, and a less reliable response to ovulation- inducing drugs such as hCG.

Conclusions
The aged maiden mare is primarily a challenge because we tend to forget that they may have congenital abnormalities that have not been identified previously, or that the reproductive tract will have aged despite their having never been bred. Assuming that the mare is reproductively normal, the greatest challenge is generally to ensure adequate cervical patency and prevent the development of persistent post breeding endometritis. It is however, increasingly clear that being pregnant is good for the uterus while giving birth can do wonders for subsequent cervical relaxation.
Effective fluid therapy is an essential part of any care plan for a critically ill foal. Foals are not just small horses and a number of important physiological differences must be considered when formulating a fluid plan.

- Foals have higher body water content than adult horses (approximately 75% of body weight compared to 60%) with a relatively larger extracellular fluid compartment.
- Foals have a higher metabolic rate and surface area which leads to increased insensible fluid losses.
- Healthy foals have a high fluid intake. An average foal will consume between 20–25% of their body weight in milk daily.
- Foals have a reduced renal concentrating ability and a reduced ability to excrete excess water and sodium.

The combined effect of these differences mean that foals have a higher fluid requirement than adult horses. Reduced fluid intake or increased fluid losses can quickly cause severe perfusion abnormalities. Inappropriate (usually high sodium) or excessive fluid therapy can also be detrimental due to fluid and sodium retention.

Recognition of the need for fluid therapy

Clinical signs of hypovolaemia include cold extremities, obtundation, prolonged capillary refill time, poor pulse quality, poor jugular refill and decreased urine output. Tachycardia can be present but is a variable finding in the foal. Clinical signs of dehydration include tacky mucous membranes, increased skin tent (unreliable), sunken eyes or reduced corneal moisture. Measurement of urine specific gravity can be very useful when assessing hydration. A normal foal has hypothenuric urine (<1.010).

Laboratory markers can also be used to evaluate the need (and efficacy) of fluid therapy. Measurement of blood lactate can help assess tissue perfusion. Increased blood lactate indicates reduced tissue perfusion and is often (but not exclusively) associated with hypovolaemia. A normal foal has hypothenuric urine (<1.010).

Serial measurements of packed cell volume and total protein can be useful when monitoring response to therapy but are less sensitive than the use of blood lactate. Serum biochemistry can be useful to evaluate for signs of renal and other organ dysfunction. Measurement of protein concentrations and electrolytes are very important in critically ill foals and foals with diarrhoea as electrolyte derangements are common. Immunoglobulin G concentration should be measured in young foals. Glucose concentration should be measured to evaluate the need for emergency energy support.

Other indices including blood pressure, oxygen extraction ratio and central venous pressure can be used when evaluating the need for fluids but in reality careful clinical assessment with rapid response is more important.

Emergency fluid resuscitation

Isotonic crystalloids are usually the first-line choice for resuscitation therapy. Hartmann’s solution is the best commercially available fluid. 0.9% sodium chloride should be avoided as it creates a strong ion acidosis. Hypertonic saline should also be avoided as it can cause severe sodium overload.

The ‘bolus method’ is a simple way of administering emergency fluids to a collapsed or severely hypovolaemic foal. This involves administration of a 20 ml/kg bwt bolus of isotonic crystalloids over 15–20 min and then evaluating the clinical effect. Positive signs include improved mentation, improved capillary refill time or colour, improved pulse quality or extremity temperature or urination. Up to 3 boluses can be administered safely. If 3 boluses fail to improve the clinical signs of perfusion, other options such as vasoactive drugs should be considered.

If glucose concentration cannot be measured, 20 ml of 50% dextrose can be added to each litre of fluids to create a 1% solution. This will correct life-threatening hypoglycaemia without causing severe hyperglycaemia. It is preferable to measure blood glucose concentration as many collapsed or critically ill foals are hyperglycaemic.

Maintenance fluid therapy

Isotonic crystalloids are not appropriate for maintenance therapy in foals due to their high sodium content. This is especially important in foals that are not receiving oral water or milk. A good general guideline is to try and limit sodium intake to around 3 mEq/kg/day. In practice, this is often quite difficult as 1 l of Hartmann’s or plasma provides roughly this daily amount. The sodium content of drugs, flush solutions etc should also be considered.

Commercially available maintenance fluids include 5% dextrose or 0.18% sodium chloride plus 4% dextrose. Other fluids such as Plasmalyte-56 have a better composition but are not currently available in the UK. Alternatively, Hartmann’s solution and 5% dextrose can be combined at a ratio of 1:3 or 4.

Maintenance fluid rates vary between foals but a good starting point is 4–6 ml/kg bwt/h. This rate should be frequently re-evaluated as it can often be reduced after a few hours. Some clinicians prefer to use a lower rate for maintenance. This can be calculated as 100 ml/kg bwt/day for the first 10 kg, then 50 ml/kg bwt/day for the second 10 kg and then 25 ml/kg bwt/day for all additional weight. For a 50 kg foal this equates to an hourly rate of 94 ml/h.

Basic energy requirements should also be considered when considering maintenance fluids. A supply rate of 4–8 mg/kg bwt/min of dextrose is a good starting point. The lower end of this rate can be provided by 240 ml/h of 5% dextrose or 300 ml/h of 4% dextrose. These rates are often appropriate in the early stages of fluid therapy but additional 50% dextrose can be added when fluid rates are slowed down.
Colloids
There is little data evaluating the use of colloids in equine neonates. In human neonates, no consistent benefit has been found when comparing colloids to crystalloids for resuscitation. Hydroxyl-ethyl starch or modified fluid-gelatine solutions have both been used in foals. These products may be most useful in treating older foals with diarrhoea-induced hypoalbuminaemia. Plasma can be very useful to provide immunoglobulins and colloidal support.

Further reading
Pitfalls in treatment of angular limb deformities
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Case selection
It is critical that one identifies angular limb deformities (ALDs) that have arisen secondarily to other problems rather than simply asymmetrical physeal growth. Examples are ALDs resulting from incomplete ossification of cuboidal bones, those originating from physeal damage (physeal fractures, septic physeitis) and those that occur on occasion secondarily to lameness in a contralateral limb.

It is important to consider the age of the foal. In young foals, some ALDs (such as mild carpal or tarsal valgus) are essentially normal and intervention is unnecessary if they are continually improving. Those that stop improving require treatment. It is also important to know what changes naturally occur and to anticipate this. For example, chest widening is a normal part of maturation. This causes the elbows to be pushed out, causing an inward rotation/deviation of the lower limbs. The result is that mild carpal valgus will improve, yet fetlock varus will worsen. This effect is magnified in foals with concurrent offset cannons. As this change sometimes occurs later in life, if not anticipated it will lead to many foals presented at >6 months of age with untreated fetlock varus.

Generally it is recommended that periosteal elevation (PE) of the fetlocks and carpi/tarsi is performed around 2–3 weeks of age and 10–12 weeks respectively, and transphyseal retardation techniques of the fetlocks and carpi/tarsi are done around 6 weeks of age and 9–12 months respectively. Often foals are presented later than ideal or ALDs worsen at a later stage. In these instances, transphyseal retardation techniques of the fetlock and knee can be undertaken as late as 4 months and 16 months respectively, with some success.

Hoof trimming
Foals with varus deformities will wear the outside of the foot more and require excess hoof to be removed medially to produce a flat sole. The opposite is true for valgus deformities. It is easy to remove excess hoof, causing bleeding from the solar surface, pain and lameness. The most commonly made mistake is to over-trim severe ALDs. No amount of excess trimming will correct an ALD. It will, however, result in a deformed hoof capsule, detracting from sales value and potential athletic function.

Hoof extensions
In order to encourage correct physiological loading of the limb, extensions should be applied laterally in a varus deformity, and medially for valgus deformities. Most commonly, polymers such as Equithane® and Equilor® are used. It requires practice to build even, flat, weight bearing, long lasting extensions. Success relies on meticulous hoof preparation. Most of the polymers set with an exothermic reaction. It is essential to protect the coronary band from this, as thermal necrosis may cause the hoof capsule to slough off.

Periosteal elevations
Although the efficacy of the PE has been questioned, it is still a commonly performed procedure. There are few complications resulting from the procedure, which is carried out on the concave side of the limb. When performing it on the distolateral radius, it is important to elevate and thus avoid the lateral digital extensor tendon and to transect the distal ulna if present. Owners of potential sales foals should be warned that on occasion, the procedure may result in surprisingly large bony or fibrous lumps. The fibrous lumps may be related to the degree of haemorrhage from the periosteum and a roll of gauze placed into the concavity of the distal radius, followed by firm bandaging may alleviate this.

Transphyseal screws
The perfect screw should be close to the edge of the physis and engage 50–75% of the epiphysis.

Complications associated with this procedure are:
- a. Screw placed across midline; this is relatively easy to do if care is not taken to insert the drill more parallel to the limb than first anticipated. It is also easy to make this mistake in small pony foals with carpal valgus as the chest hinders your ability to drill parallel to the bone
- b. Screw placed too abaxially; this will result in insufficient purchase in the bone. Avoid this by creating a seat in the bone at the site of entry, so you are less likely to slip down the side of the bone
- c. A drill hole drilled into the joint; this will not always lead to complications but has the potential to result in the development of subchondral bone cystic lesions
- d. Screw that is too short; this will not engage the epiphysis sufficiently. Correction will not be achieved, or correction will suddenly ‘stop’

Complications associated with screw removal include:
- a. Stripping the screw head. This arises from a failure to clean the screw head recess from the plug of fibrous tissue (always present), a blunt screwdriver or a screwdriver inserted into the screw head at an angle. If this occurs, extraction screws are available which have a conical tip to grasp the screw recess (Conical Extraction Screws)
- b. A buried screw head. This arises from creating too large a ‘seat’, excessive countersinking or screws left in place for a long period of time. It is essential to clear the screw head completely of surrounding bone, or the screw head will snap
- c. A broken screw head. This requires removal with pliers (special pliers made by Synthes are available). The screw shaft must be cleared of bone to achieve this.
- d. Removal of a bent screw. This must be done with caution to avoid screw breakage. Removal of broken screw shafts will be discussed.

Complications following transphyseal screws are:
- a. Infection
- b. Over correction due to lack of owner compliance
- c. Physeitis
- d. Metaphyseal collapse resulting in over correction.

It is worth noting that metaphyseal collapse is seen more commonly with transphyseal screws rather than screws and wires [1]. It seems to be more common in the carpi of older weanlings/yearlings. It is for this reason that many hospitals have reverted to screws and wires in these instances.
Transphyseal screws and wires
Prior to 2004, screws and wires were the standard implants used to perform growth retardation. The procedure was largely superseded by single transphyseal screws as this is generally faster and cheaper to place and often leaves a less obvious cosmetic blemish.

Complications seen with screws and wires include infection, wire breakage, over-correction if owner compliance is poor and the development of a cosmetic blemish.

Particular care should be taken when performing the procedure in cases of bilateral carpal valgus, as there is the potential for skin incisions to rub against each other (this is also the case with transphyseal screws).

Manufacturer’s address
A Vet. Synthes, Eimattstrasse 3, 436 Oberdorf, Switzerland. www.depuy synthes.com

Reference
Urinary defects in foals – are you sure it’s a ruptured bladder?

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The diagnosis of a classic case of ruptured bladder is often quite easy. However, there are a number of other conditions that can manifest in a similar way.

**Bladder rupture**
Foals with a ruptured bladder usually present at around 2–3 days of age. Colts or fillies can be affected. Clinical signs usually include an increased heart rate, shallow rapid respiration, progressive abdominal distension and generalised lethargy and depression. Signs of urination are variable. Some foals will strain and pass small volumes of urine whilst others will be seen to urinate quite normally. Blood work reveals a high creatinine concentration (usually with a relatively normal urea concentration), hyponatraemia, hypochloraemia and hyperkalaemia. There are also often signs of inflammation (neutrophilia and increased serum amyloid A concentration). The clinical signs and blood work changes can be milder in foals that are receiving intravenous fluids.

Ultrasound examination of the abdomen reveals an accumulation of peritoneal fluid that is often mildly echogenic. The bladder appears collapsed.

Diagnosis is often made based on clinical signs and laboratory abnormalities but a diagnosis of uroabdomen can be confirmed by measurement of peritoneal fluid creatinine concentration (ratio of blood to abdominal creatinine will be >2:1). If there is any uncertainty, radiopaque dye can be instilled into the bladder and radiographed to check for leakage into the abdomen.

Following diagnosis, treatment involves medical stabilisation prior to surgical repair. Stabilisation involves intravenous fluids (either 0.9% NaCl or Hartmann’s), placement of a urinary catheter and abdominal drainage. In some cases, intravenous glucose and/or insulin are necessary to treat life-threatening hyperkalaemia. Prior to surgery sodium should ideally be greater than 120 mmol/l and potassium below 5.5 mmol/l.

**Differentiating bladder rupture from other conditions**

1. **Foals with abdominal distension**

   There are 2 different subsets of foals with other diagnoses that can be confused with a bladder rupture. The first subset is foals presenting with abdominal distension for other reasons.

   The correct diagnosis can usually be made using a combination of ultrasound and basic laboratory tests. Figure 1 shows how ultrasound can be extremely useful.

   **Fig 1:** Using ultrasound to help evaluate the likelihood of a bladder rupture.

   Defects elsewhere in the urinary tract

   A small proportion of foals with uroabdomen will have a ureteral defect. If ultrasound reveals signs of abdominal fluid accumulation without a collapsed bladder this should raise the suspicion of a more complicated problem. The kidneys and peri-renal area should be imaged carefully with ultrasound as some proximal defects can lead to retroperitoneal fluid accumulation. A sample of peritoneal fluid should be collected for evaluation. Uroabdomen is confirmed if the peritoneal creatinine concentration is high (ratio >2:1). In this instance it may be useful to instill radiopaque dye into the bladder to confirm whether a small bladder defect is present. If this is normal then an intravenous pyelogram with radiography can be performed. The high body water content of foals dilutes out the dye and the images obtained can be disappointing. If a ureteral defect is suspected, careful surgical exploration may be necessary to confirm the diagnosis and correct the problem. Small defects in the bladder can also cause uroabdomen. These can also be addressed surgically.

   **Septic peritonitis**

   Septic peritonitis can develop as a primary manifestation of sepsis or occur secondary to gastrointestinal disease or inflammation. Ultrasound in these cases usually reveals a more echogenic appearance to the peritoneal fluid. The foal will also usually display more clinical signs of systemic inflammatory response syndrome (SIRS) or sepsis. Diagnosis requires evaluation of a peritoneal fluid sample. This usually reveals an increased white blood cell count, total protein and lactate concentration. Cytology can also be useful. Creatinine concentration will be similar to blood concentration. Blood work will reveal signs of systemic inflammation but will not usually reveal the classic electrolyte abnormalities seen with uroabdomen.

   Treatment of peritonitis depends on its aetiology but usually involves broad spectrum antimicrobials +/- abdominal lavage or exploration.

   **Colic**

   Some foals with severe intestinal distension will also strain to urinate raising the suspicion of a ruptured bladder. The severity of colic and pain displayed by these foals is usually much greater than in foals presenting with a ruptured bladder.

   ‘High’ meconium impaction causing severe gas distension of the colon is the most common underlying cause. Ultrasound reveals gas distension of the large colon +/- meconium balls.
2. Foals presenting with abnormal laboratory values

Spurious hypercreatininaemia
A high creatinine concentration can be detected relatively commonly in young neonates (<36 h of age). In foals with normal renal function this is termed spurious hypercreatininaemia. This abnormality is suspected to be related to abnormal placental clearance of creatinine. Some of these foals will have experienced in utero placentitis or be born with clinical signs of neonatal maladjustment syndrome. However, some foals appear completely normal. Urea concentration is normal. No treatment is usually necessary but it is important to monitor creatinine concentration. This should roughly halve every 24 h until it has returned to normal.

Acute kidney injury
Foals with acute kidney injury can present with blood work abnormalities very similar to a foal with uroabdomen.

Abnormalities include a high urea and creatinine concentration, hypornatraemia, hypochloraemia and hyperkalaemia. These foals may also have hypercalcaemia and hypermagnesaemia.

Causes of acute kidney injury include birth hypoxia, sepsis, nephrotoxic drugs (oxytetracyline, aminoglycosides, nonsteroidal anti-inflammatory). Early recognition and careful treatment of these foals is essential.

Further reading
Mare reconstructive surgery: when and what?
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Maintaining a yearly breeding interval is critical to avoid economic wastage in the Thoroughbred broodmare industry. A variety of reconstructive surgeries are available to allow us to restore or enhance fertility. It is important that we strive for good surgical technique, in combination with appropriate timing, in order that the mare can be successfully and expeditiously re-bred.

Conditions in which reconstructive surgery are mandatory are third degree perineal lacerations, rectovaginal fistulas, and cervical tears. Conditions that may benefit from reconstructive surgeries include second degree perineal lacerations, uro vagina and pneumovagina.

Caslick's procedure
In subfertile mares requiring multiple cycles to conceive, this procedure may need to be repeated several times each season. Removal of excess tissue and skin should be avoided. The suture should continue 3–4 cm past the pelvic brim.

Episioplasty
This is required when a Caslick’s procedure alone cannot restore the desired anatomy, such as severe sinking of the anus or following a second degree perineal laceration. It is performed under standing sedation with local infiltration, rather than epidural anaesthesia. It consists of removal of triangular pieces of mucosa, connecting dorsally, from each side of the vestibule. The most ventral borders are sutured together in a simple continuous pattern. This leaves a defect above, which is sutured closed, obliterating dead space and increasing the size of the perineal body whilst decreasing the size of the vestibule. Skin is closed by performing a Caslick’s procedure.

Perineal body transection
This is required when a Caslick’s procedure and an episioplasty cannot restore the desired anatomy, usually in cases of severe sinking of the anus and positioning of the vulva dorsal to the pelvic brim. The aim is to sever the tissue within the perineal body to allow the vulva to attain a more normal alignment. This is performed under standing sedation with local infiltration. A towel clamp is placed on the dorsal commissure of the vulva and the ventral aspect of the anus. A horizontal incision is made midway between the two and continued cranially for approximately 10 cm. It is helpful to place a hand periodically in the rectum and vagina to avoid penetration of either. The incision is left open for second intention healing.

Urethral extensions
Many variations of this surgical technique exist [1–3]. Our preferred technique is that of McKinnon and Belden [4]. The procedure creates an extended tunnel from the urethral orifice, underneath the transverse fold to the caudal vestibule. A horizontal incision of the transverse fold is made 3 cm cranial to the caudal border. The edges of this incision are continued laterally to each vaginal wall and then caudally, to form a piece of tissue which can be reflected caudally. With sufficient dissection, the tissue flaps can be apposed in a ‘Y’ shape without excess tension. Tissue is sutured in a continuous inverting pattern.

This surgery can be performed and the mares bred in the following cycle, or the vagina can be manually cleaned, the mare bred, and the surgery performed immediately following ovulation [5].

Rectovaginal fistula repair
Fistulas contract as they attempt to heal, and small fistulas may heal spontaneously. The ideal timing of surgery is 3–4 weeks after parturition, which will allow contraction of the fistula and production of a fibrous ring of scar tissue around the edges of the fistula, whilst also allowing efficient re-breeding. We have successfully bred mares on the second (prostaglandin induced) cycle after parturition, and performed surgery immediately following breeding and confirmation of ovulation, to allow timely re-breeding [6].

Fistulas can be repaired via an approach through the vagina [7], through the rectum [8,9], through a horizontal incision into the perineal body [7] or by converting to a third degree perineal laceration [10]. Our preferred technique is the transrectal approach. Episiotomy is required for this surgery. This approach is straightforward if using appropriate retractors; our preferred instrumentation is the Aanes modified Finoccheto retractors*. The retractors are placed through the anus, and the fibrous ring surrounding the fistula is incised and undermined in all directions for several millimetres. The fistula is then closed transversely in three layers; the perineal body, the rectal mucosa, and vaginal mucosa. The retractors need to be placed into the vestibule for the vaginal layer.

Repair of third degree perineal lacerations
These are challenging surgeries. Surgery needs to be delayed for several weeks following parturition, to allow sloughing of necrotic tissue and the production of scar tissue which will hold sutures. We commonly leave them for several weeks or months, as the endometritis resulting from these injuries is usually reversible [11]. If present for more than one breeding season, it would be prudent to perform a uterine biopsy prior to operating.

Epidural anaesthesia is essential and surgery should not be started without adequate anaesthesia, as they are lengthy procedures. Prior to starting surgery, it is vital that the mare has received several doses of paraffin oil, and been held off feed or allowed access only to green pasture. Without appropriate attention to faecal softening, success rates dwindle.

The rectum is packed with cotton wool. Towel clamps are placed on either side of the dorsal vulval commissure and retracted. A line of scar tissue can be identified at the junction of the rectum and vestibule. An incision is made just below this and continued slightly cranially, then caudodorsally along the vestibular wall. With sufficient dissection, enough tissue can be undermined to produce flaps of tissue which can be apposed without tension. This reflected vestibular mucosa/submucosa is the ventral border of the perineal tissue. The rectal mucosa/submucosa is also undermined until it too can be apposed on midline. There are now three layers to close; vestibular mucosa/submucosa, rectal mucosa/submucosa and the perineal body between the two. These layers are closed contemporaneously, starting with the vaginal layer, then the rectal layer. Tension is held...
on these sutures, whilst the tissue between the two (the re-created perineal body) is closed. In order for this repair to be successful, these tissue layers must be closed without excess tension. This is achieved through adequate dissection, and appropriate choice of suture pattern for the perineal body. Many people advocate a purse-string suture; our preference is a transverse pattern, described by McKinnon [12].

Manufacturer's address
*Sontec Instruments, Colorado, USA

References

Further reading

NOTES
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13.30–13.50
Vaccination of pregnant mares and youngstock: could we do better?
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No abstract submitted
Diagnosing infectious respiratory disease: avoiding the pitfalls

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Infectious respiratory disease is a common condition affecting foals of all ages. Although pneumonia in neonates is usually part of generalised systemic sepsis in older foals and weanlings it is generally a primary condition [1]. The main challenge facing clinicians is determining the most likely causal agent and then treating appropriately with the most suitable antimicrobials.

*Streptococcus zooepidemicus* is the most common cause of respiratory infection in older foals and may in some cases lead to pneumonia. This can develop following a viral infection such as associated with equine herpes virus or equine influenza virus or other stressors such as hot, dry and dusty environmental conditions, long transport journeys or weaning. In the author’s practice there is no evidence of equine influenza currently being a significant influence on foal respiratory disease probably due to the high level of vaccination on stud farms in the area. In contrast, *Rhodococcus equi*, a common cause of bacterial pneumonia in foals from a month to 6 months of age, is of major concern to stud farm clinicians and owners alike. This is mainly because of its insidious nature with foals often not presenting until they have developed severe disease and obvious signs such as marked dyspnoea which may, in some cases, then progress to acute respiratory distress and even sudden death. In the early stages of the disease a foal may have only vague clinical signs such as an occasional cough or increased respiratory rate or effort. When the foal finally presents with obvious signs it may have already developed a widespread purulent bronchopneumonia with abscessation. If *Rhodococcus equi* becomes established on a stud farm endemic disease on an annual basis in the foal population becomes of real concern. In this situation instituting a routine screening programme becomes imperative to avoid significant foal morbidity and mortality [2].

Diagnosis of infection should include a physical examination. Although auscultation of the lung fields can be helpful, some foals with significant pulmonary disease may have little abnormality evident. Upper respiratory signs such as nasal discharge and enlarged submandibular glands are generally not that helpful. On endemic *R. equi* farms coughing either at rest or when foals are being turned out or caught up can be associated with the early stages of developing disease. Blood sampling of foals for haematology and biochemistry is helpful especially determining the white blood cell and differential counts, plasma fibrinogen and serum amyloid A. White blood cell and differential counts may be markedly elevated in severe disease as will the biochemical markers of inflammation serum amyloid A and plasma fibrinogen [3,4]. They may also help with the timing of infection and response to treatment although they are not helpful in distinguishing the different bacterial causes. Tracheal wash via endoscopy or transtracheal aspirate for cytology and culture is important to confirm the causal bacteria. Following identification antimicrobial sensitivity can be determined. Increasingly, polymerase chain reaction (PCR) is used to identify the virulent VapA associated *R. equi* bacteria in tracheal wash samples [5]. Both culture and PCR have their limitations and even on endemic *R. equi* farms where disease is clearly widespread not all foals may be culture or PCR positive and repeated testing may be necessary to confirm bacterial identity. Thoracic imaging is very helpful in defining the severity and extent of pneumonia. Thoracic radiographs will confirm an interstitial or alveolar pattern and the presence of lymphadenopathy, abscesses or cavitary lesions and how widespread these lesions are. Although radiography is best performed in a hospital setting, field radiography can produce quite acceptable images. Thoracic ultrasonography is a much easier modality to use and is accurate at finding lesions near the periphery of the lung or that extend to the pleural surface; however, lesions that are located deep in the lung parenchyma or more centrally in the chest will not be visible using ultrasonography [6].

Not all foal pneumonia is caused by *R. equi* or *Streptococcus zooepidemicus* and other bacteria and viruses may be identified using culture and PCR techniques. In addition, the influence of migrating ascarid larvae may become more important as increasing resistance to anthelmintics appears to be occurring. The presence of high numbers of eosinophils in tracheal aspirate cytology in conjunction with positive faecal egg counts may be consistent with ascarid larvae being involved.

Various screening programmes can be used to avoid the scenario of late diagnosis where *R. equi* is endemic. This may be as simple as once or twice daily routine temperature measurement or chest auscultation to blood sampling for white blood cell count, fibrinogen and SAA, and routine screening chest ultrasounds. No one test has sufficient specificity and sensitivity to be used in isolation and combinations are normally chosen depending on economic and other factors.

References

Practical management of parasites on breeding premises

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The challenge to control equine endoparasites is not new; however, given the widespread resistance to all classes of anthelmintic drugs there is an urgent need to implement a more targeted approach to worm control and this applies particularly to the stud farm with a wide age range of animals. Previously, the risk of worm-associated disease led to the introduction of interval dose treatments, this effectively controlled worms but led to an over-treatment of all stock and the widespread development of anthelmintic drug resistance, this approach is now inappropriate [12]. A targeted approach to worm control is now recommended [3] whereby a proportion of worms is left unexposed to anthelmintics so there is no selection pressure for resistance to occur, any resistant genes in the worm population are diluted in this susceptible population (refugia). This is the ‘gold standard’ on the stud farm together with pasture and stable management with the added benefit of being less expensive than interval dose regimes and good for the preservation of anthelmintic medications [2].

Management methods
Between 11% [4] and 20% [5] of horses excrete 80% of eggs. In order to identify these ‘high-shedders’ faecal worm egg counts (FWECS) should be taken every 2 months from all stock. This allows the appropriate targeted treatment of significantly (e.g. >2000 egg) affected horses only (see below) which should then be confirmed to have been effective by the use of faecal worm egg count reduction test (FWECRT) 14 days later. In order to allow ‘refugia’ horses should not be ‘closed and moved’ as this just allows the resistant worms to contaminate the new pasture [5]. Paddock care should include; the removal (by hand or mechanically) of droppings from all paddocks twice weekly with daily attention paid to the nursery paddocks, cutting of roughs (offers protection to larvae), grazing with cattle/sheep, use ‘clean’ paddocks for youngest foals and avoid them following onto paddocks grazed by older foals/yearlings. Disinfection and cleaning of all stables and foaling boxes regularly throughout the breeding season. New arrivals should not be mixed before a quarantine period and appropriate treatment. A weighbridge is recommended for accurate dosing of all stock.

Endoparasites on the stud farm

Strongyloides westeri
Foals are infected early in life generally via ingestion of L3 larva via the milk although food ingestion and transdermal infection can occur. Generally asymptomatic unless high burden occurs in which case weight loss, scour etc. can occur. Environmental contamination can build up over years. Mares are at risk of disease causing generalised malaise, coughing, nasal discharge (respiratory tract inflammation), weight loss, colic (can be surgical – SI impaction). Affected foals can have other concurrent disease. Treatment is complex due to the widespread resistance to ivermectin, moxidectin is still effective (although there is reduced egg reappearance period – ERP) against adult and larva stages although it can not be used in foals under 4 months. Fenbendazole (adults with some larva activity) and pyrantel (adults only) are potential alternatives [7]. The infection rate reduces after 6 months with immunity development and infection uncommon from 12 to 18 months.

Parascaris equorum
Considered to be the most significant endoparasite of foals with widespread distribution (38% of animals <1 year old positive on FEC) [2.5]. Prolific egg laying worm with sticky, thick walled resistant eggs persisting in the environment (PPP 10–12 weeks). Clinical signs of disease can include generalised malaise, coughing, nasal discharge (respiratory tract inflammation), weight loss, colic (can be surgical – SI impaction). Affected foals can have other concurrent disease. Treatment is complex due to the widespread resistance to ivermectin, moxidectin is still effective (although there is reduced egg reappearance period – ERP) against adult and larva stages although it can not be used in foals under 4 months. Fenbendazole (adults with some larva activity) and pyrantel (adults only) are potential alternatives [7]. The infection rate reduces after 6 months with immunity development and infection uncommon from 12 to 18 months.

Cyathostomins
Older foals and adults are at risk of disease causing generalised signs including weight loss, colic, diarrhoea and anorexia. There is limited survival of the larvae over winter with a build up of environmental contamination during the stud season increasing the incidence of clinical signs towards the end of the year. The larval eruption (‘larval cyathostomiasis’) resulting in acute colitis is traditionally seen in winter/early spring but can occur at any point during the year. There is widespread resistance to BZs, with lower resistance to tetrahydropyrimidines (THPs) and ivermectin, resistance to moxidectin is reported [4]. All foals should be treated with moxidectin at the end of the grazing season to reduce larval infection.

Anoplocephala perfoliata
Must be considered in the older foal as well as adult, associated with colic. Limited ability to detect infection. All horses (including foals) should be treated at the end of the grazing season (praziquantel or double dose pyrantel).

Summary
It is possibly the equine breeding industry that has most to lose should the incidence of anthelmintic resistance increase. There is a need to improve client understanding as the usefulness of FWEC and risk of drug resistance is not the majority view [8]. The approach should be veterinary driven and involve FWEC, FWECRT, occasional strategic dosing and effective environmental management methods.

References

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Proceedings of the British Equine Veterinary Association Congress, 2015 - Liverpool, United Kingdom
An approach to diarrhoea in foals: are we missing some tricks?
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Introduction
Diarrhoea is a common presentation in foals of all ages and the condition is often self-limiting. The greatest challenge for the equine practitioner is to determine if the cause of the diarrhoea is potentially infectious or not and to institute proper treatment for affected foals. This presentation will focus on the clinical work-up of older foals (>1 month of age) with diarrhoea and on how to judiciously use various diagnostic tools.

Diagnostic work-up
Recognising changes in faecal character, from cow-pie faeces to watery diarrhoea, is generally straightforward. That said, one needs to keep in mind that systemic clinical signs such as fever, depression, anorexia, colic or abdominal distention can precede the development of diarrhoea. It is important to recognise early signs in order to institute proper diagnostics, treatments and biosecurity protocols.

Obtaining historical information can provide clues to the aetiology of the diarrhoea. Questions may include: Have there been or are there currently any other animals on the farm having fevers or diarrhoea? Has the foal received any medications that may have predisposed it to gastrointestinal disease? Have there been any changes in management (feeding, turnout)? What is the consistency of the faeces? What is the age of the foal?

The physical examination of the patient is important to confirm fever, abdominal distention, colic and faecal consistency. Further, perfusion and hydration need to be determined in order to assess intravascular volume status. The clinical information may help determine if the patient is in need of immediate treatment and will also help prioritising diagnostics. The equine practitioner should attempt to categorise foals with diarrhoea into one of three categories: (i) healthy foal with otherwise normal vital parameters; (ii) stable foal with various clinical abnormalities including lethargy, anorexia and fever; (iii) foal with evidence of hypovolaemia or moderate to severe dehydration and more severe clinical signs (colic, abdominal distention).

Table 1: Common causes of diarrhoea in older foals with their specific diagnostic tests

<table>
<thead>
<tr>
<th>Disease</th>
<th>Blood work</th>
<th>Faecal testing</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotavirus</td>
<td>Electrolyte abnormalities, metabolic acidosis</td>
<td>EM, ELISA, qPCR</td>
<td></td>
</tr>
<tr>
<td>Coronavirus</td>
<td>Electrolyte abnormalities, metabolic acidosis</td>
<td>EM, ELISA, qPCR</td>
<td>Mono-infection is uncommon, often present with other enteric pathogens</td>
</tr>
<tr>
<td>Salmonellosis (Salmonella spp.)</td>
<td>Neutropenia, left shift, toxic changes, electrolyte abnormalities, metabolic acidosis</td>
<td>Culture, qPCR</td>
<td>Pre-incubation of faeces in enrichment broth recommended</td>
</tr>
<tr>
<td>Clostridium difficile</td>
<td>Neutropenia, left shift, toxic changes, electrolyte abnormalities, metabolic acidosis</td>
<td>Culture, ELISA, qPCR</td>
<td>Can be found in the faeces of healthy foals</td>
</tr>
<tr>
<td>Clostridium perfringens</td>
<td>Neutropenia, left shift, toxic changes, electrolyte abnormalities, hypoproteinaemia, metabolic acidosis</td>
<td>Culture, qPCR, ELISA</td>
<td>Can be found in the faeces of healthy foals</td>
</tr>
<tr>
<td>Lawsonia intracellularis</td>
<td>Hypoproteinaemia/hypalbuminaemia</td>
<td>qPCR, serology</td>
<td>Important to combine both antigen and antibody detection</td>
</tr>
<tr>
<td>Rhodococcus equi</td>
<td>Leukocytosis, neutrophilia, hyperfibrinogenaemia, hyperglobulinaemia</td>
<td>qPCR</td>
<td>Antigen detection in faeces</td>
</tr>
<tr>
<td>Parascaris equorum</td>
<td>Hypoproteinaemia</td>
<td>Faecal egg count or flotation</td>
<td></td>
</tr>
<tr>
<td>Anoplocephala perfoliata</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cyathostomins</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NSAID toxicity</td>
<td>Neutropenia, left shift, toxic changes, electrolyte abnormalities, hypoproteinaemia, metabolic acidosis</td>
<td>Not applicable</td>
<td>Abdominal ultrasound</td>
</tr>
<tr>
<td>Sand impaction</td>
<td>Unremarkable</td>
<td>Sand flotation</td>
<td>Abdominal radiograph recommended</td>
</tr>
<tr>
<td>Gastric/duodenal ulceration</td>
<td>Unremarkable</td>
<td>Occult blood testing</td>
<td>Endoscopic examination of stomach and duodenum</td>
</tr>
<tr>
<td>Peritonitis</td>
<td>Leukocytosis, neutrophilia, hyperfibrinogenaemia, hyperglobulinaemia</td>
<td>Not applicable</td>
<td>Abdominal ultrasound and abdominocentesis for cytology and culture</td>
</tr>
<tr>
<td>Dietary intolerance</td>
<td>Unremarkable</td>
<td>Not applicable</td>
<td>Healthy foal</td>
</tr>
</tbody>
</table>

qPCR = quantitative PCR; EM = electron microscopy; ELISA = enzyme-linked immunosorbent assay; NSAID = nonsteroidal anti-inflammatory drug.
Minimal database should include a complete blood cell count and chemistry panel. Identification of neutropenia, immature neutrophils and toxic changes of the neutrophils may suggest a more severe inflammatory condition associated with the diarrhoea. Further, increased red blood cell parameters and total protein concentration indicate immediate treatment. The chemistry panel is generally less helpful in categorising the cause of the diarrhoea, however, it helps assess organ injury. Specifically, azotaemia is common with severe diarrhoea and will limit the use of drugs with nephrotoxic potential such as nonsteroidal anti-inflammatory drugs and specific antimicrobials (oxytetracycline, gentamycin). The protein concentration (total, albumin and globulins) should be carefully assessed. Protein-losing enteropathy is common in many infectious conditions that cause diarrhoea in foals and can result in low protein concentrations. A normal protein concentration may be found with mild disease or it can be found when protein losing enteropathy is combined with severe dehydration.

Obtaining faeces for testing is an important part of the practical diagnostic approach. A variety of simple but practical tests can be performed. These include gross inspection (consistency, odour, and fibre lengths), faecal flotation for sand, testing for occult blood, faecal analysis for parasites and infectious pathogen testing. Faecal testing for specific enteric pathogens relies on conventional microbiological culture (Salmonella spp.), ELISA test kit (Clostridium difficile toxin A and B gene, Clostridium perfringens alpha toxin, rotavirus, coronavirus, Rhodococcus equi, Lawsonia intracellularis). Faecal samples should be collected in a sealable container (faecal or urine cup), kept refrigerated and submitted to the laboratory for specific testing. If faeces are unavailable at the time of the foal’s evaluation, a faecal swab from the rectum may be adequate for certain tests.

A urine sample can be used to further evaluate kidney function and hydration status, which can be relevant if azotaemia is revealed in the foal’s blood work. Overall, urine sample collection is of lower priority than obtaining a faecal sample in foals with diarrhoea.

Imaging the abdominal cavity with ultrasound is practical and useful and can easily be performed in the field. Identification of fluid-filled large or small intestinal loops may raise suspicion that diarrhoea is imminent in foals with systemic clinical signs. Additionally, inflammation or thickening of the intestinal wall (≥3 mm) can indicate disease severity and raise the index of suspicion for certain conditions (i.e. equine proliferative enteropathy). Identification of the segment of intestine affected (small vs. large) may also help the examiner prioritise the possible causes of diarrhoea. Given the relatively small size of foals, a linear probe on a basic ultrasound machine can be used effectively to evaluate the intestines.

Evaluation of foreign material (i.e. sand, gravel and wire) may be one of the main reasons to radiograph foals with diarrhoea. The degree of gas distension can be appreciated, but this can typically also be evaluated during physical examination. Small portable x-ray units can effectively radiograph the abdomen of a foal and can help to rule out foreign material as a cause for the diarrhoea.

More invasive procedures including abdominocentesis, gastro-/duodenoscopy and intestinal biopsies are generally restricted to diarrhoea cases that are refractory to treatment.

**Causes of diarrhoea in older foals**

Aetiology of diarrhoea in foals can be grouped into infectious and non-infectious causes. The clinical presentation for both conditions can be similar; however, the diagnostic work-up and treatment will be different (see Table 1).
HALL 3b
FRIDAY 11th SEPTEMBER

Reproduction Workshop
Chaired by Jonathan Pycock

15.35–17.00
Terttu Katila, James Crabtree and Tom Stout

The panel will present and discuss their own difficult cases promoting debate of current contentious areas.

NOTES
Lameness 1
Chaired by Jane Boswell
Sponsored by HBLB

08.30–08.45
Head and pelvic movement asymmetries at trot in riding horses perceived as sound by their owner

M. Rhodin1, A. Egenvall1, P.H. Andersen1 and T. Pfau2
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Reasons for performing study: Recent studies evaluating owner sound horses have identified a large proportion of horses with motion asymmetries but the prevalence, type and magnitude of asymmetries have not been investigated. The increasing use of objective lameness evaluation necessitates a further characterisation of the differences between lameness and motion asymmetries. Objectives: To investigate prevalence, and quantify type and magnitude of motion asymmetries during straight-line trot in riding horses, perceived sound by their owners. Study design: Cross-sectional prospective study. Methods: Vertical head and pelvic movement symmetry was measured in 220 Warmblood riding horses, all functioning in daily work and considered sound by their owners; 100 of these individuals had been included in a previous report [1]. Body-mounted uni-axial accelerometers were used and differences between maximum and minimum head (HDmax, HDmin) and pelvic (PDmax, PDmin) vertical displacement between left and right forelimb and hindlimb stances were calculated during straight-line trot. Previously used symmetry thresholds (absolute differences >6 mm for the head and >3 mm for the pelvic variables) were used. Results: The thresholds for symmetry were exceeded for 159 horses (72%) for at least one variable, HDmax (n = 41, mean 12.7 mm, s.d. 5.5), HDmin (n = 58, mean 14.3 mm, s.d. 7.1), PDmax (n = 87, mean 6.5 mm, s.d. 3.10), PDmin (n = 77, mean 5.7 mm, s.d. 2.1). Contra-lateral and ipsilateral concurrent fore- and hindlimb asymmetries were detected in 41 and 49 horses, respectively. Conclusions: A surprisingly large proportion (72%) of horses perceived as sound by their owners showed movement asymmetries during straight-line trot. It is not known to what extent these asymmetries are related to pain or mechanical abnormalities as opposed to ‘normal variation’ and this leads to 2 potential welfare problems – either too many horses in training are actually ‘lame’ or many horses categorised as ‘lame’ have no locomotor system disease. Ethical animal research: This study was conducted within guidelines of the participating sites institutional animal care and use procedures (C: 206/10, C48/13) and informed consent for data collection was obtained from the horse owners prior to the study. Source of funding: None. Competing interests: None declared.

08.45–09.00
Objective assessment of back kinematics and movement asymmetry in horses: effect of elastic resistance band training

V. Simons1, R. Weller1, N.C. Stubbs2, N. Rombach3 and T. Pfau1
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Reasons for performing study: Training and rehabilitation techniques which improve core muscle strength are beneficial for improvement of dynamic stability of the equine vertebral column. The Equiband™ system, consisting of resistance bands attached to a customised saddle pad, is suggested to provide constant proprioceptive feedback during motion to encourage recruitment of abdominal and hindquarter musculature. Objectives: To quantify the effect of the Equiband™ system on back kinematics and movement symmetry. Study design: Longitudinal intervention study. Methods: Quantitative analysis of back movement and gait symmetry before/after a 4-week exercise programme. Inertial sensor data was collected from 7 horses at Weeks 0 and 4 of a fixed exercise protocol. Analysis with and without the Equiband™ system was completed at trot in hand on a hard surface, and for both reins on the lunge on a soft surface. Six back kinematic and 3 movement symmetry parameters were calculated according to published methods. Movement symmetry values were side-corrected to allow comparison between reins on the lunge. A mixed model (P<0.05) evaluated the effects of the Equiband™ system over time, and trotting direction on back kinematic and movement symmetry parameters. Results: The Equiband™ system significantly reduced (all P<0.02) roll, pitch and mediolateral displacement in the cranial-mid thoracic region. Across all horses, back displacement and range of motion values were significantly greater (P<0.01) on the lunge than in a straight line, movement symmetry was consistent with having corrected all horses to be left-sided. Conclusion: Preliminary results suggest the Equiband™ system may aid dynamic stabilisation of the vertebral column. Ethical animal research: This study was authorised by the Ethics and Welfare Committee of the Royal Veterinary College, London (URN Approval Number 1238). Written consent was obtained from the owner/keeper of each animal. Source of funding: Royal Veterinary College. Competing interests: N.C. Stubbs and N. Rombach developed the Equiband™ system. The remaining authors have no competing interests.

09.00–09.15
Thoracolumbar movement in sound horses trotting in hand and on the lunge

L. Greve1, S. Dyson2 and T. Pfau2
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Reasons for performing study: Lameness negatively affects the welfare of horses; it often coexists with thoracolumbar pain. The mechanisms linking the two are not well
understood. Objectives: To document thoracolumbar movement in subjectively sound horses comparing straight lines with circles on left and right reins; to relate these observations to the objectively determined symmetry/asymmetry of hindlimb gait. Study design: Cross-sectional study. Methods: Fourteen non-lame horses were trotted in straight lines and lunged on a 10 m diameter circle on left and right reins and inertial sensor data collected at landmarks: withers, 13th (T13) and 18th thoracic vertebrae, 3rd lumbar vertebra, tubera sacrale, left and right tubera coxae. Data were processed using published methods [1]; pitch and roll, dorsoventral and lateral motion and symmetry within each stride were assessed. Results: Dorsoventral motion during one stride had a sinusoidal pattern with 2 oscillations. The greatest amplitude and symmetry (110 ± 4 mm, 96 ± 1% in straight lines vs. 127 ± 5 mm, 94 ± 1% in circles) occurred at T13. Circles induced greater rotation around the transverse axis (>1.3°, P = 0.002) and movement in a lateral direction (>16 mm P = 0.002), greater dorsoventral amplitude and asymmetry; however, the latter differences were nonsignificant. There were no significant differences between reins. The difference in the left and right hindlimb stance phases and the 2 oscillations of the thoracolumbar were significantly associated. Greater circle-induced upward movement of a tuber coxae during the contralateral hindlimb stance was associated with greater circle-induced asymmetry of the 2 oscillations of the thoracolumbar (P = 0.04). Conclusions: Moving on a circle induces measurable changes in thoracolumbar movement compared with moving in straight lines, associated with alterations in the hindlimb gait. Ethical animal research: The study was approved by the Ethical Review Committee of the Animal Health Trust. Owners gave informed consent for their horses’ inclusion in the study. Source of funding: RVC PhD funding of Line Greve. Competing interests: None declared.


09.15–09.30
An in vitro investigation of the effect of curve running on equine distal limb tendon strain

R.S.V. Parkes, T.H. Witte, T. Pfau and R. Weller

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Reasons for performing study: Horses run on curves during training and competition, and are often trotted in circles to assist lameness diagnosis. The effects of moving on a curve on tendon strain in the distal limb are not known. Objectives: To investigate the effect of curve running on the tendons and ligaments of the equine distal limb. Study design: Controlled experimental study. Methods: Cadaver forelimbs from 6 Thoroughbred horses were loaded on a forceplate using a hydraulic ram. Limbs were loaded to 17–33 N/kg on a flat surface and with medial and lateral wooden wedges under the hoof to simulate curve running with the limb being on the inside and outside of a curve, respectively. Tendon length was measured for the superficial and deep digital flexor tendons (SDFT and DDFT), accessory ligament of the DDFT (ALDDFT), the suspensory ligament body (SL) and the medial and lateral suspensory ligament branches (SBL and SBLU) using motion capture. A mixed effects model was used for data analysis. Results: Under most loading conditions SL was under most strain and DDFT least. For a medial 15° wedge SDFT was under 0.4% greater load than SL (P = 0.04). SBM was under 0.48% greater strain than SBL with a lateral 20° wedge (P = 0.01), and SBL was under 1.37% greater strain than SBM with a medial 20° wedge (P=0.01). Conclusions: Curve running leads to increasing and asymmetrical strain on the suspensory ligament branches. This difference is unlikely to be sufficient to cause injury, but may assist lameness diagnosis. Ethical animal research: None declared.

Source of funding: None declared.

09.30–09.45
Goniometric measurement of limb stiffness: validation of a potential predictor of tendon healing

R. Tucker1, B.D. Jacklin2, S. Gillespie1, L. Vaughan1, A.R. Fiske-Jackson1 and R.K. Smith1

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Reasons for performing study: Injury to the superficial digital flexor tendon (SDFT) is common in equids, with a high risk of re-injury associated with changes in tendon stiffness. In vivo measurement of limb stiffness has been shown to correlate with tendon stiffness after injury [1] but requires kinematic analysis which is impractical in a clinical setting. We have developed a simple system for measuring limb stiffness statically, which could be used as a tool for monitoring SDFT healing. Objectives: To validate a goniometric measurement of limb stiffness. Study design: Cross-sectional study. Methods: Initially, forelimb stiffness indices were determined at the walk for 6 equids using a validated kinematic analysis [1]. Limb stiffness indices were then calculated using portable floor scales to record ground reaction force (GRF), and an electrogoniometer to record metacarpophalangeal joint angle. Goniometric limb stiffness indices were subsequently measured in 11 horses ranging from 2 to 20 years of age, with no clinical evidence of SDFT injury. Strength and significance of correlation and agreement between the measurement methods was assessed and association between limb stiffness, limb (left vs. right), weight and age of horse and were calculated. Results: There were strong positive correlations between GRF and joint angle (R² = 0.98) and between the static and kinematic methods (R = 0.78, P<0.01). There was a positive correlation between limb stiffness and weight (R² = 0.85, P<0.01), but no association with age or limb. Conclusions: This study validated the measurement of limb stiffness in a clinical setting. The positive correlation of limb stiffness and weight supports the theory of an optimised limb spring [2] for energy-efficient cursorial locomotion which may, in turn, provide a clinically-relevant measure of running efficiency and therefore the quality of tendon healing post injury.

Ethical animal research: Owner consent was obtained. Source of funding: None. Competing interests: None declared.


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What effect does medium and extended trot have on the kinematics of the forelimb in dressage horses?

**V.A. Walker, C.A. Tranquille, S.J. Dyson, R. Newton and R.C. Murray**

Animal Health Trust, Lanwades Park, Kentford, Newmarket, Suffolk, CB8 7UU, UK. Email: vawalker87@gmail.com

**Reasons for performing study:** Metacarpophalangeal joint hyperextension overload is increasingly being recognised in dressage horses and, like forelimb suspensory ligament injury, tends to be seen in horses with extravagant trot steps. However, there is limited understanding of the effects of different paces within the trot on forelimb movement, therefore it is difficult to advise rationally on prevention or management of these types of injury. **Objectives:** To compare forelimb kinematics of collected and medium or extended trot in dressage horses. **Study design:** Prospective study. **Methods:** Twenty mixed-breed dressage horses (age 9 ± 4 years; height 168 ± 6 cm; weight 600 ± 63 kg; median competition level = advanced medium) were tested at collected and medium/extended trot (age and training level dependent) in a straight line on an artificial surface ridden by their own rider at sitting trot. Four strides of each pace were recorded using high speed motion capture (240 Hz). Markers were placed on the horses’ forelimbs at predetermined anatomical sites. Fetlock, carpus, elbow and shoulder angles were derived at midstance. Descriptive statistics and mixed effect multilevel regression analyses were performed on the data. **Results:** Fetlock extension angle was significantly increased at medium compared with collected trot (coefficient: 5.70; CI 2.58–8.82; P<0.01) and extended compared with collected trot (coefficient: 5.16–12.02; P<0.01). Fetlock extension angle was significantly increased when carpus extension angle (coefficient: 0.61; CI = 0.4–0.82; P<0.01) and shoulder flexion angle were increased (coefficient: 0.18; CI 0.01–0.33; P<0.05). **Conclusions:** Fetlock extension increased when the horses performed lengthened trot paces, more in extended than medium trot. The loading of the carpus and shoulder were related to fetlock extension, suggesting that lengthened paces affect the loading of the entire forelimb. Lengthened paces may be contraindicated in horses with fetlock hyperextension or suspensory ligament injury; they may be a potential risk factor for these injuries. Interaction with the surface could also have a role that could be further investigated. **Ethical animal research:** The study was approved by the Animal Health Trust ethical review committee. Owners gave informed consent for their horses’ inclusion in the study. **Sources of funding:** Elise Pilkington Charitable Trust, Dr Wilfrid Bechtolsheimer, British Dressage. **Competing interests:** None declared.

**Lameness 2**

Chaired by Marcus Head

Sponsored by HBLB

**10.30-10.45**

Identification of disease specific metabolic fingerprints in early osteoarthritis

**M. Peffers1, C. Riggs2, M. Phelan3 and P. Clegg**

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**Reasons for performing study:** Synovial fluid (SF) is located in joint cavities, tendon sheaths and bursae. In joints it comprises a serum filtrate with additional contributions from articular cartilage, synovium and bone. Low molecular weight metabolites represent the end product of the cell regulatory processes. Synovial fluid represents a potential source of disease specific metabolites that could aid in the understanding of the pathogenesis of osteoarthritis (OA) and be used in its early diagnosis. **Objectives:** We hypothesise that there are different metabolic profiles that can be identified in early OA SF and some of these metabolites are potential biomarkers. **Study design:** Cross-sectional study. **Methods:** Synovial fluid was used from the metacarpophalangeal joints of 9 normal and 9 OA Thoroughbred horses following macroscopic, microscopic and synovitis scoring. SF was analysed with Proton (1H)- nuclear magnetic resonance (NMR) spectroscopy with a 600 MHz Avance III equipped with a cryoprobe and chilled sample-jet autosampler. The software we use is Topspin 3.1 and IconNMR 4.6.7. The following methods were used in order to identify changes in lipids and small molecules; 1D Nuclear Overhauser Effect, Longitudinal Encode-decode and Carr-Purcell-Meiboom-Gill. Data analysis was undertaken using unsupervised statistical methods and Ingenuity Pathway Analysis (IPA). **Results:** The results demonstrated clustering on principle component analysis between normal and OA samples. Seven metabolites were identified as significantly different in OA P<0.05; mobile lipid 1, methyl group, 2 lactates, proline and 2 citrates. Furthermore total lipid load correlated very closely to Mankin’s scoring. Using IPA we identified metabolic pathways relating to altered glycolysis in early OA. **Conclusions:** We identified the metabolic fingerprint of early OA which may allow for better phenotyping of disease states and thereby facilitate targeting of improved treatment regimes. **Ethical animal research:** Samples were collected at post mortem examination with informed owner consent. **Sources of funding:** Wellcome Trust and the MRC and Arthritis Research UK as part of the MRC - Arthritis Research UK Centre for Integrated research into Musculoskeletal Ageing (CIMA). **Competing interests:** None declared.
Normal radiographic anatomy of the donkey foot from birth to 2 years of age

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Reasons for performing study: Normal radiographic anatomy of the juvenile donkey foot has not been reported previously. Objectives: To provide a radiographic survey of the anatomical development of the donkey foot from 0 to 2 years of age. Study design: Radiographic survey. Methods: The right front foot of 9 donkey foals born in the spring of 2012, housed and fed in the same conditions, were radiographed every month for the first 6 months of age and every 3 months for the following 18 months. Latero-median radiographs with and without barium markers at the coronary band and anterior-posterior radiographs of both front feet were obtained during weightbearing. Radiographs were obtained at 55 kV and 3 mAs with mobile kx-ray equipment (Gemini, GE Healthcare, USA). The distal physis of the metacarpus (McIII) was closed at the mean age of 10.7 months (SD: 11.5, 19). The distal physis of the middle phalanx was closed at the mean age of 17.8 months (SD: 11.5, 21). The proximal physis of the proximal phalanx was closed at the mean age of 15.5 months (SD: 11.5, 21). The distal physis appeared as a clear radiolucent line at 2 weeks of age and was still visible subtly at 24 months. The proximal physis of the middle phalanx was closed at the mean age of 10.7 months (SD: 11.5, 19). The distal physis of the proximal phalanx was visible at birth but closed at 4 days. Conclusions: Based on our results, it seems that physes close at an older age in the donkey foal compared to the horse.

Ethical animal research: Ethical approval was granted from the Royal Veterinary College Ethics and Welfare committee as part of the first author’s final year research project. Source of funding: Funding was provided by the Royal Veterinary College as part of the first and second authors’ final year research project. Competing interests: None declared.

Sensitivity of transcranial magnetic stimulation in relation to histopathological findings in six horses with compressive lesions of the spinal cord

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Reasons for performing study: Transcranial magnetic stimulation (TMS) is an electrophysiological technique used to elicit motor evoked potentials (MEPs) to evaluate the functional integrity of the descending motor fibres in the spinal cord. Successful application of the technique was reported in horses with spinal cord compression. However, limited data are available on the correlation of TMS and histopathological changes. Objectives: To determine sensitivity of TMS for assessing the integrity of the spinal cord in horses with compressive lesions of the spinal cord. Study design: Case series. Methods: The study was conducted on 6 horses with spinal ataxia grade III/IV/V admitted to the Faculty of Veterinary Medicine, Ghent University. The horses underwent TMS, radiography of the cervical or thoracolumbar vertebral column, and myelography (4/6). All horses were subjected to euthanasia and the spinal cord examined histopathologically. Results: In 5/6 horses, MEPs were recorded in all areas. Radiography revealed cervical vertebral malformation (4/5) with cervical vertebral canal stenosis (3/5) and tumour/osteomyelitis (1/5). Five horses had abnormal MEPs with normal onset latencies in both extensor carpi radialis muscles and cranial tibialis muscles were recorded, suggesting a cervical spinal cord lesion. Radiography revealed deformation of the 7th and 8th thoracic vertebrae.
Myelography showed reduction in dural diameter and dorsal contrast column (4/4). Histopathological examination of the spinal cord confirmed compressive type lesions in all 6 horses with degenerative changes in the white matter of all funiculi, ballooning of myelin sheaths, swollen axons, loss of axons and astroglial activation. **Conclusions:** In this case series abnormal function of descending motor pathways as registered by TMS showed 100% sensitivity with the histopathological characteristics of compressive lesions in the spinal cord, but the number of horses is limited and further research is warranted. **Ethical animal research:** Research ethics committee oversight not currently required by this conference: the study was performed on material collected during clinical procedures. Explicit owner informed consent for participation in this study was not stated. **Source of funding:** Not applicable. **Competing interests:** None declared.

11.30–11.45 **Diffusion of radiodense contrast medium after perineural injection of the palmar digital nerves**

**A. Nagy**¹ and **R. Malton**²

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**Reasons for performing study:** Limited information exists on distribution of local anaesthetic solution following palmar digital nerve blocks. **Objectives:** To demonstrate potential distribution of local anaesthetic solution following perineural injection of the palmar digital nerves using 2 different volumes of contrast medium and 2 different injection sites. **Study design:** Experimental. **Methods:** Twelve mature horses were used. Perineural injection of the palmar digital nerves were performed at the level of or 2 cm proximal to the proximal aspect of the ipsilateral ungular cartilage, using 1.5 or 2.5 ml radiodense contrast medium. In total 96 injections were performed. Four standard radiographic views of the pastern were obtained immediately after injections and 10 and 20 min later. Images were analysed subjectively and objectively. **Results:** After dorsal injections, the contrast medium was distributed in a diffuse manner extending proximally over the half of the length of PP. A dorsal ring block was performed on the ipsilateral side, 1.5 cm proximal to the palpable palmar aspect of the proximal eminence of the middle phalanx, using 2 or 5 ml contrast medium. Both forelimbs were injected on 2 days (48 injections). Four standard radiographic views of the pastern were obtained immediately, 10 and 20 min after injections. Images were analysed subjectively and objectively. **Results:** After dorsal injections the contrast medium was distributed in a diffuse manner extending proximally over the half of the length of PP in all limbs (greatest proximal extension: 89.0% of the length of PP [from distal] after 2 ml, 94.2% after 5 ml). There was significant proximal diffusion in the first 10 min after injection and significant dorsal diffusion between all time points (P<0.01). There was significant positive association between injected volume and the proximal extension of the dorsal contrast patch (P = 0.01). The median dorsal diffusion was to the dorsal midline of PP; 5 ml contrast medium resulted in significantly greater dorsal diffusion than 2 ml (P<0.01). The dorsal and the palmar contrast patches did not merge. **Conclusions:** Diffusion to the proximal aspect of P1 occurred even after injection of only 2 ml contrast medium. Fetlock region pain may be influenced by a mid-pastern ring block. **Ethical animal research:** Written consent had been obtained from a representative of the horses’ owner prior to starting the study. **Source of funding:** None. **Competing interests:** None declared.

11.45–12.00 **Diffusion of radiodense contrast medium after a mid-pastern ring block**

**R. Malton**¹ and **A. Nagy**²

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**Reasons for performing study:** Diffusion of local anaesthetic solution after a mid-pastern ring block has not been investigated. **Objectives:** To demonstrate potential distribution of local anaesthetic solution following injection of radiodense contrast medium as performed for a mid-pastern ring block. **Study design:** Experimental. **Methods:** Twelve mature horses were used. One and a half ml radiodense contrast medium was injected over the medial or lateral palmar digital nerve at the level of the proximal aspect of the ungular cartilages. A dorsal ring block was performed on the ipsilateral side, 1.5 cm proximal to the palpable palmar aspect of the proximal eminence of the middle phalanx, using 2 or 5 ml contrast medium. Both forelimbs were injected on 2 days (48 injections). Four standard radiographic views of the pastern were obtained immediately, 10 and 20 min after injections. Images were analysed subjectively and objectively. **Results:** After dorsal injections the contrast medium was injected in a diffuse manner extending proximally over the half of the length of PP [from distal] after 2 ml, 94.2% after 5 ml). There was significant proximal diffusion in the first 10 min after injection and significant dorsal diffusion between all time points (P<0.01). There was significant positive association between injected volume and the proximal extension of the dorsal contrast patch (P = 0.01). The median dorsal diffusion was to the dorsal midline of PP; 5 ml contrast medium resulted in significantly greater dorsal diffusion than 2 ml (P<0.01). The dorsal and the palmar contrast patches did not merge. **Conclusions:** Diffusion to the proximal aspect of P1 occurred even after injection of only 2 ml contrast medium. Fetlock region pain may be influenced by a mid-pastern ring block. **Ethical animal research:** Written consent had been obtained from a representative of the horses’ owner prior to starting the study. **Source of funding:** None. **Competing interests:** None declared.

12.00–12.15 **Proximal suspensory desmopathy in hindlimbs: a correlative clinical, ultrasonographic, gross post mortem and histological study**

**S. Dyson**¹ and **M.J. Pinilla**²,³

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**Reasons for performing study:** It has been suggested that ultrasonography is unreliable for the detection of hindlimb proximal suspensory desmopathy (PSD) based on comparison between ultrasonographic and magnetic resonance images. **Objectives:** To compare ultrasonography with gross and histopathological post mortem examination in horses with PSD diagnosed based on the response to local anaesthesia and ultrasonography.

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**Source of funding:** None. **Competing interests:** None declared.
Study design: Retrospective study. Methods: Nineteen horses with hindlimb PSD were humanely destroyed. The ultrasonographic abnormalities were graded prospectively as mild, moderate or severe based on predefined criteria. Thirty-seven lame limbs were examined grossly and 36 suspensory ligaments (SLs) were examined histologically. The histological images were graded blindly based on predefined criteria (0–3 for each tissue type; 0 = normal, 3 = severe abnormality). Descriptive statistics were performed. Results: Ultrasonographic lesions were graded moderate in 31/38 (81.6%) and severe in 7/38 (18.4%) limbs; in 4/36 (11.1%) limbs adhesion formation between the proximal aspect of the SL and the accessory ligament of the deep digital flexor tendon was predicted. Gross post mortem examination revealed substantial adhesions between the proximal aspect of the SL and adjacent soft tissues in 10/37 (27.0%) limbs; in 10/37 (27.0%) limbs there were adhesions between the body of the SL and the mid plantar aspect of the third metatarsal bone, extending distally in 6 (16.2%) limbs. Histology revealed abnormalities (grades 1–3) of the collagenous tissue in 25/36 (69.4%) limbs. Muscle was abnormal (grades 1–3) in 35/36 (97.2%) limbs and adipose tissue (grades 1–3) in 16/36 (44.4%) limbs. Neural abnormalities (grades 1–3) were seen in 23/36 (63.9%) limbs and vascular changes (grade 1 and 2) in 2/36 (5.6%) limbs. In 1/36 limbs no abnormality was detected. Conclusions: Ultrasonography was reasonably reliable for the detection of SL pathology based on histology as a gold standard, but the ability to detect gross adhesions was limited. Ethical animal research: The study was approved by the Ethical Review Committee of the Animal Health Trust, and had informed consent of the owners. Source of funding: None. Competing interests: None declared.

12.15–12.30
An epidemiological investigation of the aid of magnetic resonance imaging in determining long-term prognosis for soundness following palmar/plantar digital neurectomy for chronic foot pain

C.E. Wylie, R.J. Payne, A.P. Bathe, T.R.C. Greet, M.J. Head, S.J. Boys-Smith and S.E. Powell

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Reasons for performing study: Accurate diagnosis of chronic foot pain by magnetic resonance imaging (MRI) allows appropriate case selection for palmar/plantar digital neurectomy (PDN). Objectives: To report follow-up for chronic foot pain treated by PDN, with and without MRI diagnosis. Study design: Retrospective cohort study. Methods: The electronic patient records of all animals that underwent PDN were reviewed. Follow-up was obtained from owners using a structured postal/telephone questionnaire. Chi squared/Fisher’s exact tests or 2-sample t tests were used, with statistical significance set as P<0.05. Results: One hundred and nine PDN cases were undertaken. Follow-up response rate was 72.5%. From these 79 cases, 52 had MRI (MRI+) and 27 did not (MRI-). There was no significant difference in case distribution between the 2 groups: predominately horses, Warmbloods, geldings, used for full competitions, except MRI+ were younger than MRI- (median 9.99 and 11.71 years respectively, P = 0.004). Median follow-up time for MRI+ was 31.4 months, and for MRI- was 36.8 months. There was no significant difference in outcome. In total, 78.9% MRI+ achieved their intended use, compared with 73.1% MRI-. For those intended for exercise, 83.7% MRI+ reached a level of exercise, compared with 87.5% MRI-. Median length of exercise maintenance was 25.2 months for MRI+ and 24.0 months for MRI-. For MRI+ there was one suspected and one confirmed neuroma and 4 neuritis cases. Two MRI- animals developed neuritis. Complications requiring euthanasia occurred in 2 MRI- cases: complete rupture of the deep digital flexor tendon in a bilateral forelimb lameness and one previous chronic laminitic with solar prolapse. Conclusions: These results are comparable with previous reports of 80% of MRI+ returning to previous athletic use for 20 months. Achievement of intended use, length of exercise maintenance and complication rate was similar with and without MRI diagnosis, although both catastrophic complications occurred in animals which did not undergo MRI. Ethical animal research: Ethical approval obtained: AHT-47-2013. Explicit owner informed consent for inclusion of animals in this study was not stated. Source of funding: C.E. Wylie is funded by The Margaret Giffen Charitable Trust. Competing interests: None declared.

NOTES
What makes an equine practice profitable?
Julian Samuelson
Bell Equine Veterinary Clinic, Mereworth, Maidstone, Kent, ME18 5GS, UK

Introduction
Since graduating in 1987, my own experience has mirrored the evolution in equine practice, from a broad-based multi-species approach, to a more specialist single species focus. This progress continues and, if anything, the pace and scale of change is increasing.

Has this affected the profitability of the industry so far, and what are the constant revenue drivers? What are the challenges, and what does the future hold for equine practice? These are the issues that will be considered in this presentation, through a broad conceptual approach, rather than in a financially analytical style that is less relevant between different practices and difficult to extrapolate over time.

When I graduated in the late 1980s, most vets practised multi-species general practice. The 1990s saw the advent of a more single species focus and practices being set up to provide this specialism. The 2000s saw this specialism being consolidated with a healthy period of economic growth throughout the industry. The intervention of the banking crisis and ensuing recession imposed a pause in most aspects of business development at the end of the decade; however, gradual growth is resuming and this leads to the following questions: where next for our industry?, what will the 2010s decade be remembered for?, and how can equine practices position themselves to maximise a sustainable profit in this environment?

Current challenges
All forms of business may be visualised as a transformation process, whereby input resources such as financial capital, human capital, drugs, equipment and buildings are transformed by the business enterprise to an output, in this instance – the provision of equine veterinary services to clients, and in so doing, generate a profit. The business process is influenced by external factors such as regulation, competition and the economy, as well as being subject to business behaviour and management decisions, or in other words – business strategy.

The challenges influencing this business model, may be characterised by borrowing the Donald Rumsfeld style of categorisation: The known knowns include the effects on the human capital input resource of the increasing number of students (with their own increased debt burden), the gender and generational demographic transformation of the profession and the geographic influences. The known unknowns include the ongoing economic environment, the impact of UK and EU regulation such as Health and Safety, the Working Time Directive, the Veterinary Medicines Regulation review, and succession planning. By their very definition, it is impossible to specify the unknown unknowns, the Black Swan events [1] that may impact our profession, but perhaps these could come from an emergent vector borne disease process or something similar.

The combination of these myriad of challenges could build into a perfect storm that will profoundly affect the ongoing profitability of equine practice, unless the business model continues to follow the optimum strategy as well as evolving to take advantage of the new operational environment.

Business strategy
In the transformation process model of business, business strategy is a key element of the process, with the resulting profit not being “the explanation, cause or rationale of business behaviour and business decisions, but rather the test of their validity” [2]. The principal aim of any business strategy is to create sustainable competitive advantage; this may be achieved by pursuing a cost advantage or differentiation advantage [3]. Both, if executed properly, can lead to enduring profitability; however, it is easy to fail to effectively implement and maintain either strategy, as recently demonstrated by Tesco in the supermarket sector.

In the professional services sector, cost advantage is extremely difficult to maintain and a differentiation strategy is optimum. As a result of extensive recent research in the Return on Assets from 25,000 companies quoted on the US Exchanges between 1966 and 2010, Raynor and Ahmed [4] found that the data revealed surprisingly simple guidelines for organisational excellence. They suggest that there are three fundamental rules for making a company truly great:

• Rule one: Better before cheaper – compete on differentiators other than price;
• Rule two: Revenue before cost – prioritise increasing revenue over reducing costs; and
• Rule three: There are no other rules – follow rules 1 and 2 and organisational excellence will follow.

When looking at the development of our own business, and other successful equine practices, it is clear that these concepts – that is focusing on differentiators such as service, clinical excellence and innovation – have consistently been more successful and more profitable than focusing on cutting costs or competing on price.

However, when considering equine practice, the third rule should perhaps be – Get paid!

What of the future?
As already noted, the pace and scale of change within the equine profession is gathering momentum, fed by the intrinsic and extrinsic factors influencing the industry. How will this reshape equine veterinary businesses?

I believe that the 2010s will be characterised as the decade of consolidation, precipitated by the emergent interest and involvement of corporates within the sector, and other businesses positioning themselves to withstand and confront this competitive challenge by merging with or acquiring other practices.

The recession notwithstanding, over the last 30 years it has been relatively easy to run a profitable equine practice;
this will be much more difficult over the next 30 years. However by continuing to focus on the three simple rules for organisational excellence, and putting in place a strategy that ensures that equine businesses don’t just grow bigger, but grow better too, the profession can withstand all the ensuing challenges.

References
Making a success of marketing my practice

Alison Lambert
Onswitch, 2 The Avenue, Grantham, Lincolnshire, NG31 6TA, UK

Marketing - why should I bother?
The primary role of marketing is to make potential customers aware that your business offers services that they need. The secondary function is then to convince them that you can do this better than anyone else around.

The five-step veterinary business model
Every veterinary business relies on the telephone. Industry data finds that as much as 90% of initial client contact happens via this medium. Don’t forget though, that every time a potential new client calls you to check pricing and zone visit rates, your competitors are also receiving that same call. The practice eventually chosen to deliver care will be the one that ‘feels’ best over the phone, so it’s essential that the entire team live the practice ethos at every point of contact.

As you’ll see from the model below, ‘marketing’ is fundamental to the first and last stage of the model - driving up awareness in the local area so that horse owners call you, and helping your delighted clients recommend your services to others, so that they too will pick up the phone and drive another cycle of the model:
1. Make the phone ring
2. Convert the call into an appointment
3. Convert the consultation into relevant diagnostic and treatment plans
4. Charge correctly for the work done
5. Get recommended.

In the good old, bad old days, making the phone ring was as simple as placing an ad in the Yellow Pages. Now that’s nowhere near enough, and here’s why:

• Much more veterinary competition. Over the last 25 years the total number of practices in the UK has more than doubled, whilst the horse population is decreasing (BETA 2011 trade survey).
• Increased reliance on other equine service providers. Onswitch’s research with horse owners finds that, except for emergencies, the vet is often the last point of contact. Owners consult their farrier, dental technician, saddle fitter or feed merchant for advice, as well as asking other owners and staff at the livery yard. Estimates suggest that there are in excess of 19,000 businesses serving the equine sector (BETA 2006 trade survey).
• Raised expectations. If your receptionist is surly and forgets to return calls, the hard truth is that owners will vote with their feet. And they’ll tell their friends.
• The internet. Faced with unusual behaviour or symptoms, owners will almost certainly check out Dr Google. They’ll post questions on their Facebook page or Tweet their horse friends for help. Online equine forums and the websites of respected organisations will also be explored.

Now that we’ve faced the reality that the modern equine practice is operating in, the need for clear and effective marketing should not be in question. So how do you do it?

Making the phone ring
First and foremost you need to get your practice seen. Don’t underestimate simple and cost-effective solutions such as stringing a professionally designed and printed banner across your gates, adding graphics and posters across the exterior of your building and painting vehicles with practice details. Just make sure everything is produced professionally, spelled correctly and uses the brand logo and colours consistently.

Many traditional local advertising routes remain cost-effective and deliver good results today, so consider marketing your practice within a ten mile radius via any or all of the following:
• Half-page advert in regional magazines, especially those with a country/equine flavour.
• Posters at tack shops and feed merchants.
• Stands and sponsorship at county shows and equine events.
• Social media. It’s vital not only that you have a practice Facebook page, but that it’s updated daily with news and information of interest to horse owners. Encourage your clients to ‘like’ the page and each of their friends will then become aware of you too. Horse owners are passionate users of social media so it’s key that you replicate their enthusiasm with plenty of your own. Respond to posts quickly and address any issues directly to show that you really are passionate about providing an amazing service. Create a ‘Twitter feed’, and use it!
• Website. Your online presence should mirror your practice completely - if your website is ‘under construction’ or features staff who left years ago, or ‘coming soon’ on the news page, then the message you are sending to potential owners is that you don’t quite get it. Which they will assume applies to your day job too.

And most importantly, because you need to ensure that whatever you spend on marketing is delivering a positive return on your investment, when new clients register, ask them where they heard about you and do more of that!

Getting recommended
Providing great clinical care is taken as read - it’s the excellent customer experience that will really get your clients telling others about you. You can actively encourage this in two ways:
• Friend-Get-Friend schemes. A cost-neutral way to reward clients by giving both them and their friend a voucher off your services, thus immediately bringing you two appointments and a new client.
• Key Opinion Leader (KOL) programmes. Those equine service providers we mentioned earlier? We call them KOLs - like it or not they are key, and your clients do follow their advice. So if your local farrier knows that your practice is excellent, he will send his clients to you. Developing a mutually beneficial partnership with local businesses makes excellent sense - hold open days, social events, and educational evenings with equine speakers and free wine! It’s not about buying their recommendations, or treating your own horses at mates rates; it’s about working together to provide great equine care.

You should also ask your clients to leave feedback on your Facebook page as well as online reviews for your practice - both great ways of spreading positive word of mouth to horse owners in the area.

The session will also explore the benefits of the Net Promoter Score - a robust method of measuring recommendations.
Changes to the Practice Standards Scheme

Tim Mair
Bell Equine Veterinary Clinic, Mereworth, Maidstone, Kent, ME18 5GS, UK

The new Practice Standards Scheme will go live in November 2015. Equine practices can apply to be accredited as:

• Core Standards
• General Practice - Ambulatory
• General Practice (GP)
• Veterinary Hospital

The General Practice (Ambulatory) category has been specifically introduced in an attempt to appeal to first opinion equine practices. General Practice (Ambulatory) practices must meet the Core and GP requirements in all of the modules except ‘In-Patients’.

In addition to accreditation under the Practice Standards Scheme, equine practices are eligible to apply to be inspected for additional PSS Awards in:

• Team and Professional Responsibility
• Client Service
• Ambulatory Service
• Diagnostic Service
• In-patient Service (not available to GP – Ambulatory practices)

Practices will be designated as ‘Good’ or ‘Outstanding’ within the Awards they select, and will be free to promote themselves as such. This follows a similar format to that used by Ofsted in the inspection of schools.

Within each of the Modules there are ‘Award Points’ which go above and beyond Module requirements, and focus upon behaviours and outcomes. Every clause within the ‘Awards Points’ section is given a weighting in terms of the points it is allocated.

• In order to be designated as ‘Good’ in a Module a practice will need to achieve 60% of the available points.
• A practice which achieves 80% or more will be designated as ‘Outstanding’.

The Modules fit together to form the Awards. Practices that wish to achieve an Award must be at ‘Good’ or ‘Outstanding’ in every Module in the Award. In order to be designated as ‘Outstanding’ within an Award a practice must be ‘Outstanding’ in all the Modules in the particular Award.

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<td>Required modules</td>
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<td>Pain Management</td>
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<td>Required modules</td>
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<td>Laboratory and Clinical Pathology</td>
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<td>Required modules</td>
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<td>Anaesthesia</td>
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Proceedings of the British Equine Veterinary Association Congress, 2015 - Liverpool, United Kingdom
Challenges in Equine Practice Management

Chaired by Keith Chandler
Sponsored by Merial Equine Health

15.30–17.00

Panel: Julian Samuelson, Alison Lambert, Wendy Furness and Steve Headon

The panel will discuss current challenges in equine practice management.

NOTES
09.00-09.20

Lower airway disease – are we moving forwards or full circle?

R. Scott Pirie

Dick Vet Equine Hospital, Royal (Dick) School of Veterinary Studies, Easter Bush Veterinary Centre, Easter Bush, Roslin, Midlothian, EH25 9RG, UK

With the exception of the integument, the lower airways represent the only anatomical structure which maintains constant exposure to the external environment. Consequently, a significant majority of lower airway diseases result from the inhalation of infectious (e.g. viral or bacterial) or non-infectious (e.g. particulates, allergens, noxious gases) agents. Examples include equine influenza, which results from inhalation of aerosolised viral particles with subsequent damage to the respiratory epithelium and recurrent airway obstruction (RAO), which results from inhalation of organic dust, with a subsequent hypersensitivity response to allergens resulting in the classic disease phenotype. However, there is less of a clear distinction between infectious and non-infectious aetiologies in relation to other lower airway diseases. Of these, inflammatory airway disease (IAD) has received the greatest attention over the past decade. However, many of the studies aimed at identifying a common aetiopathogenic pathway in IAD have yielded either conflicting or confusing results. Such inconsistencies may partly be attributable to the rather broad phenotypic definition of IAD, which is largely based on the presence of increased airway mucus and evidence of lower airway neutrophilic, metachromatic and/or eosinophil inflammation.

Upon consideration of the proposed key aetiological candidates in IAD, it is clear that the currently employed phenotypic criteria could feasibly be fulfilled by many, if not all (both infectious and non-infectious) of them. In comparison to infectious candidates, this ‘common phenotype-many causes’ issue is of greater significance with respect to the role of inhaled non-infectious agents. This is largely due to the extensive array of potential pro-inflammatory agents present within stabling and training environments (e.g. organic dust) and the extensive variation in their relative proportions between such environments. Furthermore, the likely synergistic pro-inflammatory capacity of various dust-derived agents and the likely variation in genetic susceptibility to individual components renders any effort to identify a common pathogenic pathway an enormous and likely unachievable task.

As recent interest in the role of inhaled non-infectious agents in IAD aetiopathogenesis has gathered momentum, so has the question of the possible association between IAD and RAO, particularly in light of the potential commonality in inhaled aetiological candidates. Does RAO represent a distinct environmental airway disease to IAD, or does it simply reflect a greater severity of a similar or identical disease? To date, this question remains unanswered. Recent work has demonstrated that, despite a general acceptance of the pivotal role of inhaled moulds in RAO aetiopathogenesis, there is significant variation with regard to both the modes of genetic susceptibility and the immunological pathways involved. In other words, the RAO disease phenotype, despite being considerably ‘tighter’ than that of IAD, can be attained via various immunological and inflammatory pathways. Furthermore, there is anecdotal evidence that, prior to the development of laboured breathing, RAO cases will have fulfilled the phenotypic definition of IAD for a variable period of time, thus indicating a degree of temporal overlap. These points further highlight the inherent difficulties associated with any attempt to further sub-categorise IAD under its current definition.

Consequently, there is an increasing interest in developing more appropriate means by which to sub-categorise equine IAD, particularly in light of the inevitable overlap in many specific areas (e.g. disease phenotype, cytological profile, environmental exposures etc.). Such overlap, and the inherent limitations associated with any attempts to ‘pigeon-hole’ IAD subtypes, will likely result in the proposal to re-define ‘equine environmental airway diseases’ in general. An approach akin to that applied to human asthma will likely be proposed, which recognises the (a) broad common factors amongst the majority of disease subgroups (e.g. disease induction via exposure to organic dust), (b) areas of overlap between particular disease subgroups (e.g. BALF cytology in neutrophilic IAD and RAO) and (c) factors specific to certain disease subgroups (e.g. detrimental breathing at rest in RAO and summer pasture-associated RAO [SPARAO], BALF cytology in eosinophilic IAD, the inciting environment in SPARAO). Theoretically, even within specific disease subgroups, further subdivisions may be applied based on current knowledge (e.g. polarised immunological profiles or genetic background in RAO) or future developments (e.g. specific environmental exposures).

Although this may be perceived by some as a backward step, it clearly reflects an overall awareness of the complexity of environmental airway disease, a factor evidenced by the extensive data derived from similar or equivalent diseases in humans. It is likely that the disadvantages of such an approach will be significantly outweighed by the advantages, with one major advantage being a likely reduction in the confusion which surrounds current terminology amongst both practitioners and owners. Future efforts to further define specific IAD subgroups will inevitably continue; however, it is increasingly apparent that such efforts will be largely restricted to an appropriate research setting in which the molecular and genetic tools necessary to illuminate specific pathways are available. Furthermore, one focus of such research efforts will be to identify more specific and appropriate biomarkers of individual environmental airway disease subgroups, thus permitting larger cohort studies of cases with a more tightly defined disease phenotype.

Although it may be argued that such an approach is akin to moving full circle, currently available data suggests that the likely success of any efforts to move forward in
this area of research rely on the realisation that such an approach is necessary. The currently broad phenotypic definitions, combined with the vast array of potential aetiological agents, combined with the complexities of disease pathways, combined with the genetic diversities within equine populations all risk a gradual stagnation of knowledge progression at best, and the propagation of confusion at worst. Whichever view is taken, either moving full circle or moving forward, both seem preferable to the risk of inertia.
Imaging the LRT: tricks of the trade
Mary Beth Whitcomb
School of Veterinary Medicine, University of California, One Shields Avenue, Davis, California 95616, USA

Thoracic ultrasound can be readily performed with standard ultrasound equipment [1,2]. Indications include fever of unknown origin, poor response to therapy for influenza, failure to thrive and clinical findings consistent with lower respiratory tract (LRT) disease. Ultrasound is a valuable complement to radiography and is often the only modality available to field practitioners. Advantages include detection of small effusions, characterisation of pleural fluid, visualisation of lung parenchyma through effusion and lack of radiation exposure. While abnormal lung must extend to the pleural surface to be visible, many radiographic lesions are detectable with ultrasound.

Thoracic ultrasound is possible with almost any transducer, including a rectal probe. A depth setting of 4–10 cm is adequate to visualize pleural surfaces; however, a low frequency transducer is necessary for the cranial mediastinum and in horses with extensive pathology. Alcohol saturation is generally adequate, although clipping may be necessary in thick coated horses. The visible lung field typically extends from the 5–15th intercostal spaces (ICS). Although most pathology is located cranioventrally, pleural surfaces should be evaluated from their dorsal to ventral extent in each ICS. Normal lung surfaces appear as a horizontal hyperechoic line that glides smoothly with respiration. Because ultrasound waves are reflected by air, only the surface of a normally aerated lung is visible.

Comet tails are the most common ultrasonographic abnormality and result from pleural surface irregularities. They appear as hyperechoic lines radiating vertically or obliquely from the pleural surface. A few small comet tails are common in healthy horses and foals. Numerous small comet tails or a few large comet tails are consistent with disease and are often seen in horses with pneumonia. Size is proportional to the size of the pleural/pulmonary lesion.

Pulmonary consolidation is seen in horses with more severe or advanced pneumonia. Sound waves can penetrate consolidated lung to produce hypoechoic areas that often appear similar to liver parenchyma or ‘hepatised’. Pleural effusion is a consistent feature of pleuropneumonia. Effusion is generally anechoic, although echogenic fluid may be present in horses with haemorrhax or pyothorax. Pinpoint hyperechoic gas echoes within pleural fluid is consistent with anaerobic pleuritis [3]. Pleural effusion can be quantified by labelling the fluid line in centimetres dorsal or ventral to the point of the shoulder. Serial ultrasonography is valuable to evaluate therapeutic response and fluid re-accumulation. Atelectasis often accompanies effusion and appears as a ‘squished’ wedge of lung tissue ventrally. Fibrin deposition in horses with pleuropneumonia can appear as a hypoechoic layer on visceral or parietal pleural surfaces or as linear strands between surfaces. Large, loculated fibrin clots may be found ventrally in horses with severe pleural effusion. The pericardio-diaphragmatic ligament is a normal structure that becomes visible caudal to the heart in horses with pleural effusion. It is differentiated from fibrin by its characteristic undulating movement with the heartbeat. Pulmonary abscesses are detectable when they extend to the pleural surface [4]. Abscesses tend to be more clearly demarcated than consolidated areas. Encapsulation may become evident with abscess maturation. Fluid accumulation or gas echoes may be visible within abscesses. Ultrasound is a valuable screening tool for Rhodococcus equi infections in foals. R. equi abscesses can appear as small nodules or large areas of abscessation in more advanced cases [5].

Pneumothorax may occur secondary to trauma or even as a sequela to pleuropneumonia [6]. Ultrasound is useful but challenging because free air has a similar hyperechoic appearance to a normally aerated lung. Close inspection will reveal a lack of movement of the dorsally located pneumothorax with respiration and normal gliding motions of aerated lung ventral to the pneumothorax. Intrapleural air may also be found in horses with indwelling chest tubes or recent thoracocentesis.

Lymphoma is the most common thoracic neoplasia [7]. It often creates large cranial mediastinal masses and severe pleural effusion without additional significant pulmonary abnormalities [8]. Metastatic neoplasia of other tumour types is less common but can also produce effusions and pulmonary/pleural masses. Biopsy or pleurocentesis is usually necessary for differentiation.

Ultrasound of the cranial mediastinal region is indicated when effusion inhibits radiographic visibility and in horses suspicious for thoracic neoplasia or cranial abscessation. Evaluation is not straightforward and requires experience. This region is accessed with a low frequency transducer from the 3rd ICS, either through the triceps or caudal to the triceps after extending the limb forward. Masses are often extensive in horses with lymphoma. Cranial mediastinal abscessation as a sequelae of pleuropneumonia can create encapsulated abscesses with or without loculations [9]. Ultrasound-guided biopsy or aspiration in standing horses has been reported [10], but general anaesthesia is preferable due to the close proximity of the heart.

References
Therapeutics for lower respiratory tract disease

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This abstract gives an overview of the available pharmaceutical interventions for recurrent airway obstruction (RAO) and inflammatory airway disease (IAD) with selected examples grouped in Table 1.

The table below is of course not exhaustive. Interesting new approaches continue to be explored. Of note, horses with RAO or IAD fed low dust diets showed additional improvement with omega-3 FA supplementation for 2 weeks [9]. A novel phytotherapeutic product (benefit of ‘not being doping’) is based on inhaled curcumin and may decrease neutrophilic airway inflammation [10]. Perhaps the most innovative approach, but also furthest from practical application, is the use of cytosine-phosphate-guanosine-oligodeoxynucleotides (CpG-ODN) bound to gelatin nanoparticles, which has shown clinical efficacy in RAO by shifting the immunresponse away from Th2-type pathways [11].

On the other hand, some treatment modalities have been around for a long time, even though there is still little evidence for their efficacy in IAD or RAO. Published randomised controlled trials are lacking and they are therefore just mentioned briefly: They include ‘mucoactive treatments’ using acetylcysteine (5–10 mg/kg bwt q. 12 h, per os), bromhexin, ammoniumchloride and potassiumjodide-infusions or ‘hyperinfusions-therapy’ [reviewed in 12]. Antibiotics, such as oxytetracycline, ceftefur sodium, potentiated sulphonamides or enrofloxacin, also belong in the category of ‘unproven’ drugs, even though their use is documented in IAD of young racehorses [13].

Table 1: Examples of therapeutics for lower airway disease

<table>
<thead>
<tr>
<th>Drug and dose</th>
<th>RAO</th>
<th>IAD</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Systemic corticosteroids</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prednisolone 1–2 mg/kg bwt, q. 12–24 h, per os</td>
<td>[1] (review)</td>
<td>in analogy to RAO</td>
<td>inexpensive; well absorbed</td>
</tr>
<tr>
<td>Dexamethasone, 0.05–0.1 mg/kg bwt, q. 24 h, i.v., i.m., per os</td>
<td>[1,2]</td>
<td>[3]</td>
<td>inexpensive, increase dose when given per os</td>
</tr>
<tr>
<td><strong>Inhaled corticosteroids</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beclomethasone, 1–3 mg/kg bwt, q. 12 h by MDI</td>
<td>[1]</td>
<td>[4] not peer-reviewed</td>
<td>duration: 8–12 h</td>
</tr>
<tr>
<td>Fluticasone**, 1000 µg (2–4 µg/kg bwt), q. 12 h by MDI</td>
<td>[1]</td>
<td>[3.4]</td>
<td>duration: 8–12 h</td>
</tr>
<tr>
<td><strong>Systemic bronchodilators</strong>**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clenbuterol, 0.8–2 µg/kg bwt, q. 12 h, per os or i.v.</td>
<td>[1]</td>
<td>[1] in analogy to RAO, when bronchoconstriction is present</td>
<td>tachyphylaxis after 3 weeks of treatment</td>
</tr>
<tr>
<td>Scopolaminbutylbromide (N-butylscopolammonium Bromid), 0.3 mg/kg bwt i.v.</td>
<td>[5]</td>
<td>not indicated</td>
<td>onset: 10 min; duration: 30–40 min</td>
</tr>
<tr>
<td><strong>Inhaled bronchodilators</strong>**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salmeterol, 360 µg (3 actuations), by MDI, q. 12 h</td>
<td>[1,6]</td>
<td>in analogy to RAO, when bronchoconstriction is present</td>
<td>onset: 15–30 min; duration: 6–8 h</td>
</tr>
<tr>
<td>Albuterol (salbutamol), 125 µg (5 actuations), by MDI, q. 6 h</td>
<td>[1]</td>
<td>in analogy to RAO, when bronchoconstriction is present</td>
<td>onset: 5 min; duration: 0.5–3 h</td>
</tr>
<tr>
<td>Ipratropium bromide, 2–3 µg/kg bwt as a 0.02% solution for nebulisation or by MDI (also with albuterol): 270 µg (15 actuations), q. 6 h</td>
<td>[1]</td>
<td>[4] not peer-reviewed</td>
<td>duration: 4–6 h</td>
</tr>
<tr>
<td><strong>Immunomodulators</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium cromoglycate (mast cell stabilisers, cromones also include nedocromil sodium), 0.02% solution for nebulisation 200 mg, q. 12 h (also by MDI),</td>
<td>not usually a sole treatment for RAO</td>
<td>IAD with increased mast cells [7]</td>
<td>best used prophylactically</td>
</tr>
<tr>
<td>Interferon-α (50–150 u q. 24 h, per os or for 5 days)</td>
<td>[8]</td>
<td>low-dose more efficacious than higher doses</td>
<td></td>
</tr>
</tbody>
</table>

* Often corticosteroids do not influence BALF neutrophil percentages.
** Considered most potent and longest-acting inhaled glucocorticoid for treatment of equine RAO.
*** Scopolaminbutylbromide is an interesting alternative to atropinsulfate (0.01 mg/kg bwt i.v.) or glycopyrolate (0.007 mg/kg bwt i.v.) for similar short-term acute relief of bronchospasm, but without the side effects of the latter.
**** Bronchodilators, like β₂-agonists and anticholinergics, are usually not used as sole therapy for IAD. Although clenbuterol increases mucociliary activity and has some anti-inflammatory effects, the anti-inflammatory action of bronchodilators is generally considered insufficient and efficacy may decrease with prolonged use. Bronchodilators can, however, be given prior to inhaled corticosteroids to improve deposition of the latter in the lower airways.
References


NOTES
Managing RAO and IAD cases – the role of environmental management

Emmanuelle van Erck-Westergren

Horses, and more specifically working horses, are prone to airway diseases: they live in closed environments, inhale high amounts of particles and are exposed to increased immune challenges when travelling or competing. Environmental factors such as respirable dust, including bio-aerosol, noxious gases and unconditioned air play a determining role in triggering and maintaining recurrent airway obstruction (RAO) and inflammatory airway disease (IAD).

While it is essential to treat inflammation and alleviate its functional consequences, the management of RAO and IAD cannot be limited to medical therapy: improving the horse's direct environment is key to the long-term management of these cases. The owners' perception of risk and implementation of solutions can be far from the veterinarian's guidelines. As equine healthcare professionals, we play an essential role in both identifying defective environments and bringing remedying solutions.

Pasture

A 24-h turnout at pasture in a temperate climate would be the ideal environment for a horse with RAO or IAD. It has been demonstrated that horses are more likely to develop lower airway inflammation when they are stabled [1,2]. They are exposed to high levels of dust of various quality and quantity, as well as to other noxious elements such as endotoxins, allergens and ammonia [3]. The concentration and number of inhalable particles varies with stable design as well as with the location of a stall within the building [4]. Variations in particle concentrations also depend on management practices, time of day and season of year.

Building design

The quality of ventilation, the level of humidity and dust is determined by building configuration. Ventilation is difficult to appreciate subjectively. Ideally, buildings should have sufficient side-openings as well as roof vents to ensure proper air circulation without creating draughts. Built-in ventilation systems are often difficult to access for cleaning and can become dust traps. Humidity fosters colonisation from pathogenic moulds and bacteria. In cold climates, closing doors and windows creates a warm and humid environment, favourable to micro-organic growth. Materials that are easy to disinfect should be preferred.

The storage of hay and straw within the stable building is detrimental [1]. If there are dedicated storage areas for bedding and forage, the same rules regarding building hygiene apply: these should be protected from humidity and soil contaminants, regularly disinfected and distant from manure disposals, tracks or bordering roads.

Bedding

The choice of bedding directly influences the amount of inhalable contaminants. Straw is a popular bedding source: it is cheap and easy to recyle and represents an appreciable source of fibre. However its hygienic quality can be difficult to control. Saprophyte microorganisms naturally contaminate hay and straw. The level of microbial development within the bales depends on several factors, which include humidity levels during harvest, duration of drying, length of stem cuts, pressing and storage conditions [5]. Paper and cardboard beddings yield much lower levels of dust particles and aeroallergens than straw [6]. Large dust-free wood shavings are also a good alternative.

Forage

Soaking hay is a cheap way of reducing inhalable dust, however it promotes bacterial growth and drains sugars [7]. Specially conditioned hay should be considered for RAO or IAD-affected horses, including grass silage, haylage or steamed hay. The hygienic and nutritional quality of silage or haylage produced by local farmers can be irregular. Commercially available haylage usually undergoes quality-control but is expensive. Hay-steamers are a promising alternative: the heat kills all bacteria and moulds contained in the hay [8]. Some haysteamers do not allow homogenous circulation of the streaming water and improper temperatures at the core of the bale results in microbial incubation rather than elimination.

Management practices

Adopting high quality dust-free forage and bedding for a single horse is insufficient and environmental management should be applied to the entire stable unit. The levels of respirable dust vary according to the time of the day and are highest when human activity increases (cleaning, feeding, work, tacking...) [4]. Horses should be turned-out when the boxes are cleaned. Practices such as sweeping, using blowers or entering the stable with an engine-run vehicle should be avoided.

Several 'air-cleaning' devices, derived from techniques used in hospitals, have been tested to reduce the amount of circulating particles and sterilise the air. These are not necessarily adapted to stable-type environments and further research is required.

Prevention remains a guarantee for the maintenance of lower airway health. The tools and training for environmental assessment are currently not sufficiently accessible to equine veterinarians.

References

HALL 1a
SATURDAY 12th SEPTEMBER

Respiratory Medicine Case Based Panel
Chaired by Scott Pirie
Sponsored by Boehringer Ingelheim

11:10–12:20
Panel: Tim Brazil, Vince Gerber and Emmanuelle van Erck-Westergren

The panel will present their own cases and discuss challenging respiratory disorders covering current areas of contention.

NOTES
Endoscopic evaluation of the equine urinary tract has been well described [1-4]. It is important that prior to endoscopy a thorough physical examination of the horse is carried out. Rectal examination may be indicated to palpate the left kidney, bladder and urethra. Physical findings should be supported by urinalysis ± culture and sensitivity, a complete blood count and serum biochemistry. Renal and bladder ultrasonography may also be appropriate.

**Indications**

- Haematuria (urethra, bladder, ureters)
- Urinary calculi
- Urethral obstruction
- Renal disease – assessment of renal function, pyelonephritis, neoplasia, idiopathic renal haematuria
- Urinary incontinence, bladder paralysis, urine scalding
- Bladder neoplasia
- Bladder trauma, e.g. parturition
- Abnormal urination
- Haemosperma in stallions

**Equipment list**

**Essential:**
- Sedation
- Twitch
- Stocks to restrain horse
- Endoscope – flexible fibreoptic or video-endoscope at least 1 m long, diameter 10 mm or less (paediatric scope: 7 mm for foal, pony, miniature horse)
- Cold sterilising solution
- 2 litres sterile water
- Sterile gloves
- K-Y Jelly – sterile
- Dilute chlorhexidine or povidone-iodine solution
- Cotton wool or gauze swabs
- Tail bandage

**Optional:**
- Sterile urinary catheter
- Sterile polypropylene tubing for urine sample collection
- Sterile 10 ml syringes
- Sterile sample pots
- Biopsy instrument

**Patient preparation**

The horse should be adequately restrained. Ideally 3 helpers are required, one to hold the horse, one to insert the endoscope, one to drive the endoscope. Sedation is required to relax the penis in the male, usually an alpha-2 agonist ± butorphanol i.v. so affect urinalysis results. Some male cases may require acepromazine but paraphimosis is a recognised side effect so use with caution. A tail bandage should be placed to minimise contamination from tail swish. The external genitalia should be cleaned with dilute chlorhexidine or povidone-iodine to minimise contamination of the urinary tract.

**How to perform and optimise diagnostic information**

**Procedure**

The endoscope should be cold sterilised and carefully rinsed with sterile water before use. To enable thorough visualisation of the bladder a urinary catheter may need to be passed first to remove any urine. The person inserting the scope should wear sterile gloves. In the male horse the penis should be held firmly with one hand proximal to the glans and steady traction applied. The other hand guides the endoscope into the urethra to be advanced as instructed by the driver. The urethra should be occluded round the scope when distending with air. This may stimulate the horse to urinate around the scope which should be allowed. In the female one hand should be inserted into the ventral floor of the vagina to locate the urethral opening so the endoscope can be inserted. The urethra in the mare is short and primary lesions are rare. At all times the scope should be advanced slowly and carefully to minimise trauma.

**Urethra**

Normal mucosal appearance is pink with longitudinal folds. These flatten out and may appear redder than normal when distended with air. It is normal that the submucosa vasculature is more prominent towards the bladder. If the horse has been recently catheterised there may be mild wall irritation. At the ischial arch the endoscope turns the corner and the urethra widens. The multiple openings of the accessory sex glands can be seen (more obvious in stallions). As the scope bends backwards these will appear at the bottom of the endoscopic view.

**Abnormalities**

- Urethritis
- Proximal urethral defects
- Strictures
- Urethrolithiasis
- Neoplasia
- Disease of accessory sex glands

**Bladder**

Entry via urethral sphincter. The endoscope faces the same way as the horse so the right side of the bladder is on the right side of the horse and vice versa. The position of the urine pool aids orientation and should be ventral. The bladder should be distended with air using the endoscope to assess the internal wall which should be pink and smooth. This can appear irregular if indented with abdominal viscera. Submucosal vascularisation can appear prominent in the...
normal horse. Grab biopsies can be taken via the endoscope biopsy channel if required for culture and sensitivity and histopathology.

Abnormalities
- Cystitis
- Urolithiasis
- Trauma/rupture
- Neoplasia
- Paralysis/sabulous bladder

**Ureters**
The slit-like openings are located at the 10 and 2 o’clock position on the dorsal aspect of the trigone just within the bladder neck. They can be seen more easily with the endoscope retroflexed. Urine is pulse-released approximately every minute in normal horses. Urine samples can be collected separately from each ureter using a sterile 8 French polypropylene catheter via the biopsy channel. Gentle suction should be applied to avoid trauma and collapse of the ureters so a sample can be obtained. If the openings cannot be located dyes such as sodium fluorescein (10 mg/kg bwt) which gives a green colour, indigotindisulfonate (indigo carmine 0.25 mg/kg bwt, purple-blue), azosulfamide (2.0 mg/kg bwt, red) or phenolsulfonphalein (1.0 mg/kg bwt, red) can be injected i.v. and visualised via endoscopy [3]. Furosemide can be given as a diuretic if the patient’s condition allows.

**Abnormalities**
- Ectopia – rare
- Diagnosis of renal haematuria or pyuria
- Assessment of renal function if a kidney is unable to be imaged ultrasonographically

**Complications of the procedure**
- Low risk of introducing infection
- Iatrogenic trauma
- Recent case report of suspected venous air embolism during urinary tract endoscopy in a standing horse [5].

**References**
Indications for renal ultrasound include axotaemia, haematuria, pollakuria, dysuria, uroliths or palpable left renal enlargement [1-6]. In horses with nonspecific clinical signs, renal abnormalities may be found during routine abdominal ultrasound [1,7]. A low frequency (2–5 MHz) transducer is necessary to evaluate adult kidneys due to their deep location. Rectal transducers are insufficient for transcutaneous imaging. Ideally, the hair is clipped with No. 40 blades, the skin washed and ultrasound gel applied. Alcohol saturation is acceptable in appropriate cases, but subtle findings may be missed. An abdominal program should be used and time-gain-compensation controls adjusted for deep cavity imaging.

The left kidney is visible in the left paralumbar fossa (PLF) and left 15–17th intercostal spaces (ICS) deep to the spleen at 20–30 cm scanning depth. Transrectally, the caudal portion of the left kidney is visible at arm’s length. The right kidney is seen dorsally in the right 15–17th ICS adjacent to the body wall at 15–20 cm depth and generally cannot be imaged transrectally. Ultrasonographic parameters include size, shape, cortical echogenicity (hypoechogenic to the adjacent spleen), cortical thickness, medullary echogenicity (hypoechogenic to the cortex) and corticomedullary distinction. The renal pelvis is evaluated for nephroliths and pyelectasia. Reported renal measurements are somewhat variable [1,8-9].

Small kidneys are generally associated with chronic renal failure [2]. Affected kidneys are often nearly unrecognisable with a distorted shape, increased cortical echogenicity and thickness, poor corticomedullary distinction, nephrolith(s) or peripelvic mineralisation. One kidney may appear end-stage and the other enlarged with relatively normal renal parenchyma [2]. Enlarged kidneys with cortical changes may accompany multiple renal pathologies, often requiring biopsy for differentiation [12,4-7]. Horses with acute renal failure may show a subcapsular anechoic layer of perirenal oedema. Renal architecture is seldom grossly distorted, but the corticomedullary junction may appear especially distinct. Multiple small cortical cysts sometimes accompany acute or chronic renal failure, whereas lone cysts are typically an incidental finding. Renal abscesses produce variably shaped hypoechoic areas within the cortex or medulla [7]. Examiners should avoid overinterpretation of the deep medullary hypoechoic region within the right kidney as a mass or abscess. Renal neoplasia is encountered with some regularity at referral hospitals. Renal adenocarcinoma is the most common primary tumour, producing large masses that completely efface renal parenchyma [10]. Renal metastases of other tumours have also been reported [1].

Horses with urolithiasis often present with post exercise haematuria, axotaemia and, occasionally, mild colic [3,5,6]. Nephroliths appear as hyperechoic structures within the renal pelvis that cast hard shadows. Renal sludge can appear similarly but produces a less distinct shadow. Idiopathic renal haematuria should be considered in horses with gross haematuria [3,5]. Horses are typically unilaterally affected and show pelvic distention due to clots and haemorrhage. Renal architecture is otherwise unremarkable. Biopsy and nephrectomy have been unrewarding. The contralateral kidney may later become affected transrectally. Ultrasound of the urinary tract is indicated in all horses with renal disease. The bladder is located ventral to the rectum and contains variably echogenic urine due to mucus and crystals. Cystoliths may be found at the trigone or dependent portion of the bladder. Cystitis is challenging to diagnose, as a recently emptied bladder can appear falsely thickened. The normal appearance of the caudal ureters has been described [11]. The ureters are evaluated individually from the trigone to each kidney or as far proximally as possible. Ureteral motility is helpful to differentiate between blood vessels and the vas deferens in males. Ureteroliths with associated ureteral thickening can be found along the length of the ureter [6]. Cystoscopy should always follow ultrasound because gas introduced during endoscopy can obscure ultrasonographic visibility or mimic the appearance of uroliths.

Ultrasound-guidance (USG) is useful for biopsy, aspiration and even lavage ± antimicrobial deposition into renal abscesses [12]. Right renal sampling is preferable in horses with nonspecific or bilateral abnormalities. Left renal sampling is possible but results in splenic penetration. Blind biopsy is not recommended. Clotting profiles may reduce the risk of post-procedural haemorrhage [13]. Sampling of the cortex and medulla is recommended, but sampling sites may vary with lesion location. Automatic biopsy instruments decrease acquisition time, but needle ‘throw’ must be considered. Procedures should be performed steriley and USG used continuously to monitor needle positioning. Two biopsy samples for histopathology and culture/sensitivity are beneficial.

References

Imaging the equine kidney – tricks of the trade
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HALL 1a
SATURDAY 12th SEPTEMBER

14.10–14.30

Urolithiasis – managing urinary stones
Mark Hillyer
Newmarket Equine Hospital, Cambridge Road, Newmarket, Suffolk, CB8 0FG, UK

No abstract submitted

NOTES
Sabulous cystitis is a poorly understood syndrome of urinary incontinence characterised by detrusor muscle dysfunction and an end-stage atonic bladder. The incidence of this condition is not clear but experience in our hospital would suggest that its presentation is as common as that of cystic calculi. In one study of 37 cases of incontinence, 20/37 cases had abnormal detrusor function. The terminology used in textbooks and journals to describe the condition can be confusing. It is probably best to consider the build-up of sabulous material in the bladder, and the cystitis it inevitably causes, as a clinical sign not a diagnosis. One must therefore consider the potential conditions which could lead to this build-up, which include:

Primary lower motor neurone dysfunction (neurological) of the bladder
- Cauda equine neuritis/polyneuritis equi
- Lumbo-sacral trauma
- Equine protozoal myeloencephalitis (EPM)
- Toxins, e.g. sorghum grass (white clover?)
- Neoplasia, e.g. lymphosarcoma
- Equine degenerative myeloencephalopathy (EDM)

Primary/idiopathic detrusor muscle dysfunction (may or may not have an undiagnosed neurological origin)

Secondary detrusor muscle dysfunction
- Historic/protracted upper motor neurone disease, e.g. cervical vertebral malformation/stenosis
- Chronic cystitis (local effects on bladder function)
- Impaired voiding (e.g. secondary to chronic back/hindlimb pain)
- Multiparity/dystocia (urethral ± secondary detrusor dysfunction).

Clinical presentation
Generally, these cases present with an insidious onset of incontinence, with owners often stating that the horse dribbles periodically or continuously, and that it is particularly prominent when the horse vocalises or moves, likely due to an increase in abdominal pressure. Findings in these cases are summarised in the Table 1.

Physiology and pathology
The key to understanding the development of end-stage bladder with build-up of sabulous material (and the potential therapeutic approaches) is knowledge of neuromuscular (especially reflex) control of the urinary bladder. Receptors for stretch and pressure are found in the bladder wall and bladder neck, while afferents travel in the pelvic nerve to the sacral spinal cord. Reflexes are mediated at the level of sacral (somatic and PNS) and lumbar (SNS) spinal cord while micturition is also influenced by higher centres in midbrain cerebellum and cerebrum. Key anatomic efferent pathways are noted in Table 2 and it is dysfunction of these complex control mechanisms that leads to the end stage bladder.

Treatment and prognosis
Treatment of these cases is often frustrating. On initial presentation, assuming significant cystitis is present, it is worth managing these cases with aggressive bladder lavage, systemic antibiosis and anti-inflammatory therapy in case severe inflammation is the sole cause of neurogenic and/or myogenic dysfunction. Return of the signs after aggressive therapy suggests that the prognosis is poor: no therapies are curative in the cases, although dedicated owners can manage the signs. Pharmacological manipulation of bladder function using parasympathomimetics (to increase detrusor

**Table 1: Key clinical findings associated with incontinence due to an end stage/atonic bladder**

<table>
<thead>
<tr>
<th>Signalment</th>
<th>Any age</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Any breed</td>
</tr>
<tr>
<td></td>
<td>More common in mares and geldings</td>
</tr>
</tbody>
</table>

| History      | Insidious onset of incontinence|
|--------------| Horses may fail to posture to urinate (no perception?) or fail to produce significant urine (impaired evacuation mechanisms) |
|              | Pollakuria and stranguria may be present |
|              | Owners may often confuse this syndrome with PU/PD |

| Clinical examination | Urine crystals on hair, strong smell of urine and possibly scalding |
|                     | • perineum and inner thighs in mares |
|                     | • prepuce and inner hindlimbs in males |
|                     | Careful neurological examination is critical to rule out primary neurological disease: |
|                     | • perineal hypalgesia (pudendal n. mediated) |
|                     | • ataxia |
|                     | • reduced tail tone |
|                     | • dilated anus (pudendal n.) ± faecal retention |

| Rectal examination and ultrasound | Large flaccid bladder, easy to express urine |
|                                  | May feel sludge/putty like mass in ventral bladder |
|                                  | Ultrasongrams clearly show sludge in the floor of the bladder |

| Urinalysis | Evidence of cystitis common (blood and WBCs, various bacterial spp. cultured) |

| Cystoscopy | Sludge/sand in bladder |
|           | Erythematous mucosa (secondary cystitis) |

| Other techniques | Cystometry and urethra pressure profilometry has been described |
tone) and/or sympathomimetics (to increase sphincter tone) has met with limited success in horses except in those cases where the primary cause is temporary. Oestrogens have also been used in a limited number of mares with suspected primary urethral sphincter incompetence.

**Further reading**


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**NOTES**

**Table 2: Neuroanatomic efferent pathways involved in bladder control**

<table>
<thead>
<tr>
<th>Nervous system</th>
<th>Aim</th>
<th>Spinal cord segment</th>
<th>Efferent nerve</th>
<th>Post ganglionic cell bodies</th>
<th>Effector tissue</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Somatic</td>
<td>Store</td>
<td>S1–S3</td>
<td>Pudendal nerve</td>
<td>N/A</td>
<td>External urethral sphincter (striated)</td>
<td>Contracts</td>
</tr>
<tr>
<td>SNS</td>
<td>Store</td>
<td>L1–L5</td>
<td>Splanchnic nerves then hypogastric nerve</td>
<td>Caudal mesenteric ganglion/pelvic plexus</td>
<td>Detrusor muscle</td>
<td>Relaxes (β)</td>
</tr>
<tr>
<td>PNS</td>
<td>Eliminate</td>
<td>S1–S3</td>
<td>Pelvic nerve via pelvic plexus</td>
<td>Bladder wall</td>
<td>Detrusor muscle</td>
<td>Contracts</td>
</tr>
</tbody>
</table>

**Table 2 continued**

<table>
<thead>
<tr>
<th>Nervous system</th>
<th>Aim</th>
<th>Spinal cord segment</th>
<th>Efferent nerve</th>
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<tbody>
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<td>Bladder wall</td>
<td>Detrusor muscle</td>
<td>Contracts</td>
</tr>
</tbody>
</table>

PNS Eliminates S1–S3 Pelvic nerve via pelvic plexus

Bladder wall Detrusor muscle Contracts

Internal urethral sphincter (smooth muscle) Relaxes

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Proceedings of the British Equine Veterinary Association Congress, 2015 - Liverpool, United Kingdom
Imaging Panel
Chaired by Sarah Powell

15.45–17.30
Panel: Christoph Lischer, Richard Mitchell, Michael Ross and Hans Wilderjans

The Imaging Panel aims to demonstrate different approaches to the reading and interpretation of diagnostic images, and to encourage debate about the interpretation of the clinical significance of imaging findings.

NOTES
Epidemiology of anaesthesia-related mortality and morbidity

Mark Senior
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Depressingly, equine anaesthetic-related fatalities have apparently remained at a similar level over the last few decades despite apparent advances in equipment, training and drug availability [1]. In contrast, some anaesthetic-related morbidities appear to have changed in their frequency [2]. Therefore, it is important that we continue to strive to determine the frequency, and understand the causes, of anaesthetic-related mortalities and morbidities (ARMMs). Such understanding means the benefits of performing a procedure can be considered against the potential for complications and case management may be modified if causes are avoidable. Discussing ARMMs is also an important part of gaining informed consent to undertake anaesthesia in the owner’s horse.

Epidemiology is the study of disease in (animal) populations and of factors that determine its occurrence. The frequency that equine ARMMs occur is well suited to analysis using many epidemiological methods. In recent years, the number and complexity of epidemiological studies in equine anaesthesia has increased. The ability to interpret such studies is vital for vets in order for them to make potential improvements to their anaesthetic practice and facilitates discussion between colleagues and owners.

The purpose of this talk is to provide the equine vet with an understanding of the methodologies that can be employed in epidemiological studies.

Frequency
An important aim of any study into ARMMs is to know how often they occur. There are different ways that the frequency of disease (e.g. death or new morbidity) can be measured. Prevalence refers to the number of cases in a population at a single specific time point. Incidence refers to the number of new cases in a defined population within a set time period. Importantly we can use incidence to estimate risk [3].

Risk
Another aim in many studies is to determine what the risk of an adverse outcome occurring may be. In epidemiological studies ‘risk’ is used to describe several subtly but importantly different things. Risk may be an overall risk for the study population or an individual horse’s risk. An animal may be exposed to several types of risk at the same time, and the ‘risk factors’ that are presented in epidemiological studies may not reflect the true or overall exposure to risk of an individual. Risk can also be used to evaluate the association of causal factors with a disease. Studies attempting to estimate the influence or association of a hypothesised causal factor on the occurrence of a disease often do this by expressing risk as relative risks [4]. Two terms widely used are risk ratio (RR) and odds ratio (OR) [5]. As RR or OR are relative measures they are always expressed in relation to a reference variable and the value is only relative to that reference variable. The reference variable, always has an RR or OR value of 1.0 and is often the subset with the largest number of cases or a biologically/clinically relevant sub-set.

Study design
Study design affects what results will be obtained from that study. Case studies and case series are descriptive reports of ARMMs and tend to be limited to hypothesising possible causal factors. However, their value should not be underestimated, particularly when further case reports review previous reports and update current (lack of) understanding [6] and/or case series begin to elucidate likely causal factors [7]. More complicated study designs include: case-control studies [8], cohort studies/nested-case-control studies [9], intervention studies and observational studies [10].

Longitudinal studies investigate changes over time and can be interventional or observational. They can be prospective or retrospective. Cross-sectional studies select a sample population from a larger population at a given time point and then assess presence or absence of disease for each individual in the sample on a single occasion. Many cross-sectional studies are descriptive and are often called surveys. The strength of evidence from a study is also sensitive to time. Prospective studies collect data going forwards in time from a defined start point in a study. Retrospective studies collect data that refer to or was recorded during past events. Often data collected in retrospective studies relies on data collection systems that may not have been designed to accurately obtain the data required by the study or the ability of study participants to recall events from the past. In general, data from retrospective studies are considered less reliable.

Single centre studies are generally considered to provide weaker evidence compared to multicentre studies. Multicentre studies have the advantages of being likely to introduce more heterogeneity into the study population and being able to generate sufficient case numbers over a shorter period of time. However, utilising multicentre study designs can also introduce problems [11].

Univariable and multivariable statistical analysis
The problem in studying ARMMs is that there is likely to be two or more causal factors contributing to the outcome of the disease. In univariable analysis, we measure the association between just one of these causal factors (e.g. age) and the disease (e.g. death), yet the result we obtain will also include the effects of the other unmeasured or confounding factors and is therefore not accurate. It is important to interpret epidemiological studies that utilise univariable approaches alone cautiously. In studies designed...
to measure multiple causal factors, it is possible to tease out how the measured causal factors may confound each other using multivariable models. The standard practice is to analyse the association of all the measured variables to the disease individually using univariable analysis, and then those showing a reasonable association then go into the multivariable model. Commonly, variables that had an apparently strong association with the disease drop out of the model because they are strongly confounded by another variable. Multivariable studies should still be interpreted carefully as they only attempt to explain the data using the measured variables and do not account for confounding by unmeasured variables. This is why multivariable models sometimes produce results that seem difficult to explain.

The increasing number of practices performing equine general anaesthetics means that more practitioners will become involved in future epidemiological studies.

References
Anaesthesia and the law: what you need to know to avoid getting into trouble

John F.R. Hird
Hird & Partners, Shelf Equine Clinic, Lower Giles Hill Farm, Shelf, Halifax, HX3 7TW, UK

Perhaps the commonest misconception held both inside and outside the veterinary profession in the UK is that civil litigation, more commonly described as ‘suing for damages’, is an unwelcome import from the United States. What they are doing today, we do tomorrow, so runs the assumption. The foundation of the Veterinary Mutual Defence Society as long ago as 1865 illustrates just how wrong that assumption has always been.

The Society was formed expressly “for the purpose of forming a society for mutual defence against unjust actions at law for alleged malpractice or occasional accidents during operations”. In consequence of many vexatious and unjustifiable actions at law having been threatened and sometimes instituted, for alleged depreciation in the value of horses and other animals as a result of some act or omission on the part of a veterinary surgeon or his qualified assistant, and because it has been repeatedly sought on behalf of the public to make the members of the profession not only responsible for their opinions (fairly and honestly expressed in the discharge of their duty), but also to hold them responsible for accidents resulting from necessary surgical operations and for other accidents or causes of dispute occurring in the ordinary course of veterinary practice, or whilst an animal is in the care or custody of a veterinary surgeon…”

Little has changed since, indeed, matters have only got worse. These days our clients tend to regard the equine veterinary surgeon as an infinite source of compensation in any instance where matters do not turn out to their satisfaction.

Statistics show that British animal owners lead the world in their desire to pursue litigation against the veterinary profession for a plethora of perceived mistakes, omissions and, in many cases, simply because they aren’t satisfied with the end result. Therefore it is not surprising that today’s new graduates tend to approach their veterinary career with an underlying dread of being sued.

Nowhere is this dread more likely to manifest itself than in the mind of the equine anaesthetist. He or she starts the operating list knowing that horses were never designed by the mind of the equine anaesthetist. He or she starts the operating list knowing that horses were never designed by nature to be anaesthetised. Filling the lungs with a volatile anaesthetic agent inevitably experience one or more disasters at some stage

Which law are you going to fall foul of?

Unlike exceeding the speed limit, there is no specific legislation that the anaesthetist will fall foul of, but the two potential areas for trouble to arise are:

a) A claim for damages under civil law, arising from a successful allegation of professional negligence.

b) A complaint to the Royal College of Veterinary Surgeons, alleging professional misconduct by the anaesthetist.

Civil negligence

The most comprehensible definition of negligence is, ‘failing to do what a similarly qualified person would reasonably be expected to do’, and the reverse, which is ‘doing what a similarly qualified person would be expected not to do’.

The key parts of this definition are, what do we mean by ‘similarly qualified’, and what is meant by the word ‘reasonable’? The first part is easier to answer, in that a veterinary anaesthetist who has obtained a higher qualification in the speciality, e.g. a Certificate, or Diploma, will be judged by the standards to be expected of that level of qualification. In lay terms, he or she would be expected to know better than an ordinary MRCVS what to do in any given situation.

The definition of what is ‘reasonable’ is far more open to interpretation, and lies solely in the hands of a lay (i.e. not an MRCVS) Judge, sitting in a civil court.

The areas of equine anaesthesia which can give rise to such claims are legion, and will be discussed during the lecture, but perhaps the most contentious is the issue of informed consent. The definition of what constitutes informed consent is continuously evolving [2], but following an anaesthetic death claims’ lawyers will often argue that consent was not given for the use of any unlicensed drugs which had been given, and consent for general anaesthesia would have been withheld if this had been explained to the owner beforehand.

The various aspects of what might be considered a ‘reasonable’ general anaesthetic in the horse will be discussed, as well as the skills that might be deemed necessary in order to avoid being accused of straying outside one’s area of competence. This is an area that the RCVS might consider amounts to professional misconduct.

RCVS complaints

In recent years the Royal College has gone out of its way to demonstrate that it is a ‘first rate regulator’, as a consequence of which it is extremely easy to lodge a complaint against a veterinary surgeon, and the vast majority are completely without merit.

What to do when things go wrong

Any equine anaesthetist who has a clinical workload will inevitably experience one or more disasters at some stage in their career. How such situations are best handled, and the consequences minimised will be reviewed, as well as those actions that might seem tempting at the time, but should be avoided at all costs.

References


What have we learnt from CEPEF 1-4?

Chair: Mark Senior
Panel: Eddie Clutton, Alex Dugdale, John Hird and Elizabeth Leece

It is now 20 years since the results from CEPEF-1 were published. The CEPEF series of studies are probably some of the most commonly cited studies related to equine anaesthesia as they have provided valuable epidemiological evidence into anaesthetic-related fatalities. Yet over the last 20 years equine anaesthetic-related fatality rates have apparently not improved, in contrast with those in dogs and cats over the same period. This panel discussion will explore what lessons have been learnt from CEPEF 1-4 and whether anything has been missed or ignored, and relate these to improving fatality rates. The panel will also discuss challenges and opportunities for further CEPEF studies.
A human patient cannot be anaesthetised without capnography in a number of countries because not only is it a useful guide for monitoring ventilation, but it can warn of severe, life-threatening problems, such as equipment failure or even cardiac arrest. In horses, it can also be a valuable tool, although for monitoring of ventilation, arterial blood gases are more helpful.

Arterial blood gas analysis can never be replaced by the non-invasive monitors of ventilation in horses such as the pulse oximeter and capnograph. A systematic approach to blood gas analysis should be adopted to allow rapid analysis under anaesthesia, looking at arterial oxygenation (PaO₂) and carbon dioxide levels (PaCO₂) along with the pH. After sample collection, without contamination with air bubbles, the arterial oxygen tension should be considered in conjunction with the fraction of inspired oxygen (FiO₂), which is approximately 0.8 when using 100% oxygen in a circle breathing system. The alveolar oxygen partial pressure (P A O₂) can be calculated when the arterial carbon dioxide partial pressure (P A CO₂) is known where P a represents the barometric pressure and P 100 represents the pressure of water.

\[
P A O₂ = (P a - P H₂O) \times F i O₂ - \frac{P A CO₂}{0.8}
\]
\[
= 520 \text{ mmHg}
\]

The alveolar-arterial gradient (P A O₂-P a O₂) can then be calculated and this should be less than 20 mmHg with values greater than this reflecting more commonly VO₂ mismatching, right-left shunt or rarely diffusion impairment. The arterial to inspired fraction can also be compared (P a O₂/F i O₂) and this should be greater than 200 with normal values reaching 500. If this ratio is less than 200 it represents a severe problem with oxygenation. Different strategies with ventilation or use of bronchodilators may be used to improve oxygenation.

Unfortunately in the horse, hypoxaemia is not always associated with poor ventilation due to marked alterations in ventilation and perfusion matching. So to assess ventilation we need to monitor the arterial levels of carbon dioxide. The normal range is 35–45 mmHg (4.6–6 kPa) and an elevation in this reflects hypercapnia which is most commonly due to hypoventilation under anaesthesia and can lead to a respiratory acidosis, with a potential reduction in the pH. An indirect monitor of ventilation in horses and arterial blood gases should be used to evaluate ventilation especially during anaesthesia lasting over 60 min [1]. In horses that are being ventilated, the PaCO₂-PE’CO₂ increases to a mean of 12 ± 4.5 mmHg (1.6 ± 0.8 kPa) and this value increases as the weight of the patient increases or when positioned in dorsal recumbency [2]. The effect seems to be worsened in compromised horses such as those undergoing colic surgery [3]. It is suggested that if blood gas analysis is not available, ventilation to a P a CO₂ of 35-45 mmHg should maintain arterial carbon dioxide levels within the normal range in healthy, elective horses but that capnography cannot be used as a substitute for arterial blood gases in compromised horses.

And so the capnograph cannot replace the use of arterial blood gas analysis to measure ventilation; however, trends and changes in the arterial to end tidal gradient can be used as an indicator of pathophysiological changes. Furthermore, a review of the capnograph waveform can give further information during anaesthesia during spontaneous and steady state ventilation and can lead to early diagnosis of potentially lethal problems. Figure 1 shows a diagram of a normal capnograph trace.

Fig 1: Diagram of a normal capnograph trace.

Rebreathing represents a problem with the equipment and the baseline does not return to zero during inspiration (phase I). If the inspired CO₂ starts to increase slowly this is likely due to exhaustion of the soda lime, but if the baseline rapidly increases, it is likely that one of the unidirectional valves in the circle breathing system is stuck in the open position. Phase II represents emptying of the alveoli and should rise steeply; however, a slow rise may represent a degree of resistance to expiration. Phase III should show a gradual rise due to different time constants (and therefore rates of emptying) until reaching the end tidal CO₂ measured at the end of this phase. Phase 0 represents the start of inspiration and the trace should fall rapidly down to zero. Differences in the pattern of the waveform will be illustrated during the lecture.

Finally during constant ventilation, a rapid fall in P a CO₂ can be seen in cardiac arrest or sudden decreases in

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cardiac output and action should be taken immediately. The capnograph is a good indicator of maintenance of cardiac output during CPR and replaces trying to feel for a pulse during compressions, with values above 15 mmHg aimed for, although this will rapidly rise once a return to spontaneous circulation is resumed.

A combination of capnography and arterial blood gas analysis is recommended for equine anaesthesia, particularly for prolonged procedures when spontaneous ventilation is allowed. Capnography allows for a bedside monitor of trends and early recognition of problems although does not necessarily indicate how good ventilation is in adult horses without a concurrent arterial blood gas analysis. In foals, capnography will reflect more effectively the degree of hypoventilation present.

References
A guide to artificial ventilation: when, how and with what?

Alex Dugdale
University of Liverpool, Leahurst Campus, Neston, Wirral, CH64 7TE, UK

During normal spontaneous inhalation, active expansion of the chest cavity by contraction of the diaphragm and intercostal muscles creates negative pressure in the lungs so that air is effectively sucked into them. Exhalation is a passive process, whereby relaxation of respiratory muscles facilitates elastic recoil of the chest wall and lungs so that air is pushed out under positive pressure. A short pause usually follows the end of exhalation.

Horses, however, are a bit different to this ‘human’ model, in that they breathe ‘around’ (rather than ‘up from’), their functional residual capacity and have active and passive components of both inhalation and exhalation. That is, there is a passive, elastic recoil phase, followed by an active, respiratory muscle contraction phase for both inhalation and exhalation.

The changes in the normally sub-atmospheric, intra-thoracic pressure accompanying spontaneous ventilation also affect the cardiovascular system and constitute the ‘thoracic/ respiratory pump’ mechanism. With positive pressure ventilation (PPV), gases are pushed into the lungs during inhalation and then exhalation is a passive process, which continues until the pressure within the alveoli equates with atmospheric pressure. Positive pressure ventilation directly counteracts the normal thoracic pump mechanism and is one of the reasons why it can be detrimental to the cardiovascular system. The other is that by altering the carbon dioxide content of the blood, PPV can affect the sympathetic tone which indirectly affects the cardiovascular system.

When is PPV necessary?

Poor ventilation

Hypoventilation may accompany anything which interferes with the normal process of breathing. Potential causes therefore include: respiratory tract obstruction; cervical spinal lesions affecting especially the phrenic nerves (C5, 6, 7); depression of chemoreceptors (e.g. general anaesthesia); neuromuscular junction disorders or respiratory muscle weakness (myasthenia gravis, tetanus, botulism); administration of neuromuscular blockers (general anaesthesia); chest wall/diaphragm trauma (e.g. flail chest, botulism, administration of neuromuscular blockers, general anaesthesia); chest wall/diaphragm trauma (e.g. flail chest, botulism, administration of neuromuscular blockers, general anaesthesia); chest wall diaphragm trauma (e.g. flail chest, ruptured diaphragm); restriction of chest wall movement (e.g. recumbency); diaphragmatic ‘splinting’ (increased intra-abdominal pressure, e.g. colon torsion, late pregnancy/hydrops); and pleural space disorders (pneumothorax, pleural effusions, diaphragmatic herniation with incarceration of abdominal viscera within the chest cavity).

Under general anaesthesia, hypventilation most commonly develops because of reduced ventilatory drive from depressed chemoreceptors and reduced ability to generate adequate tidal volume because of muscle relaxation and the effects of recumbency. Additional problems such as diaphragmatic splinting (secondary to increased intra-abdominal pressure), or diaphragmatic herniation, may exacerbate the situation; and use of neuromuscular blockers mandates the provision of PPV.

Poor oxygenation

Hypoaxaemia is a common consequence of ventilation/perfusion mismatching under general anaesthesia, rather than hypoventilation per se, especially when high inspired percentages of oxygen tend to be commonly provided.

Hypoaxaemia is therefore a relative indication for PPV. Ideally, PPV should be provided from the outset of anaesthesia (especially for big/obese horses due to in dorsal recumbency for prolonged anaesthetic times), to try to prevent hypoaxaemia from developing. When PPV is used to treat hypoaxaemia, it usually works best if accompanied by an alveolar recruitment manoeuvre (ARM) (e.g. ‘sigh breath’), and positive end expiratory pressure (PEEP). Positive end expiratory pressure effectively ‘stops’ passive exhalation at a pressure slightly above atmospheric pressure. These strategies also impact on cardiovascular function.

Respiratory muscle fatigue

Debility may weaken respiratory muscles but it is usually when ventilatory requirements are further increased that animals struggle, e.g. foals with respiratory disease.

To smooth the course of volatile anaesthetic maintenance, by ensuring the horse has sufficient uptake of the anaesthetic agent. Such use of PPV is mainly for our convenience.

Hypoxaemia and/or hypoaxaemia warrant PPV when

Breathing rate: <2 per min and/or profound hypercapnia/respiratory acidosis.

Capnography: end tidal CO₂ tensions >60 mmHg (8 kPa) will result in alarms sounding but values don’t always reflect pure changes in ventilation as they can also be affected by pulmonary perfusion and metabolic rate. Ideally, check arterial blood gas.

Arterial blood gas analysis: gold standard. When (or before) pH <7.2 with PaCO₂ >60–70 mmHg (8–9.3 kPa), and/or when (or before) PaO₂ <60 mmHg (8 kPa) → ventilation can be instituted.

How and with what to provide PPV?

A cuffed endotracheal (orotracheal or nasotracheal) tube is required. Manual bag-squeezing (O₂/anaesthetic), or actuation of a demand valve (O₂ only), can be used short-term. For longer term provision of ‘mechanical’ PPV, equine ventilators, with either bellows-in-a-canister (ascending bellows are easier to leak-test and drain condensed water from than descending bellows), or a piston, provide one of two common ventilation modes (Table 1). Common ventilator settings are given in Table 2.

Alveolar recruitment manoeuvres are bigger than normal breaths, often with an end-inspiratory ‘hold’. Up to 60–80 cmH₂O PIP may be required to “recruit alveoli” to treat hypoaxaemia, with PEEP values of 10–30 cmH₂O necessary to maintain that recruitment, so beware adverse CV effects.

Monitor effectiveness

Aim for PETCO₂ and/or PaCO₂ around 40–60 mmHg (5.3–8 kPa) and PaO₂ >60 mmHg (SpO₂ >90%). Monitor CV status; beware haemodynamic side effects of PPV.
Table 1: Ventilation modes

<table>
<thead>
<tr>
<th>Pressure-controlled ventilation</th>
<th>Volume-controlled ventilation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Each breath is delivered up to a pre-set pressure (PIP) → Tidal volume may vary if respiratory compliance or resistance change</td>
<td>Pre-set tidal volume is always delivered, regardless of compliance/resistance of patient’s respiratory system → PIP may vary (set maximum pressure limit)</td>
</tr>
<tr>
<td>Small leaks and ‘compression volume’ of system generally compensated for</td>
<td>Small leaks and ‘compression volume’ not easily compensated for</td>
</tr>
</tbody>
</table>

Table 2: Common ventilator settings

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tidal volume</td>
<td>10 ml/kg bwt</td>
</tr>
<tr>
<td>Frequency</td>
<td>4-8 breaths/min</td>
</tr>
<tr>
<td>Inspiratory time</td>
<td>1-3 s</td>
</tr>
<tr>
<td>Inspiratory time: expiratory time ratio</td>
<td>1:2 to 1:3</td>
</tr>
<tr>
<td>Peak inspiratory pressure (PIP)</td>
<td>20–40 cm H2O</td>
</tr>
<tr>
<td>Positive end expiratory pressure (PEEP)</td>
<td>-10 cm H2O possibly best applied from outset of PPV. 10+ cm H2O applied following provision of an alveolar recruitment manoeuvre (ARM) to maintain any advantage gained.</td>
</tr>
<tr>
<td>Trigger sensitivity</td>
<td>You may be able to ‘assist’ or fully ‘control’ the breaths.</td>
</tr>
</tbody>
</table>

NOTES

Further reading
A guide to maintenance of anaesthesia: volatile, intravenous agents or both?

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How can we improve equine anaesthesia? We always ask this question in our attempts to minimise the problems associated with equine anaesthesia and the inherent risk of mortality. There is no doubt that the way we maintain anaesthesia, often with drugs which compromise our patients, is associated with side effects and there is constant research evaluating new techniques. But how do we choose which technique is the best?

Firstly we need to decide whether a volatile agent should be used. This will depend on facilities available, staffing, costs, the type and duration of surgeries being performed. Currently isoflurane is the only licensed agent available although newer agents like sevoflurane and desflurane are widely used for their potential benefits in recovery, offering more rapid elimination. These effects may be amplified for longer procedures when tissue solubility of the drugs as well as the blood gas solubility becomes important. A stronger, more coordinated recovery may result, although many patient and surgical factors play an important role in recovery, such as pain, temperament and anaesthesia time. Inhalational agents cause similar degrees of respiratory and cardiovascular depression, all of which can affect recovery and support during maintenance. The use of intravenous agents to reduce the inhalational requirements during the maintenance period, using the partial intravenous anaesthesia (PIVA) technique, may be beneficial. These may be beneficial for longer procedures where the pre-anaesthetic medication effects are no longer helpful and often provide analgesia, less overall cardiovascular effects and can influence recovery.

A number of PIVA techniques have been described, listed in Table 1, but how do we choose which technique to employ? The α₂ agonists are commonly used in equine practice and infusions may result in a decrease of inhalational agents (although not necessarily), good background of analgesia, and better blood pressure maintenance. Romifidine has been associated with less ataxia in recovery although the quality and timing of recovery was similar when no infusion was used. When any of the α₂ agonists are used experimentally, they cause a MAC reduction; however, in the clinical setting reductions in isoflurane requirements are not seen. This is probably due to a difficulty in monitoring the appropriate depth of anaesthesia and when employing these drugs, a lighter plane of anaesthesia will provide a surgical plane of anaesthesia compared with inhalational agents alone. Another commonly employed technique is lidocaine infusion, providing excellent analgesia, particularly for inflammatory processes and reduces inhalational agent requirements significantly. However, the potential therapeutic plasma levels can also fall in the toxic range and there is great inter-individual variation with the clearance of this drug. This is exacerbated by reduced liver blood flow during anaesthesia and the drug can cumulate resulting in uncoordinated and ataxic recoveries. It is therefore recommended to stop the infusion 30 min before the end of anaesthesia. If using in colic surgery where there is severe cardiovascular compromise, the infusion rate should be halved. Ketamine is another drug that has been used and can be extremely useful where chronic pain exists or when severe nociception or neuropathic pain exists. The dose currently suggested is debatable since much lower infusion rates are used in small animal patients and humans. Accumulation of the drug can affect recovery adversely. Ketamine infusions are useful for neonatal foal anaesthesia where there are limited cardiovascular effects and the pharmacokinetic profile is favourable.

If anaesthesia is to be maintained in the field, then options are more limited. Ideally drugs that have a fixed context sensitive half time should be used so that accumulation does not prolong recovery or affect quality. More importantly the length of procedure should be limited. Inhalational agents may be used if portable equipment and cylinders are available but more often total intravenous anaesthesia (TIVA) is employed either with top-ups of combinations such as α₂ agonists and ketamine otherwise the use of a triple drip can be employed. Other drugs and combinations have been investigated but the use of the triple combination of an α₂ agonist, guaifenesin and ketamine are the most popular combination, providing analgesia, unconsciousness and muscle relaxation. Importantly, signs of depth of anaesthesia during TIVA are different than under inhalational anaesthesia with larcimation, a brisk palpable

<table>
<thead>
<tr>
<th>Drug</th>
<th>Loading dose</th>
<th>Dose</th>
<th>Comments</th>
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</thead>
<tbody>
<tr>
<td>Xylazine</td>
<td>0.6 ± 0.1 mg/kg bwt</td>
<td>1 mg/kg bwt/h</td>
<td>MAC₃₀ reduction of 17%</td>
</tr>
<tr>
<td>Cetomidine</td>
<td>10 µg/kg bwt</td>
<td>5 µg/kg bwt/h</td>
<td>No MAC reduction seen clinically (as with other α₂ agonists).</td>
</tr>
<tr>
<td>Romifidine</td>
<td>80 µg/kg bwt</td>
<td>40 µg/kg bwt/h</td>
<td>Fewer horses ataxic in recovery, less attempts to stand.</td>
</tr>
<tr>
<td>Medetomidine</td>
<td>7 µg/kg bwt</td>
<td>3.5 µg/kg bwt/h</td>
<td>MAC₃₀ reduction 20%. Easier maintenance and improved recovery quality, fewer attempts to stand, longer time in sternal recumbency.</td>
</tr>
<tr>
<td>Dexametomidine</td>
<td>3.5 µg/kg bwt</td>
<td>1.75 µg/kg bwt/h</td>
<td>MAC₃₀ reduction experimentally. Improved recovery quality, slightly longer recovery times</td>
</tr>
<tr>
<td>Lidocaine</td>
<td>1.5-2.5 mg/kg bwt</td>
<td>25-50 µg/kg bwt/min</td>
<td>MAC reduction 20–25%, stop CRI 30 min before recovery to minimise ataxia.</td>
</tr>
<tr>
<td>Ketamine</td>
<td>2.2 mg/kg bwt</td>
<td>1 mg/kg bwt/h</td>
<td>MAC₃₀ reduction 16%</td>
</tr>
<tr>
<td>Morphine</td>
<td>0.05 mg/kg bwt</td>
<td>0.1 mg/kg bwt/h</td>
<td>More stable anaesthetic, and better recovery, fewer attempts to sternal/stand. No consistent MAC reduction</td>
</tr>
</tbody>
</table>
and spontaneous blinking often present. Blood pressure is normally well maintained and ventilation is a useful guide to depth of anaesthesia and response to surgery.

Finally with any maintenance technique the basics should not be forgotten. Thorough monitoring of parameters by a person designated to anaesthesia is recommended, supporting blood pressure and ventilation as required and providing good analgesia, including the use of local blocks where possible.

References
Upper Respiratory Tract
Chaired by Henry Tremaine
Sponsored by HBLB

13.30–13.50
Resting endoscopy in the vetting process – can it be trusted?
Tim Greet
Rossdales Equine Hospital, Cotton End Road, Exning, Newmarket, Suffolk, CB8 7NN, UK

The role of endoscopy in the clinical assessment of the equine upper airway is described. A number of conditions, which can seriously impair athletic performance, are readily identified using this technique. However, an increasing number of causes of upper airway obstruction cannot be identified without the use of dynamic endoscopy.

Equally frustratingly there is a surprisingly poor correlation between laryngeal motility irregularities noted during quiet respiration and those occurring during fast exercise.

This presentation will attempt to illustrate these points and give examples of many of the more common and less commonly recognised causes of upper airway obstruction. It will also describe the author’s approach to managing client expectations when carrying out a respiratory assessment during a pre-purchase examination.

There is no doubt that whilst the use of routine endoscopy has a value in assessing equine upper airway function, in 2015 dynamic endoscopy has become the accepted gold standard diagnostic technique and should be discussed with clients in relation to horses where there is concern regarding upper airway function.
Complex upper airway obstructions

Kate Allen
Equine Sports Medicine Centre, University of Bristol, Langford, BS40 5DU, UK

Numerous types of dynamic pharyngeal and laryngeal obstructions have been described:
- Dorsal displacement of the soft palate
- Palatal instability
- Pharyngeal wall collapse
- Arytenoid cartilage collapse
- Vocal cord collapse
- Collapse of the apex of the corniculate process of the arytenoid cartilage
- Axial deviation of the aryepiglottic folds
- Epiglottic retroversion
- Epiglottic entrapment
- Cricotracheal membrane collapse

Traditional clinical teaching describes each obstruction as a single entity. In reality dynamic obstructions are frequently not simple. In a substantial proportion of horses (~50%) complex upper airway obstructions are seen, with multiple structures collapsing concurrently.

**Palatal dysfunction**

Associations between palatal instability (PI), dorsal displacement of the soft palate (DDSP), epiglottic conformation and axial deviation of the aryepiglottic folds have been described.

Numerous studies have reported significant associations between PI and DDSP, with PI being observed preceding DDSP leading to the suggestion that PI represents a preliminary stage of DDSP. Palatal instability has been defined as dorso-ventral billowing movements of the caudal portion of the soft palate with flattening of the epiglottis. Significant associations between epiglottic conformation and soft palate conformation have been identified. Both epiglottic conformation and the degree of billowing of the soft palate were significantly associated with subsequent development of DDSP.

In several studies palatal dysfunction occurred in association with other abnormalities; however, the most common additional obstruction is ADAF.

**Arytenoid cartilage collapse (ACC) and vocal cord collapse (VCC)**

Horses are significantly more likely to experience VCC with increasing severity of ACC. Several studies have shown that all horses with complete ACC also have VCC. This is not surprising as VCC occurs secondarily when the arytenoid is not fully abducted. However, there is variation between studies as to whether only left VCC or whether bilateral VCC is seen. One study reported only 22% of horses with complete ACC having bilateral VCC whereas other studies have reported 100% having bilateral VCC.

**ACC and DDSP**

Most studies suggest that concurrent ACC and DDSP is relatively uncommon. In one study only 7% of horses had complete or partial ACC and either PI or DDSP.

However, recent studies suggest an increased prevalence of DDSP after tie-back surgery.

**Axial deviation of the aryepiglottic folds (ADAF)**

Although ADAF can occur as a single entity it is one of the most common abnormalities observed in conjunction with other forms of upper airway obstructions. It has been reported that 66–93% of ADAF cases are complex. The two most common concurrent abnormalities are palatal dysfunction and ACC.

Axial deviation of the aryepiglottic folds is associated with changes in epiglottic conformation and severity of PI. It has been proposed that if elevation of the epiglottis occurs, as a result of PI, this reduces tension on the aryepiglottic folds allowing axial collapse into the lumen.

Twenty-nine to 37% of horses with ACC also have concurrent ADAF. When loss of arytenoid abduction occurs this predisposes to ADAF. However there appears to be predominance of right sided ADAF and it is unclear whether this is due to altered airway mechanics or visual perspective. A significantly higher prevalence of ADAF (34–60%) has been reported after tie-back surgery.

**Pharyngeal wall collapse (PWC)**

PWC can affect the dorsal wall, lateral wall(s) or is termed circumferential if all walls are affected. One study reported collapse of more than one wall in 90% of horses with 50% being circumferential whilst another reported that 9% of horses with PWC had collapse of only one wall, 18% collapse of 2 walls, 59% 3 walls and 14% 4 walls. The most common combination was both sides and the dorsal wall, and the second most common was both sides and the floor.

**Collapse of the apex of the corniculate process**

Collapse of the apex of one or both of the corniculate processes of the arytenoid cartilage may occur whilst abduction of the ventral aspect of the corniculate process is maintained. In many cases it is observed in conjunction with other forms of upper airway collapse particularly ADAF and VCC.

**Epiglottic entrapment (EE)**

Intermittent EE can usually be diagnosed during a resting endoscopic examination so the numbers reported undergoing exercising endoscopy are low. However it is thought that approximately 25% of horses with intermittent EE may also experience DDSP during exercise. It is likely that DDSP occurs secondarily due to physical impairment of epiglottic movement during swallowing.

**Cricotracheal ligament (CTL) collapse**

One study reported that CTL collapse in young horses was associated with other forms of dynamic airway obstruction. The CTL has no muscular component so collapse is likely to occur through altered airway mechanics or due to an abnormal cricotracheal space.

**Further reading**


Abnormal respiratory noise after airway surgery – what to do next?

Safia Barakzai

Chine House Veterinary Hospital, Sileby, Leicestershire, LE12 7RS, UK

The investigation and treatment of ongoing abnormal respiratory noise after upper respiratory tract (URT) surgery varies according to the surgery that was previously performed. As discussed by the previous presenter, multiple dynamic URT disorders are often initially present in horses making abnormal noise, and thus horses that have undergone a single surgical procedure may have concurrent disorders which have not been addressed. For most cases being returned for ongoing respiratory noise, exercising endoscopic examination holds the key to what should be done next.

Ventriculocorpectomy (VeC)

Commonly referred to as a ‘Hobday’ procedure (although technically speaking, ‘Hobday’ refers to the ventriculocorpectomy part only), this surgery is commonly performed without a definitive diagnosis having been made using exercising endoscopy for horses that are believed to be experiencing vocal fold collapse associated with recurrent laryngeal neuropathy (RLN). The prevalence of ongoing respiratory noise after VeC reported in the literature is between 18 and 34% [1–2]. Causes of ongoing noise include: pre-existing severe RLN with dynamic collapse of the arynoid cartilage, because the arytenoid collapse and associated noise has not been addressed; incomplete resection of tissue; complications associated with the surgical site such as granuloma formation; inaccurate initial diagnosis, and progression of the severity of RLN during the recovery period. Resting endoscopy should be helpful in the majority of cases but for some, exercising endoscopy will be indicated to find out exactly what the source of the noise is.

Laryngoplasty

The aetiology of continued noise and poor performance after laryngoplasty is complex. Four recent studies [3–6] reporting results of exercising endoscopy in horses that have undergone laryngoplasty have all reported that although true surgical ‘failure’ (left arytenoid instability) does occur in some cases, there is an alarmingly high incidence (48–59%) of other forms of dynamic laryngeal or pharyngeal collapse. These include right vocal fold collapse, dorsal displacement of the soft palate, (DDSP), palatal instability (PI), aryepiglottic fold collapse, collapse of the axial portion of the corniculate cartilage, etc. Clearly, more research must be done in this field, but the take home message is that horses presented for investigation of laryngoplasty ‘failure’ should always undergo dynamic endoscopy before laryngoplasty is repeated because instability of the arynoid cartilage is often not the cause of ongoing clinical signs. Treatment can then be targeted specifically, e.g. repetition of laryngoplasty, resection of right vocal cord or aryepiglottic fold, surgery for palatal issues, etc.

Tie-forward

Tie-forward surgery was originally reported to be successful in 82% of horses [7], meaning that at least one in 5 horses continued to experience respiratory noise and poor performance post operatively. Many horses with suspected palatal disorders are operated on with only a presumptive diagnosis of DDSP and therefore a proportion of these horses may have undergone an inappropriate surgical procedure. Nasopharyngeal collapse, aryepiglottic fold collapse and lower airway inflammation are, in this author’s experience, the most common alternative positive respiratory diagnoses made in horses that are suspected of having a palatal issue. The tie-forward surgery can fail due to fracture of the basihyoid bone or suture cut-through at the thyroid cartilages. Concurrent resection of a portion of the sternothyroideus tendon may reduce post operative tension on the sutures. In some horses, suture stretch appears to occur post operatively, possibly associated with repeated full extension of the head and neck to the floor when eating or drinking. The post operative position of the larynx with respect to the caudal basihyoid bone can most easily be evaluated using ultrasonography. Radiographs can also be helpful but generally a pre-operative radiograph is required to make a comparison with. If a post operative exercising endoscopic examination confirms that the palate is the source of ongoing noise, options are to try an alternative palatal treatment or repeat the tie-forward if the larynx appears to have moved back into a caudal position. It is likely that horses that undergo repeated surgeries for persistent palatal instability or DDSP will have a guarded prognosis for racing success.

Thermal cauterity of the soft palate

There is little published clinical evidence to support the efficacy of this procedure; however it is still widely performed in racehorses in the UK. In the largest study to date, 55% of horses still made some respiratory noise after thermal cautery [8]. It would be fair to say that the majority of horses undergoing this quick and inexpensive procedure do not have a definitive diagnosis of DDSP or PI and thus inaccurate diagnosis is the most likely cause of ongoing respiratory noise. If an exercising endoscopic examination confirms that the palate is the source of ongoing noise and lower respiratory inflammation can be ruled out as a contributing factor, a tie-forward surgery is indicated.

References

The risks of mortality associated with general anaesthesia is well documented in the horse and the published mortality rate for non-colic cases is quoted to be 0.9% [1]. The largest risk factor is cardiac arrest (33%) and approximately a quarter of fatalities are due to fractures occurring whilst attempting to stand during the recovery period [1]. Some clinicians would say that there has been a decrease in mortality over the last 20 years, nevertheless the risk of general anaesthesia remains higher in horses than in small animals and humans.

A logical step to decrease mortality is to not perform general anaesthesia and replace it with sedation and local anaesthesia (standing surgery) where possible. Ventriculectomy is a technique that is widely credited to Sir Frederick Hobday (Royal Veterinary College 1892). Ventriculectomy, which includes resection of the vocal cords, is largely carried out via laryngotomy whilst the horse has a general anaesthetic [2]. There are anecdotal reports of the ventriculocordectomy technique being carried out as a standing procedure historically and more recently in heavy breed horses to negate the risk of general anaesthesia. Endoscopically guided laser-assisted ventriculocordectomy or cordecomy is commonly carried out in the standing horse whilst the horse is sedated and under local anaesthesia [3,4]. The surgical technique and experiences of ventriculocordectomy as a standing procedure via laryngotomy are described in 30 horses. The technique was combined with a standing thermocautery of the soft palate under local anaesthesia and with the aid of a plastic tongue guard. Horses were sedated with a combination of detomidine hydrochloride and butorphanol tartrate or morphine sulphate, local anaesthetic was applied topically to the larynx, pharynx and nasal passageways via an endoscope in some cases, most especially if aryepiglottic fold resection was to be carried out. The ventral throat area was clipped, aseptically prepared and approximately 2–3 ml local anaesthetic was infiltrated subcutaneously. An assistant is required to apply swabs to aid in haemostasis. The head must be fully extended and the neck aligned. Further sedation is required if the head is not fully extended. A skin incision, followed by careful dissection of the paired sternothyroideus muscles followed by further careful dissection to allow exposure of the cricothyroid ligament is carried out. A gloved finger placed within the skin incision can aid in tissue dissection. The gloved finger allows the cartilage wings of the thyroid to be identified and then a No. 10 scalpel blade is used to incise the cricothyroid ligament along midline. Hobday retractors are placed. Visualisation was aided by a videendoscope within the nasal passageway in some cases. A ventriculocordectomy is carried out in a standard fashion. It is not uncommon for the horse to cough whilst the ventricles are everted and it is best to cover the laryngotomy with a swab whilst the burr is tightened.

The procedure was generally well tolerated; 4 horses shook their heads during the surgery resulting in the Hobday retractors being displaced. One horse had a moderate degree of haemorrhage and developed laryngeal oedema, which resolved with oral prednisolone treatment and oral antibiotic treatment. Notable haemorrhage was noted in 3 other cases; however, in the author’s opinion the amount of haemorrhage is generally a good deal less than that experienced when it is carried out under general anaesthesia. In conclusion ‘standing Hobday’ offers an alternative to that performed under general anaesthesia; the procedure is well tolerated, carries a low risk of mortality and does not carry the expense of a diode laser. The reported complications associated with laser ‘Hobdays’ and traditional ‘Hobdays’ were not reported in this study and a larger study population would be required to investigate this in a statistically significant manner.

References
Moral Maze:
Does Equine Practice Need to Change to be More Compatible with Family Life?

Chaired by Malcolm Morley

15.45–17.15

Panel: Carolyne Crowe, Mette Uldahl, Rob Pilsworth, Charlie Thomas, Bruce Bladon, Rob van Pelt, Jonathan Pycock and Luise Harrison

We all recognise that most equine vets have to be dedicated professionals for whom work is one of the highest priorities in their lives. Traditionally vets have worked together in practices so they have the ability to share resources and expertise as well as an out-of-hours rota and this has served us well. In the past the profession was more male dominated and many vets focused their efforts on work to the detriment of family life. However, we are now faced with changing demographics of the profession and different personal expectations – many more practitioners have, and want, a greater commitment to childcare and other aspects of family life. Work-life balance is something we all strive for but can be so difficult to achieve. This contentious moral maze debate will focus on whether equine practice needs to change in order to be more compatible with family life.

NOTES
Veterinary/Physiotherapy Interface: The Back – Diagnosis

Chaired by Sue Dyson

09.00–09.20

Is the back to blame? Evaluation of the lumbosacral spine and pelvis

Marcus J. Head
Rossdales Diagnostic Centre, Cotton End Road, Exning, Newmarket, CB8 7NN, UK

From the clinician’s perspective, the evaluation of the lumbosacral spine (SSp) and pelvis can be divided into three stages: the clinical assessment, diagnostic imaging and the response to diagnostic anaesthesia or treatment.

Unlike the limbs, accurate and objective evaluation of the SSp is difficult, if not impossible. Palpation of the spine (soft tissue and bony prominences), response to pressure and various stimulation tests (aimed at determining whether the horse has normal movement or is ‘guarding’ itself) are all employed but there is considerable variation between individuals and even within individuals at different times. I only urge that the interpretation of the clinical assessment is treated with caution; it is my opinion that in many cases it is impossible to walk up to a horse and proclaim (correctly) that it does, or does not have, back pain. Even more soft tissue covers the internal structures of the pelvis and it is equally difficult to come to conclusions here (although a great deal more of the bony surfaces can be palpated per rectum). The most important factors are to carefully assess the symmetry of the muscling and the visible/palpable bony landmarks. The examination of the spine and pelvis is part of the overall examination of the horse; just because a back problem is suspected, one must not omit to evaluate the whole animal. The horse is then examined moving in hand at the walk and trot, first in a straight line and then in circles, lunging on a hard AND soft surface. In many cases the animal will be examined being ridden by its usual rider and often by one of our staff or a professional rider. The ridden stage may be omitted if an obvious problem arises (e.g. clear lameness) or the horse is considered too dangerous to ride. It is essential that by the end of this phase of the examination everyone concerned knows what the problem is and the owner/rider and examining veterinarian are all looking at the same issue.

In most cases, diagnostic imaging consists of radiography, ultrasonography and scintigraphy (in foals, computed tomography is feasible, too). Radiographs are obtained of the neck (usually the neck base is imaged from both sides) and back (dorsal spinous processes and thoracic vertebral bodies). Frequently, views are obtained of the stifles (caudocranial and flexed lateromedial projections) and hocks (lateromedial and dorsomedial-plantarolateral obliques), particularly if there is any suspicion on clinical grounds. Ultrasonography is routinely performed to assess the intervertebral articulations of the caudal thoracic and lumbar spine, the proximal surgical ligaments of the hindlimbs as well as per rectum evaluation of the lumbosacral and sacroiliac joints (LSJ and SIJ).

By this stage, usually a few hours after the horse has been admitted, a great deal more is known about the case and a decision is made as to which path to pursue. There may be an obvious, standout lesion that can either be investigated further by local anaesthesia or by treating and assessing the horse’s response or there may be lameness that needs investigating. Remember that low-grade bilateral hindlimb lameness may be difficult to see and it is easy to pass these horses off as sound, especially if they are not examined lunging on hard and soft surfaces. Some conditions, most notably proximal suspensory desmopathy (PSD), seem to make the horse much more uncomfortable than the lameness grade might suggest (in other words, the horses can have performance-limiting discomfort with only subtle lameness). As PSD is such a common condition, it is not unusual for us to perform subtarsal anaesthesia and repeat the ridden assessment with the blocks in place even if there is very little or even no overt lameness to be seen.

Sacrococcygeal region discomfort is commonly encountered and as our understanding of the functional anatomy of the region improves it is clear that we have been grouping a number of separate issues under one broad heading. There may be primary SIJ pathology or issues in the lumbosacral intercentral, intervertebral or intertransverse joints. Unfortunately none of the diagnostic imaging modalities can give us clear proof one way or the other as to whether sacrococcygeal region pathology is present; bone scans and ultrasonography are particularly prone to giving false negative results and mild increases in radionuclide uptake in the SJs is commonly seen in horses without clinical disease being present. Regional anaesthesia is extremely useful; clinicians often worry about inducing hindlimb weakness or ataxia but this is a very rare complication. However, in many cases we will treat the LSJs and SJs based on clinical suspicion or the exclusion of other causes of back pain and assess the horse’s response to this instead of blocking (particularly if we have ultrasonographic evidence of LSJ or SIJ disease).

Scintigraphy is not usually performed as a ‘day one’ imaging modality, but reserved for cases in which no abnormality can be found with x-rays or ultrasound or in cases where clarification is required when multiple issues or inconclusive findings are present. It is the only modality that gives us accurate information about the current physiology of the skeleton, but it is not a ‘pain scan’, and positive scintigraphic findings will still often require diagnostic anaesthesia or ‘treat and see’ to be certain of their significance.

Further reading


With advancements in wireless inertial sensing, gait analysis in the horse has moved from the specialist gait laboratory into the ‘real world’ and tools are now available allowing accurate and precise quantification of head nod and hip (or pelvic) hike, two commonly used visual lameness indicators that are closely related to the mechanics of weight bearing lameness (e.g. [1,2]). These can now be used in the clinical lameness examination (e.g. [3–5]). However, lameness often goes hand-in-hand with poor performance related to back problems [6]. Here we give a brief overview of where we are in terms of feasibility of quantifying back movement under ‘real world’ conditions and report on some recently conducted studies in this field.

Traditionally, back kinematics of the horse have been assessed with optical motion capture systems. While bone-fixed markers naturally provide the closest link between measurements and the movement of the underlying bony segments, skin-fixed markers have been found to lead to acceptable results in particular in the trot [7]. While back movement over ground is not identical to back movement on the treadmill [8], assessment over ground is more compatible with the clinical poor performance examination and inertial sensors have been validated for quantification of vertical and mediolateral movement of anatomical landmarks from the withers to the caudal sacrum [9]. However, compared to symmetry parameters (head nod and hip hike) quantitative evidence of back movement in horses in particular for clinically relevant exercises is comparatively sparse.

In a recent study [10], we have collected breed specific back range of motion parameters for one particular breed of horses for in-hand and ridden exercise at the trot. Results are promising and show lower variability within breed than between ‘general population’ horses and characteristic differences were identified between different exercises. Recent research efforts have concentrated on the effects of circular locomotion on movement symmetry in horses on the lunge (e.g. [11–14]) and during ridden exercise [15]. It is imperative to collect back movement data from nonsymptomatic horses and horses with impaired performance, similar to what has been done with motion capture systems [16], to establish the diagnostic potential of these measurements when conducted over ground as an adjunct to the clinical poor performance examination.

References

Primary or secondary back pain? Maximising the vet/physio relationship
Jo Paul
Woollands Equine Rehabilitation Centre, Cockburnspath, East Lothian, TD13 5XW, UK

Primary or secondary back pain is not always easy to identify, however irrespective of the categorisation, the horse has back pain that often presents as behaviour or performance issues creating a welfare concern.

Primary back pain can be divided into structural pathology or dysfunction caused by soft tissue imbalance and joint dysfunction. Secondary back pain is often caused by the horse altering the weight transferring strategies using compensatory movement which stresses the spinal joints and soft tissue or can be secondary to medical issues.

A structured physiotherapy clinical assessment will help define which form of back pain is present and therefore allow the design of a treatment plan. There is no doubt that the professional co-operation of the multidisciplinary team is essential to resolve or manage the condition long-term [1,2]; however, each team needs to agree on roles and goals for a happy, efficient working relationship to develop.

Communication between the vet and physiotherapist is essential to help ascertain the full treatment protocol. Often working relationships have built up over many years, trust in each other’s skills, knowledge and professionalism are not always immediate but a willingness on both sides to communicate openly and honestly, respecting and appreciating the commonality and differences of practice will build a strong team approach which will benefit patients and clients.

With complex cases, agreement on a treatment protocol and professional roles prior to exposure to the client will simplify and ease the communication to the client and present a professional approach that will build confidence in each member of the team and the team as a whole.

Primary back pain
Back pain that can be clinically assessed leading to a treatment plan, showing clear clinical reasoning, can often be resolved successfully by physiotherapy treatment alone. However if there is persistent midline symptoms and/or the back pain fails to respond to physiotherapy in the agreed time frame, structural pathology in the spine should be suspected and veterinary investigations and a collaborative treatment plan should be agreed.

Secondary back pain
Often an initial veterinary clinical assessment has not revealed any lameness or other pathology, but discomfort in the back musculature has been identified hence referral to the physiotherapist. Specific postures and muscle patterning should alert the physiotherapist to the possibility that there is a primary cause of the pain. Regularly physiotherapy treatment has commenced and resolved the secondary back pain before the primary conditions become clear. If the physiotherapist suspects they are dealing with secondary back pain they should clearly discuss this with the vet and owner at the earliest opportunity so a plan to deal with the whole condition is put in place in a timely and cost effective way.

As in the human, back pain in the equine is a complex problem that often cannot be cured, but can be managed to the satisfaction of clients and the benefits to the patient. If we are to deliver best practice and develop evidenced treatment strategies, it is proposed we embrace the wealth of skills used every day by each professional and learn to combine them effectively.

References
The relationship between radiological and scintigraphic changes in the thoracolumbar spine

Marieke Zimmerman
Equine Diagnostic Centre - Equiton, Venusbergraat 1, 3560 Lummen, Belgium

Thoracolumbar pain is a common cause of poor performance. Impinging or overriding of the spinous processes (SPs), osteoarthritis of the articular process joints (APJs) and spondylosis are potential causes. Radiography and nuclear scintigraphy are often used diagnostically; increased radiopharmaceutical uptake (IRU) generally reflects increased osteoblastic activity [1]. Therefore the presence of IRU depends upon the stage of the disease.

Impinging spinous processes
Lesions are most commonly found between T14 and T17 [2]. The frequency of occurrence of radiological changes is high (87%). Mild abnormal radiographic findings are common [2], even in clinically normal horses [3], and are of unlikely clinical significance. The frequency of occurrence of IRU is lower and varies between 55% [2] and 72% [3] depending on the stage of the study.

There is a positive relationship between the severity of radiographic findings and the intensity of IRU. There are significant correlations between the total radiographic grade (sum of the grades of all the SPs) and the total scintigraphic grade and between the maximum radiographic (highest grade of any given SP in one horse) and the maximum scintigraphic grade. Overriding of the SPs was significantly associated with IRU, and type 2 proximodistal extended lesions (impingement over more than 50% of the length of the SP) were significantly more likely to be associated with IRU in the cranial SPs [2]. Positive scintigraphic findings are not always associated with primary bone injury; focal IRU in the summit of a SP is occasionally associated with supraspinous ligament injury. Impinging SPs can be present without IRU [2].

Osteoarthritis of the articular process joints
Lesions of the APJs are most frequent in the caudal thoracic spine and usually involve more than one joint per horse [4]. Impingement of the SPs at the same sites of APJ lesions is common [1,4]. There is an association between the total radiographic score and the pooled scintigraphy data for all joints [5]. For individual joints there only was a significant association between scintigraphy and radiography for the articulations between T17 and T18, with the strongest association being apparent when the IRU was graded as intense [5]. The high positive predictive value (92.5%) for scintigraphy in the detection of radiographic lesions and the high sensitivity (75%) for scintigraphy in the detection of back pain makes a positive scintigraphic finding a reasonably reliable indicator of the presence of significant osteoarthritis. Likewise the high specificity (85.3%) of scintigraphy for the detection of radiographic lesions and the high negative predictive value (85.4%) for scintigraphy for the detection of back pain, makes a negative scintigraphic result a fairly reliable predictor of the absence of significant lesion. However, sensitivity (58.8%) of scintigraphy for detection of radiographic lesions was only moderate, therefore some false negative scintigraphic results can occur [5].

Spondylosis
Spondylosis is most prevalent between T10 and T14 (66%), and often more than one intervertebral space was involved (60%) [6]. Radiographic evidence of spondylosis was seen in 3.4% of horses with clinical evidence of back pain. Only 33% of locations that had positive radiographic findings had IRU, 43.7% of locations with IRU had positive radiographic findings. However, 64.7% of horses with spondylosis had IRU. In horses with no radiographic evidence of spondylosis there was no IRU suggestive of spondylosis. Concurrent osseous pathology was seen in 60.8% of the horses with spondylosis [6].

Clinical significance
Most normal horses do not have IRU [5] and radiological changes or IRU are not necessarily associated with pain; increased bone turnover might reflect a physiological adaptation to load. There is a significant association between the number and severity of radiological findings of SPs and clinical signs of thoracolumbar pain; and a significant association between the number of SPs with IRU, IRU grade and clinical signs [7]. Horses with both radiological and scintigraphic lesions of the SPs were more likely to have thoracolumbar pain than horses with either type of lesion alone [7]. Occasionally thoracolumbar pain is associated with low-grade radiological changes, without IRU, therefore low-grade lesions should not be overlooked.

Horses with back pain generally had more APJs with a higher grade of IRU than horses without back pain [5]. Horses with radiological lesions of the SPs and concurrent osseous pathology, e.g. osteoarthritis of the APJs, are more likely to have thoracolumbar pain than horses with lesions of the SPs alone. Osteoarthritis of the APJs is more likely to be of clinical significance than radiological lesions of the SPs alone [7]. The clinical significance of spondylosis is difficult to determine [6]. Clinical significance may depend on the athletic demands placed on the horse.

The combination of radiography and scintigraphy, together with a thorough clinical examination and local analgesia, can be helpful to determine the clinical significance of lesions of the thoracolumbar spine.

References
Veterinary/Physiotherapy Interface: The Back – Treatment
Chaired by Catherine McGowan

11.00-11.20
Conservative management of back pain
Andrew Fiske-Jackson
Equine Referral Hospital, Royal Veterinary College, Hawkshead Lane, North Mymms, Hatfield, Hertfordshire, AL9 7TA, UK

Conservative management of horses with back pain most commonly consists of medication with corticosteroids, various manipulative therapies and controlled exercise programs. The two most commonly medicated sites are the interspinous spaces in cases of impinging spinous processes and the articular process joints in cases of osteoarthritis of these joints. The most commonly used drugs are methylprednisolone acetate [1] or triamcinolone acetate.

Sarapin™ (Pitcher plant) has been used over the years in a belief that it provides pain relief without motor weakness via neural blockade [2]; however, the product has failed to stand up to scrutiny and as a consequence its use is waning [3].

Tiludronate therapy has been recommended for horses with bone remodelling noted on radiography and scintigraphy [4]. It is believed that maximum beneficial effect is seen after around 2 months [5].

Extracorporeal shockwave therapy (ESWT) is used by many practitioners as a noninvasive treatment modality for pain associated with the osseous structures and bone-ligament interfaces. It induces a cascade of biological responses and molecular changes including the neovascularisation and up-regulation of angiogenetic growth factors resulting in improvement in blood supply and tissue regeneration [6]. Accurate placement of the probe is deemed important as the sonic pulse that the probe emits has a relatively small focal area. Impinging spinous processes are treated with a 35-mm probe placed each side over the affected thoracolumbar spinous processes [4]. An 80-mm probe is used to treat the articular process joints with the probe placed and directed accordingly [4]. Despite its use in the treatment of back pain, no controlled studies have been performed to assess its efficacy.

Mesotherapy involves intradermal injections from the withers caudally over the back and croup using a solution of anti-inflammatories and lactated Ringer’s [7]. It is hypothesised to work through type I and II nerve fibres that can block pain transmission within the spinal cord. Whilst there are anecdotal reports of its ability to improve the horse’s willingness to stretch over the top line and step further underneath and forward with the rear legs [7] controlled studies have not been performed.

Dynamic mobilisation exercises (‘carrot stretches’) have been shown to develop the multifidus muscle which can atrophy in response to back pain [8]. These are used by the author as part of a rehabilitation programme for horses with back pain.

Simply resting a horse with back pathology is not recommended for most clinical cases; this is likely to lead to muscle loss further complicating and lengthening the horse’s return to work. This has been shown in multiple human studies where bed rest has been demonstrated to be detrimental when compared with early mobilisation [9–12].

Below is the basic exercise regime used by the author following medication of impinging spinous processes or articular process joints:

- **Weeks 1–2:** 10–20 min long rein ing at walk
- **Weeks 3–4:** Add lungeing 5 min each rein with training aid (Equiband™ or Pessoa)
- **Weeks 5–6:** Increase lungeing to 10 min each rein; add trotting poles
- **Weeks 7–8:** Increase lungeing to 15 min each rein introducing raised trotting poles

Physiotherapy visits fortnightly from Week 2

Carrot stretches daily

At 8 weeks commence ridden exercise.

References
Dorsal spinous process ostectomy or interspinous ligament (ISL) transection?

Bruce Bladon
Donnington Grove Veterinary Surgery, Oxford Road, Newbury, Berkshire, RG14 2JB, UK

There are few more controversial conditions in the horse than kissing spines. The clinical signs are nebulous and are best assessed by a rider, who may be a skilled and reliable judge of a horse’s condition, or may be slightly lacking in talent and seeking an excuse for their own poor performance. Clinical signs vary from bucking under rider or even during tacking up, through to ‘limited impulsion’ or ‘jumping flat’.

We rely heavily on scintigraphy in the investigation of back pain. It has been shown that increased uptake in the dorsal spinous processes can occur in normal horses, questioning the validity of any scintigraphic diagnosis [1]. ‘Blocking’ the back – assessing ridden exercise before and after intraluminal local anaesthesia, is widely recommended [2]. In our experience it is very rare to block a back and have a rider pronounce no change. It is unclear if this is a ‘placebo’ effect or if there is genuine improvement.

Surgical resection of the summits of the dorsal spinous processes has been described [2] including in the standing sedated horse [3] as well as an endoscopic [4], and a wedge resection technique [5]. Dorsal spinous process resection is easier standing than under general anaesthesia. We have not performed any procedures under general anaesthesia since 2008. The horse is sedated and the surgical field is anaesthetised by subcutaneous and deeper injection of local anaesthetic. Significant volumes are used, ~150 ml of lidocaine with adrenaline for resection of 3 spinous processes. The secret to any standing surgery is complete analgesia.

An incision is made over the selected spinous process, approximately double the length of the spinous process. Sharp dissection is continued through the supraspinous ligament down to the bone. The soft tissue attachments to the spinous process are sharply transected and the ligament retracted with rib spreaders. The dorsal spinous process is resected using an oscillating saw followed by duck billed rongeurs to a depth of 3–4 cm. The procedure is then repeated over the next spinous process, removing alternate spinous processes from individual skin incision.

Intraoperative pathology is frequently impressive and it is difficult to believe that the condition is insignificant at surgery. Post operative management is box rest for 3 weeks, with a view to ridden exercise being underway by 6 months.

The results of kissing spine surgery are encouraging, with 72% of horses returned to full athletic activity [3], and 100% of 8 athletic horses returned to previous activity following standing surgery [3]. A retrospective study of our cases several years ago revealed of 29 procedures, 3 were considered complete failures, while 17 (63%) were considered a complete success.

Minimally invasive surgery, the ‘Coomer’ technique, is the recent innovation [6]. The interspinous spaces for surgery are marked and anaesthetised as for open surgery. A 1 cm incision is made immediately parasagittal to the supraspinous ligament. The ligament is undermined until an instrument can be palpated subcutaneously on the contralateral side. A dissection plane is then established between the dorsal spinous processes. We have become much less aggressive at this stage. Initially we would often use rongeurs to create a gap between the spinous processes. Latterly we use finer instruments to dissect the narrow gap between the processes under intraoperative radiographic guidance. The bone of the dorsal spinous processes is remarkably soft and it is quite possible to split the spinous processes with stout scissors.

We have observed one case which developed swelling and focal pain possibly associated with infection of adjacent bone. This resolved satisfactorily with antibiotic treatment. Despite resolution, the client started legal action. Managing client expectation can be difficult.

We conducted a retrospective study of this procedure at Donnington Grove Veterinary Surgery. The results were comparable to conventional open surgery. Of 18 horses, one has been put down and one horse represented for conventional open surgery, despite radiographically much improved appearance. Of 11 horses with appropriate follow-up, 6 (55%) had excellent results.

Our experience has been that it is almost invariably possible to dissect between the spinous processes, no matter how severe the radiographic findings. Thus, the minimally invasive technique has almost completely replaced open surgery. The results are similar, while the convalescence is greatly reduced. Sadly, this has led to less emphasis on diagnosis and a greater use of the surgery due to client demand. Conducting follow-up on any kissing spine cases is enormously satisfying, due to the enthusiasm of owners for either procedure. My personal favourite was a client who described the minimally invasive surgery as “the most successful operation they had ever had done”, which considering they had also had a horse with a colon torsion which was still alive 3 years later seemed a little surprising.

References
Do manipulative therapies help in managing horses with back pain? A veterinary perspective
Andrew P. Bathe
Rossdales Equine Hospital, Cotton End Road, Exning, Newmarket, Suffolk, CB8 7NN, UK

Equine back pain requires a thorough orthopaedic evaluation, proactive treatment of all orthopaedic issues, and the effective medical and physical management of back pain. Manual therapies are frequently employed in the management of actual and suspected back pain in the horse. Unfortunately owners are frequently unaware of the qualifications, methods and abilities of their chosen ‘back person’, often relying on word of mouth, fashion and optimistic assessments of outcome. A vet will normally only be contacted when these methods have failed. A study of 110 predominantly sport-horse riders and trainers in New Zealand showed that only 7% chose allied health therapies based on veterinary advice [1]. The veterinary profession needs to gain a greater understanding of these therapies, rather than continue its traditionally rather dismissive attitude, so that greater communication and cooperation can occur. Whereas some authors put forward many positive aspects of manual therapies [2], others emphasise the large degree of extrapolation from human work and the lack of high quality evidence-based medicine [3].

Manual therapies include touch therapies (e.g. Tellington Touch, Reiki), massage therapies, stretching, mobilisations and manipulative therapies. The latter is the topic of this presentation and is differentiated from mobilisation by the use of a high-speed thrust. Osteopathy uses both these techniques, whereas chiropractic treatment is characterised by high-velocity, low-amplitude thrusts aiming to induce therapeutic effects in joints, muscles and neurological reflexes [4]. The RCVS defines physiotherapy as including osteopathy and chiropractic, and states these must be carried out under the direction of a vet. Training is available through bodies such as the McTimoney College of Chiropractic and the International Academy of Veterinary Chiropractic, but the term Chiropractor should only be used by only human trained and registered therapists. The lack of unifying bodies for animal therapists makes it even more difficult for the owner or veterinary surgeon trying to make an informed choice of therapist.

There are a number of equine studies that show that spinal manipulative therapy (SMT) can have effects on spinal mobility and pain perception. In 10 healthy horses SMT increased the amplitude of dorsosventral passive vertical mobility at most sites, indicative of increased vertebral flexibility [5], and similarly in 24 actively ridden horses in a randomised, controlled clinical trial [6]. Chiropractic treatment and massage therapy increased spinal mechanical nociceptive thresholds within 38 horses not exhibiting signs of lumbar pain [7]. The effect on clinically affected cases is more relevant however. A study from Utrecht kinematically assessed 10 Warmblood horses with clinically diagnosed back problems before, one hour after and 3 weeks after chiropractic manipulation. This showed a subtle but statistically significant effect on locomotor parameters: transiently increased back mobility and a more persistent increase in pelvic motion symmetry [8]. A controlled accelerometric assessment of 26 sound sport horses with ‘impaired hindquarter function’ at Days 0, 10 and 20 after osteopathic treatment showed a significant increase of the dorsosventral displacement at trot for all manipulated horses and an increase of the propulsion at 3 gaits for young manipulated horses. These changes became stable at 20 days. Propulsion and regularity of the movements of the hindlimbs of old horses were perturbed after manipulation, suggesting that more time may be required for adaptation in the older horse [9].

From a veterinary perspective, physical therapy is seen to be more successful after effective veterinary treatment of underlying lameness and spinal issues such as impinging spinous processes. Cases normally present to us for further evaluation with a history of poor, transient or diminishing response to physical therapy, although it must be remembered that we won’t see cases that have responded well to such treatment! In local practice it is important to build up a good working relationship with therapists in your area. This is more difficult in referral practice because of the distances involved. One should always favour properly qualified physiotherapists and chiropractors etc., and recognise that some certifications in other areas may represent nothing more intensive than a weekend course. However these therapies do require a degree of health therapists and ‘feel’ that no amount of training can substitute for, and it is a question of finding a therapist that will work in an integrated fashion and who is effective for that individual horse, owner and problem. I normally recommend using an Association of Chartered Physiotherapists in Animal Therapy (ACPAT) Category A physio during the later stages of rehabilitation following surgery, or a couple of weeks after medical treatment of back pain – but have occasionally had problems where they have slowed down the exercise programme to the detriment of the case. More resistant cases will then be recommended to try chiropractic or osteopathic treatment.

References
Do manipulative therapies help in managing horses with back pain? A physiotherapy perspective

Naomi J.H. Smith
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Manipulative therapies encompass a range of therapeutic techniques from spinal manipulation through to mobilisation of spinal and soft tissues. In order to describe the techniques, this talk will briefly present the concept of the spinal segment comprising two articulating vertebrae. Externally applied forces (by the physiotherapist) can be used to affect movement within and/or between spinal segments.

These therapeutic forces can be high velocity thrusts at the extremes of physiological (e.g. cervical rotation) range of movement. These are defined as grade 5 ‘manipulations’ and are typically of small amplitude.

These contrast with spinal mobilisations which can be applied anywhere in the physiological range of movement – in a ‘neutral’ spinal position, mid- or end of range. As with grade 5 ‘manipulations’ they can be of small amplitude (i.e. grade 1 and grade 4) or of larger amplitude (i.e. grade 2 and grade 3); and are frequently delivered in an oscillatory manner. Spinal mobilisations are also defined according to how they are delivered relative to a horse’s symptoms. Therapeutic force can be applied which stops short of where stiffness or pain reproduction is encountered at a spinal segment, i.e. grades 1 and 2. Alternatively therapeutic force can be applied which pushes into stiffness and/or elicits pain behaviour, spasm or resentment, i.e. grades 3 and 4.

The nature of the techniques determines how each are applied. Grade 5 ‘manipulations’ along with grade 1 to 4 ‘mobilisations’ can be applied using force generated by the physiotherapist. However, reflex spinal techniques (achieved by the physiotherapist affecting a reflex contraction of the para-vertebral musculature) can also be used to generate the therapeutic force. Soft tissue mobilisations can be achieved through manual massage techniques or making use of skeletal muscle contractions which are elicited via electro-stimulatory modalities.

The indication for using manipulative therapies as part of a holistic approach depends upon their observed/theorised effects relative to the clinical problem(s) posed by the individual horse. Where local back pain symptoms can be reproduced by movement at one or more spinal segments, grade 1 and 2 mobilisations can be applied in order to modulate nociceptive signals via stimulation of the peri-aqueductal grey and/or via pain gate theory. A loss of movement at one or more spinal segments might be an inevitable consequence of long-standing pain or disuse; warranting use of large amplitude grade 2 or 3 mobilisations to introduce movement in a controlled manner at these selected levels. Similarly where contracture has occurred following immobilisation or scarring, soft-tissue mobilisation techniques can be used to reintroduce movement of tissue planes in a targeted manner.

It is therefore intended that this talk will present an overview of manipulative therapies enabling all members of the veterinary team to have an awareness of the spectrum of techniques and their respective therapeutic value/indications. A number of case studies will be used to further illustrate how selected manipulative therapies can be used to complement the medical management of the horse with back pain.
Veterinary/Physiotherapy Interface: Physiotherapy Assessment

Chaired by Marcus Head
Sponsored by the University of Liverpool

13.30–13.50
How to incorporate a vet-physio team in the evaluation and management of lameness

Sonya Nightingale
Highworth Physiotherapy Clinic, 13 High Street, Highworth, Swindon, Wiltshire, SN6 7AG, UK

To a human athlete the prospect of competing to any elite standard without physiotherapy input would be considered madness. The majority of the general population consider consulting with a physiotherapist (osteopath or chiropractor included here), if they are suffering from joint, muscular or ligament pain, ‘normal’ behaviour. Indeed, for humans, physiotherapists are fully integrated and incorporated into their ‘lameness’ evaluation and management. Should we treat the equine athlete any differently? If not; how do we provide comparative care?

In human medicine
‘Physical therapists provide services that develop, maintain and restore people’s maximum movement and functional ability. They can help people at any stage of life, when movement and function are threatened by ageing, injury, diseases, disorders, conditions or environmental factors. Physiotherapists are the specialists in human activity and movement’ [6].

Physiotherapists are qualified and professionally required to:
• undertake a comprehensive examination/assessment of the patient/client
• evaluate the findings from the examination/assessment to make clinical judgements regarding patients/clients
• formulate a diagnosis, prognosis and plan
• provide consultation within their expertise and determine when patients/clients need to be referred to another healthcare professional
• implement a physical therapist intervention/treatment programme
• determine the outcomes of any interventions/treatments
• make recommendations for self-management [1,2,6].

The curriculum framework for physiotherapy defines physiotherapy as: ‘A health care profession concerned with human function and movement and maximising potential. The exercise of clinical judgement and informed interpretation is at its core’ [3].

Physiotherapists are trained to examine gait and its abnormalities and to make a functional diagnosis, while using clinical reasoning to formulate a treatment plan. These pathologies may include muscular, ligament or joint disorders that affect quality of movement and therefore function. They may be acute or chronic in nature and the result of specific trauma or habitual postural abnormality.

These skills are readily transferable across mammalian populations as long as in depth training in comparative anatomy, ergonomics and pathology etc. is given.

In the human model the fully qualified and regulated physiotherapist (Chartered and HCPC registered in the UK) has full clinical autonomy to be the first contact practitioner to assess, diagnose and plan treatment for the client. However they are fully integrated into the wider care team and are used to working with other health care providers. These will include GPs, consultants, nutritionists, podiatrists, nurses, carers, etc. They are also professionally responsible for their clients and carry full professional indemnity insurance. [5]

However the full regulation, protection of title and clinical autonomy has only relatively recently been enshrined in law (July 2003). Is it time for the veterinary field to follow suit?

The 1966 Veterinary Surgeons Act allows for the treatment of physiotherapy under the express referral of a veterinary surgeon, but does not allow for the clinical speciality of a physiotherapist. The veterinary surgeon remains as the diagnostician and leading clinician.

This effectively allows anyone to carry out physiotherapy techniques on an animal, as long as a veterinary surgeon agrees to it, regardless of any training, regulation, insurance etc. This also means that the vet remains responsible for the actions of the therapist. With increasing pressure from clients for the use of manual therapies, is this a wise course? Would it not be better for the animal, the vet and the client if the only therapists allowed to treat were well trained, fully regulated, insured and clinically autonomous?

The Association of Chartered Physiotherapists in Animal Therapy (ACPAT) has long recognised the need for well trained, regulated and insured therapists, and as a network of the Chartered Society of Physiotherapy (CSP), is fully conversant in the requirements and standards necessary [3–5]. While working within the CSP umbrella ACPAT has also lived through the trials and tribulations of gaining legally recognised protection and regulation in the human field. ACPAT therefore has a good understanding of the problems that will be encountered in following this path in the veterinary field.

However this does not detract from the fact that animals and their owners deserve first quality care and ACPAT is therefore part of a working group, which has BEVA representatives among many others, looking into how this can be achieved, and then legally enforced.

Then, and only then, will veterinary physiotherapists have the recognition, to be a valued and essential part of evaluation and management of animal lameness.

References

Further reading

NOTES

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Proceedings of the British Equine Veterinary Association Congress, 2015 - Liverpool, United Kingdom
The interrelationship of lameness, saddle slip and back shape in sports horses

Sue Dyson
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The relationship between saddle slip and hindlimb lameness was assessed in a prospective clinical study [1]. One hundred and twenty-eight horses were evaluated and lameness (grades 0–8) and saddle slip were graded before and after diagnostic analgesia. The thoracolumbar shape and symmetry were measured objectively.

The saddle consistently slipped to one side in 54% of horses with hindlimb lameness, compared with 4% of horses with forelimb lameness, 0% with thoracolumbosacral pain and/or sacroiliac joint region pain and 0% of non-lame horses. There was a significant association between saddle slip and hindlimb lameness. Diagnostic analgesia abolishing the hindlimb lameness eliminated the saddle slip in 97% of horses. In two horses the saddle continued to slip after resolution of lameness; one horse had bilateral forelimb lameness and the other horse had concurrent hindlimb and forelimb lameness. The saddles of both horses were asymmetrically flocked. The saddle slipped to the side of the lamest hindlimb in most horses (86%). No horse with saddle slip had significant left-right asymmetry of the back at four predetermined sites (shoulder [one-third of the distance between the point of elbow and the point of shoulder], eighth [T8], thirteenth [T13] and eighteenth [T18] thoracic vertebrae). The most frequent lameness grade was 2; there was no association between lameness severity and saddle slip. Saddle slip occurred with at least two riders in all the horses with saddle slip. In horses with saddle slip that was abolished by resolution of hindlimb lameness, saddle slip was consistently greatest with a lighter-weight rider.

There was a significant positive association between saddle slip and horses with a wide back shape at T13 (defined as having a back contour at T13≥T18). This may reflect greater dorsoventral displacement at T13, which appears to be the site that comes closest to the lowest back line. The maximal range of vertical displacement occurs at this site, which is also where the equine body centre of mass is thought normally to be aligned with the rider’s centre of mass. The saddle slipped to the side of the lame or lamer hindlimb in straight lines, both whilst going large around the arena and also in circles of 20 m diameter, in most horses 86%. Saddle slip was present on both reins in 16% of horses and on only one rein in 84%. Saddle slip was consistently greater in circles compared with straight lines, irrespective of the appearance of the lameness.

It was concluded that hindlimb lameness is an important factor in inducing saddle slip. Saddle slip may be an indicator of the presence of hindlimb lameness. The study emphasised the need for education of owners, veterinarians, physiotherapists, trainers, riders and saddle fitters that saddle slip is frequently an indicator of lameness, not necessarily a manifestation of an ill-fitting saddle or asymmetric shape of the horse’s back.

The relationship between hindlimb lameness and saddle slip was verified in the survey of 506 sports horses in normal work [2]. Forty-six per cent of horses had lameness, stiffened canter or quadrupedally shortened cranial phase of steps. Twelve per cent of horses had saddle slip. Thirty-seven per cent of riders sat crookedly and could have induced back pain and/or saddle slip, but the majority of horses (78.6%) ridden by crooked riders did not have saddle slip. There was a strong positive association between saddle slip and hindlimb lameness alone and hindlimb lameness and coexistent forelimb lameness. Although 30.6% of horses with saddle slip had no detectable hindlimb lameness, 73.7% of these horses exhibited some form of hindlimb gait abnormality, particularly in canter. Multivariable analysis confirmed that saddle slip was significantly associated with hindlimb lameness and gait abnormalities (odds ratio [OR] = 52.6), saddle fitted with even contact and uniform flocking (OR = 15.5), riders sitting crookedly (OR = 6.3), saddle fitted in good balance (OR = 3.1), and large back shape ratio at T18 (OR = 1.2). Five horses had saddle slip and no hindlimb lameness or gait abnormalities. There was a variable degree of asymmetry in rider position for all horses with saddle slip, presumably induced by the asymmetry in the movement of the saddle and horse. This was usually worse with less experienced riders, whereas 12 experienced riders were crooked when the saddle slipped but not on other horses. This suggests that crookedness can be an effect of saddle slip rather than the cause.

It is currently not known why a saddle may slip in association with some hindlimb lameness and not others. It may be related to back shape and saddle fit. Paradoxically, well-fitting saddles are more likely to slip than a saddle which bridges, presumably because a saddle which bridges is more fixed in position. The direction of saddle slip is also not predictable: saddle slip occurred towards the lame(r) hindlimb more frequently than towards less the lame limb. The saddle occasionally slips to the left on the right rein and to the right on the left rein in association with bilateral hindlimb lameness. It has also been observed that saddle slip may occur when a horse is trotted in hand without a rider, indicating that the saddle slip is an effect of the horse’s gait rather than the rider.

Major left-right asymmetries in back dimensions were unusual but did occur and may induce saddle slip. In contrast to saddle slip associated with hindlimb lameness, which was usually only apparent on one rein with more slip on circles compared with straight lines, saddle slip induced by back shape asymmetry was usually apparent on both reins in straight lines and circles.

Further research into the relationships between hindlimb gait and movement of the thoracolumbosacral spine is required, which should be possible using inertial measurement units to quantify spinal movement and hindlimb gait.

References
Kinematic and neuromotor control of the equine back and pelvis with implications for diagnosis and treatment

Catherine McGowan
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Back pain and diseases of the equine vertebral column and pelvis are significant problems in all types of performance horses, potentially causing poor performance, lost training days or even retirement. Back and pelvic pain syndromes are insidious and difficult to diagnose due to the variability of presenting signs ranging from overt lameness or pain on palpation, to subtle gait alterations or even behavioural changes. Complicating matters further is that multiple problems often coexist, particularly lameness and back pain.

The veterinary approach to equine back and pelvic pain syndromes has focused primarily on identifying underlying skeletal and/or ligamentous pathology and its treatment. However, the approach to back pain in people includes identification and assessment of the musculature of the region, especially the central nervous system’s timing and control of muscle recruitment. The multifidus muscle, called ‘neuromotor control’ [1], in the presence of low back pain, the strategies used by the central nervous system to control trunk muscles may be altered resulting in less efficient muscle recruitment strategies [2]. Back pain patients, for example, display delayed activation of the musculature, depriving the painful and injured spinal segments of timely support. Knowledge gained from this research related to the changes in neuromotor control that occur with back pain have translated to the development of new rehabilitation strategies for the lumbo-pelvic muscles in back pain patients [3].

The most important muscle group for neuromotor control in the thoracolumbar region are the multifidus muscles with both in vivo and in vitro evidence demonstrating the ability of the multifidus muscle to control intervertebral motion. Morphological changes, especially reduced cross-sectional area, have been shown in the multifidus muscle in association with low back pain in people [4]. What is notable is that there is not an automatic reverse of these changes following the resolution of pain. Despite apparent recovery or resolution of pain following an episode of acute back pain, the dysfunction of multifidus persists [4].

Despite the differences between the quadruped and biped and the increased passive stability of the equine lumbar spine, research in equine back and pelvic anatomy and biomechanics have shown that the anatomy and function of the equine epaxial muscles are comparable to that of humans [5]. The multifidus in the horse was shown to be similarly morphologically orientated and thus functions in a comparable way to that in man with the sacrocaudalis dorsalis lateralis muscle continuing the function of the multifidus in the caudal spine. One difference, however, is the equine spinal anatomy and its variations, especially in the lumbosacral region, with the variations occurring in a third of Thoroughbred and mixed light breed horses. These variations could have a major effect on stability of the lumbosacral joint and affect performance through altered mobility and/or a predisposition to pathology during an athletic career [6].

The ability to assess the size and function of the lumbar multifidus has been a valuable guide to assessment, management and prevention of recurrence of back pain in man. Ultrasonography has also been found to be a repeatable and reliable tool for measurement of the equine epaxial muscles and when examined in clinical cases of equine back pathology, there was a clear reduction of the epaxial muscle size at the level of and side of significant injury or pathology [7]. Other work has shown that physiotherapy exercise can improve multifidus size and symmetry in horses [7].

The principles of neuromotor control are equally important in the pelvic region of horses and can be used to guide assessment and treatment. The development of a range of specific manual techniques to test the biomechanics of the sacroiliac joint has potential to assess equine sacroiliac dysfunction [8] and be utilised to guide rehabilitation.

References
The human Achilles tendon and the superficial digital flexor (SDF) tendon in equine athletes perform a similar role as a structure for storage and release of elastic energy. A comparison between these two structures can be made as they are functionally equivalent in improving high speed locomotion [1]. Prevention and management of Achilles tendon injuries in the elite human athlete has a direct and transferable strategy for the equine athlete due to the similarities in the disease process of the SDF tendon [2]. Achilles tendinopathy (AT) is a generic term for pathology within the Achilles tendon that causes pain, swelling and limited function [3,4]. Achilles tendon injuries are common in elite track and field accounting for 3.7% of all injuries in 13 international athletics championships from 2007 to 2012 [5]. Achilles tendinopathy is characterised by pain, swelling and impaired function of the Achilles. It is common in elite athletes with an annual incidence reported around 15% [3]. In addition to time lost from training and competition, AT can cause performance detriment due to its effect on tendon viscoelasticity and neuromuscular function [4]. Therefore, the detection, monitoring and management of AT is of critical importance for clinicians working with elite athletes with an annual incidence reported around 15% [3]. In addition to time lost from training and competition, AT can cause performance detriment due to its effect on tendon viscoelasticity and neuromuscular function [4]. Therefore, the detection, monitoring and management of AT is of critical importance for clinicians working with elite athletes. Thus far, monitoring transient changes in tendon matrix structure to minimise development of tendinopathy [14] is a novel and exciting approach to risk prevention by providing objective information on tendon quality. Further research is ongoing to establish the best prevention and ongoing management strategies for tendinopathy in the elite human and equine athlete. Thus far, monitoring of mechanical load appears to be the best prevention strategy whilst mechanical stimulus provides a neuronal down-regulation for pain management in the human athlete suffering Achilles or patella tendinopathy [7,8].

References


Physiotherapy in the elite equine athlete

Anna Johnson

This is an overview of the role of physiotherapy in the preparation for, duration and post elite competition for the elite equine athlete.

It is comparable to the human field, where much of the research is gained from, as physiotherapy is now considered a vital part of the multidisciplinary team managing the elite equine athlete. Similarly the principals of assessment, treatment and continuing rehabilitation with proprioceptive facilitation [1,2], strength and conditioning work [3,4] to gain maximum function of the equine athlete, with the aim of optimal performance on the competition day, as well as maintenance of the athlete for longevity of their competition career.

Clearly the equine athlete differs in size, shape, and locomotion with the added compromise of tack and rider, although the rider is an important rehabilitation tool through their ability to influence movement in both a positive and negative manner. The equine cannot give a ‘subjective’ history to the physiotherapist – this comes from the ‘human’ team that surround the equine athlete and communication with the home multidisciplinary, if different, is vital.

Different equestrian disciplines require various sport specific training which would also be reflected in the injuries sustained and the relevant treatment administered. Exercise based rehabilitation is based on human research and aims to facilitate normal neuro-motor control and normal movement patterns.

Current physiotherapy techniques used for the equine athlete are summarised including manual techniques [5–8], cryotherapy [9–11], electrotherapy [12–18], and methods of training with available aids to gain core stability.

At all stages physiotherapy needs to fit within the training and competition programme, and dates for hands-on treatment sessions are worked back from the main competition date to allow recovery from post treatment soreness.

References
Post operative rehabilitation following surgery
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Post operative physiotherapy is commonplace in human orthopaedic surgery care planning and is generally aimed at optimising the functional outcome. It is becoming increasingly common for veterinary physiotherapists to work within the veterinary multidisciplinary team. The role of the physiotherapist is to monitor and guide the restoration of optimal movement both locally at the surgical site and generally to address pre-op postural adaptations and movement dysfunctions that may continue to stress the repaired structure or cause secondary pathology, in other structures due to compensatory movement.

Physiotherapy principles for functional rehabilitation are similar to that of post operative rehabilitation with one main difference, the post operative protocol prescribed by the surgeon has precedence and the rehabilitation programme has to fully incorporate these requirements. This is where the skills of the Chartered Veterinary Physiotherapist become useful to the surgical team as a physiotherapy treatment plan can be developed and modified to achieve treatment objectives whilst keeping within the post-op restrictions.

For elective surgery, a pre-op assessment of the postural adaptations and movement dysfunctions can be useful and in some cases treatment of these general compensations can help make the post operative rehabilitation less complex.

Locally the aim of treatment is to restore the structure to optimal function. In the early stages physiotherapy can be used as an adjunct to pharmaceutical anti-inflammatory and pain relief. Electrotherapy modalities such as laser, ultrasound and pulsed magnetic field therapy can all be used to promote wound healing and control pain. When protocols allow, accessory and passive movement of joints can initiate return of range of movement to a surgical site and help prevent dysfunctional scar production and then lead on to graduated functional exercises until optimal function is restored.

Current physiotherapy practice is increasingly directed to the restoration of the whole body function with the view that if one part of the body is stressed and/or dysfunctional, there will be compensation elsewhere until breakdown point where pathology is identified [1,2]. If this is the case it seems remiss to ignore the postural adaptations and movement dysfunctions that are identified.

A structured treatment plan can be designed incorporating the specific post operative restrictions from the box rest stage to full function. At each stage treatment will address mobilising restricted joints and soft tissue; strengthen weak muscle, introduce neuromuscular techniques to regain co-ordination of movement and proprioception, also controlling pain and inflammation. The physiotherapist is trained to assess the patient’s condition, modify treatment and crucially communicate effectively with the surgical team.

Principles to progress the rehabilitation programme are evidence informed [3,4] but the ability of the physiotherapist to assess and modify progress is crucial to optimise the safety and efficacy of the return to function.

The frequency and duration of physiotherapy intervention is dependent on the preoperative condition of the patient, the type of operation and the competence of the client to comply with the post operative instructions [5].

References
Chiropractic treatment
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How does chiropractic care for animals work?

While chiropractors are primary contact practitioners able to work independently with human patients, legislation stipulates that animals may only be treated by a veterinary surgeon or someone authorised by a veterinary surgeon. Members of the RCC Animal Faculty adhere to this requirement, working under the authorisation of a veterinary surgeon at all times to ensure the safe treatment of the animal.

When permission has been given for an animal to be treated, the chiropractor will:
• Work from information received from the veterinary surgeon.
• Take a history from the owner regarding the animal.
• Watch the animal move and analyse the gait.
• Palpate the animal.
• Make a working chiropractic assessment and formulate a care plan.
• Explain to the owner how the treatment works and what they are about to do.

The principle of chiropractic care is to mobilise and manipulate dysfunctional joints in order to restore, improve and optimise flexibility, symmetry, coordination, strength and balance. When this is achieved this will improve function and performance in terms of reducing pain, relieving soft tissue spasms and asymmetries, increasing the mechanical strength and stability and helping to restore nerve function.

Chiropractic care involves manual treatment that is usually done by hand; any equipment is portable. Chiropractors usually visit larger animals at their yard where assessment and treatment can take place immediately as appropriate. Any condition outside the chiropractor’s remit is always referred back to the veterinary surgeon quickly. In this way, medical problems may be identified and treated more quickly than usually possible for referrals based on the owner’s knowledge.

Where does chiropractic care fit with veterinary treatment?

Chiropractic treatment is a noninvasive adjunct to veterinary treatment for many musculoskeletal and post surgical conditions and should be considered in the following instances:

Crisis care
• Musculoskeletal conditions where a noninvasive approach may be sufficient alone, and for any animal where surgery is not appropriate.
• Traumas where there is no obvious radiographic evidence of damage.

• Neurological conditions where investigations are limited by financial constraints.

Maintenance care
• Long-term neuromusculoskeletal conditions, the elderly and compensations for other injuries or after anaesthetic.
• Regular check-ups are always recommended to maintain health and prevent avoidable injury.

Competition care
• Where animals are involved in athletic activities, chiropractic care can resolve minor musculoskeletal problems that challenge performance.

Most chiropractors are trained to treat mammals, birds and many reptiles, as well as farm animals, but the majority of the patients they see are horses, dogs and cats. The chiropractor’s ability to treat the partnership between dog and handler, and horse and jockey is very valuable.

As many veterinary surgeons themselves experience back and neck problems due to the nature of their work, they also benefit personally from chiropractic treatments and are happy to recommend this form of treatment for animals.

Insurance issues
For their work with humans, all chiropractors are legally required to carry professional indemnity and liability insurance. Chiropractors who treat animals also have specific professional indemnity and liability insurance for this work.

Chiropractors are normally accepted by insurance companies who provide cover for animal treatments. All chiropractors are regulated and registered with the General Chiropractic Council.

The Royal College of Chiropractors is a Royal Chartered professional membership body and registered charity promoting quality, safety and professional excellence in chiropractic. It holds a Register of Animal Chiropractors.

Presentation messages
• How does a veterinary surgeon know when a chiropractor may be able to help?
• How does a veterinary surgeon find a regulated professional to work with?
• How does the veterinary profession find out more about this noninvasive approach?

These points and more will be discussed during the presentation.

NOTES
How to appraise a scientific paper

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Rather than merely reading a scientific paper, it is important to identify its strengths and weaknesses in order to assess the usefulness and validity of the findings. This allows the reader to decide whether to use the results in their daily clinical work and to practice evidence-based veterinary medicine [1].

A study should pose a relevant and novel research question. The reader should assess whether the study design is appropriate to answer this question, whether suitable statistical methods are used to produce quality results, and whether these results are interpreted in a manner such that the conclusions drawn can be justified [2].

This abstract provides some notes to assist the reader during critical appraisal of a scientific paper.

The title
A good title is succinct, accurate and should state clearly what the study is about.

The abstract
The abstract should be well constructed and accurately reflect the contents of the paper, including the following information:
- Why was the study performed?
- How was the study designed?
- What outcome measures were used?
- What is the significance of the study?

The introduction
- Does the study address a pertinent research question and add to existing knowledge?
- Is the introduction concise, relevant and include key references?
- Is a clear hypothesis stated?

Materials and methods
- Was ethical approval given for the study (if relevant)?
- What is the study design?
  Studies can be experimental (for example randomised controlled trials) or observational (for example cohort studies or case–control studies)
  Is the study design appropriate for the research question?
- Do the study methods address the most important potential sources of bias?
  Systematic biases, which result in the overestimation or underestimation of the ‘truth’, arise from the study design; for example systematic biases can be due to the sampling methods, the methods of data collection, or the methods of statistical analysis [3]. Once the study design of a given article has been identified, clinicians can use one of the available design-specific critical-appraisal checklists to decide whether the study in question is of high quality [4].
- Are any study groups, selection criteria, time-frames and outcome measures suitable and accurately/appropriately defined?
- How valid, reliable and repeatable are any objective methods?
- If applicable, was the assessment of outcome blinded?
- Are the appropriate statistical tests used and were the statistical analyses performed correctly?
- In particular, the approach to dealing with missing data should be specified; patients who are lost in follow-up and missing data should be clearly identified in the ‘Results’ section. Original data should be presented in such a way that readers can check the statistical accuracy of the paper [1].

Results
- Has all the data relevant to the stated study objectives been reported? Have any selected outcomes been omitted?
- Are there any potential conflicts of interest and if so are these disclosed?
- Are the tables and figures relevant, clearly labelled and correspond with the text?
- Is the data internally accurate and consistent?
- What measures of precision were used (means, medians, results of statistical tests, levels of significance)?
- If no significant effects were identified, was the power of the study sufficient?
- If the study was multi-centred, were the results homogeneous?

Discussion and conclusions
- Do the authors achieve their aims?
- Is there critical discussion of the study design, potential biases and results?
- Do the data justify the conclusions and are the conclusions drawn appropriate?
  Authors may place too much emphasis on statistically significant findings on differences that are too small to be of clinical value; alternatively, researchers may dismiss large and potentially important differences between groups that are not statistically significant, potentially because sample sizes were small. Researchers may generalise their findings to a broader population or context than is reasonable given their study sample. Statistically significant associations may be misinterpreted to imply a cause and effect [1].

Final appraisal
- Would you conduct this study differently? If so how and are the alternatives practical, ethical and cost-effective?
- Does the paper add to the clinical evidence?
- Does the paper provide sufficient evidence for you to change your clinical practice?

Critical appraisal enables clinicians to identify the most relevant, high-quality studies available to guide their clinical practice and practice evidence-based medicine.
References

09.20–09.40

Current evidence-based practice in theatre nursing

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No abstract submitted
Abdominal surgery: nurse and intern theatre essentials

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Patient preparation

The patient is anaesthetised and positioned in dorsal recumbency for abdominal surgery. A few key tips for patient preparation – the horse’s mouth should be washed out prior to anaesthesia induction to prevent tracheal contamination during intubation; antimicrobial drugs (AMD) and analgesia should be administered prior to surgery. It is important to know when the horse was last administered a nonsteroidal anti-inflammatory drug (NSAID) to prevent overdosing. Nephrotoxic drugs (e.g. gentamicin and NSAIDs) should be avoided in horses with azotaemia. While preparation varies between hospitals, a rope halter is generally placed and the horse’s shoes either removed or covered.

The entire ventral abdomen is clipped and prepared. Preparation of the prepuce varies between hospitals from simply placing gauze sponges in the preputial orifice and towel clamping closed to exterriorising and cleaning the penis/prepuce and oversewing the preputial orifice (great job for an intern!). Most hospitals have some sort of clean (not necessarily sterile) drape to cover the feet. It is essential to perform a clean prep prior to beginning the 5-minute sterile prep. Preparation is usually performed with chlorhexidine or povidone-iodine scrub. Either sterile water or alcohol is used to remove the scrub. There is evidence in the literature that suggests a chlorhexidine scrub is superior to povidone-iodine scrubs [1,2]. Similarly, surgeon scrub should begin with clean hands. Chlorhexidine gluconate aqueous scrubs appear to be superior to povidone-iodine aqueous scrubs at reducing colony forming units (CFU) on the hands [3]. Alcohol-based rubs are as effective as aqueous scrubs at reducing CFUs [3].

Prior to beginning surgery and closing the abdomen, an instrument and sponge count should be performed. The horse is usually draped with four quarter drapes and a large fenestrated drape. The ideal fenestrated drape has adhesive around the fenestration so that towel clamps are not necessary in the surgical field and a plastic pocket attached to the fenestration to facilitate scrub removal and drug delivery while in the sterile field. Velcro® tabs can also be useful for securing suction tubing and other equipment in the surgical field. Patient preparation is essential to perform a clean prep prior to beginning the initial surgical procedure.

Approach to the abdomen

A ventral approach using a traditional surgical technique is most appropriate for the majority of horses with acute colic. The ventral midline approach is started at or 1 cm cranial to the umbilicus and extended 20–35 cm (15 cm in a foal) in a cranial direction. The incision is made through the skin, subcutaneous tissue, and linea alba. Bleeding is controlled by applying haemostats or electrocautery. After the body wall is incised, the surgeon bluntly enters the peritoneum with digital pressure. All instruments and sponges must be removed from the ventral abdomen prior to entering the peritoneal cavity. Exteriorised bowel must be kept moist at all times. Exploratory laparotomy has been reviewed in detail [4].

Needle decompression

Needle decompression is performed commonly in the large colon and caecum during abdominal surgery for colic. It is performed using a 14 gauge ½ inch needle in adult horses (18 gauge ⅛ inch needle for foals and small intestine) attached to tubing connected to suction. The needle should penetrate the serosa, tunnelled within the submucosa, and then passed through the mucosa into the intestinal lumen. When all of the gas is removed, the site of needle penetration should be grasped with a moistened gauze sponge and the needle removed. The gauze sponge is immediately discarded and the site inspected for feed material, leakage, or haemorrhage. A partial thickness single cruciate or interrupted suture using 3-0 synthetic absorbable suture material can be used to oversew the needle hole if necessary [4].

Pelvic flexure enterotomy

A pelvic flexure enterotomy is performed on the antimesenteric aspect of the bowel and the incision is oriented longitudinally. The large colon is placed on a tilted table (colon tray) that is draped and abutted to the flank of the horse (left side). Digesta is removed through a pelvic flexure enterotomy by placing a hose with warm tap water within the lumen to hydrate the digesta. The digesta is massaged toward the enterotomy site. A large colon enterotomy is closed using 2-0 synthetic absorbable suture material in a full thickness simple continuous pattern oversewn with a Cushing pattern. Recently, staples have been reported to result in rapid and effective enterotomy closure [5].

Stapling equipment for advanced procedures

The types of stapling equipment that are generally used in abdominal surgery are the LDS (ligate-divide-staple) for vessel ligation, e.g. during resection of a long portion of jejunum; TA-90 (thoracoabdominal stapling device) for resection of any portion of bowel creating a blind end; and the ILA-100 or GIA-100 for creation of an anastomosis (can also be used for resection of bowel). Staples may also be used in the skin. Generally staplers consist of a re-sterilisable instrument with a disposable staple cartridge that slides into the stapler.

Body wall closure

The body wall is generally closed using No. 2 polyglyactin 910 in a simple continuous (SC) pattern, the subcutaneous tissue using a 2-0 synthetic absorbable suture material in a SC pattern, and the skin using either staples, absorbable suture in a SC pattern, or skin glue [4].

References

Considering that arthroscopic surgery is a minimally invasive procedure, not only is there a vast amount of equipment involved that requires preparation prior to surgery but the horse itself requires scrupulous preparation prior to this aseptic procedure. Teamwork between nurses and interns is key prior to, during and following surgery.

Prior to surgery
The aim of preparing the horse and equipment thoroughly prior to surgery is to keep the amount of time that the horse is under general anaesthetic to a minimum. Being one step ahead is always an advantage and if the horse can have any of the pre-op preparation done the day before, this will help operations to run smoothly on the day. For surgeries involving the foot or structures in close proximity to the foot, scrupulous preparation is essential. The horse should have the shoe removed, the foot pared and the hoof wall scrubbed thoroughly. A strong solution of iodine (10%) should be applied using gauze swabs and a foot dressing applied to keep these in place. Ideally this should be done 12–24 h prior to surgery. Equipment checks and preparations pre-op are essential to ensure that it is all in working order before the horse is anaesthetised. Communication between the intern and theatre nurse regarding positioning of the horse on the table and the surgeon's requirements should happen the day before surgery where possible, to allow for planning and organisation.

During surgery
Organisation is key during arthroscopic surgery and the main aim is to be one step ahead at all times. Although it can sometimes be difficult, trying to predict what the surgeon will require in terms of positioning and instruments will help the procedure to run as smoothly as possible. As a circulating nurse, it is essential to assist the surgeon as necessary and also the intern, should they require any assistance with the anaesthesia. As a scrub nurse, it is essential to be familiar with the surgery that is being performed, instruments required and the surgeon's requirements prior to surgery. During the operation, the scrub nurse should aim to predict what the surgeon will require next at the same time as maintaining the surgical trolley in an organised fashion. Before the end of the surgery, the intern should be organised for the recovery of the patient and have obtained post-op instructions from the surgeon.

Following surgery
No matter how successful the operation has been it is not complete until the horse is standing following surgery. The nurses and interns should work closely together to ensure the recovery goes as smoothly as possible. The positioning of the horse is essential as it is dependent on the surgery that has been performed. If the horse requires an assisted recovery, then organisation prior to placing the horse in the recovery box is key. All horses should be catheterised either prior to being placed in recovery or as soon as they are in recovery, at the same time as the intern is monitoring the horse to ensure it is safe to do so! During recovery, noise should be kept to a minimum and whilst the intern is monitoring the horse's recovery, it is essential that there is a nurse close at hand should any problems arise. If the horse has a dressing in place and it is damaged in recovery, it should be at the forefront of the nurse and intern's minds that an aseptic protocol must be followed to reapply the dressing out of recovery.
The Hospitalised Horse: Inpatient Care

Chaired by Marie Rippingale
Sponsored by Rainbow Equine Hospital

10.55–11.15

Management of the recumbent horse

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Causes of recumbency

The recumbent horse presents a logistic, diagnostic, and therapeutic challenge to the equine practitioner. Challenges faced by those working on recumbent horses include safety for patient and caretakers, obtaining a proper diagnosis, providing adequate treatment of the primary disease process, preventing secondary complications, and providing adequate nursing care. Causes of acute recumbency can be divided into non-neurological (cardiovascular, pulmonary, musculoskeletal, gastrointestinal, metabolic and others) and neurological causes (trauma, infectious disorders, degenerative disorders, neurotoxic disorders).

Assessment of the down horse

Safety of all involved should always be a primary consideration when the cause of recumbency is not immediately apparent. Anxiety and fear of being unable to get up, as well as alteration of mentation due to the underlying disease of the patient may lead the patient to vigorously struggle and thrash. Also consider that some of these disorders are highly infectious to other patients or even zoonotic to humans, therefore it is the veterinarian’s responsibility to take appropriate measures to minimise potential exposure.

If the patient is refractory to examination or is thrashing around, consider the use of sedatives. Alpha-2 agonists do generally work well and can be used alone or in combination with an opioid. Seizing patients should be sedated with diazepam and/or phenobarbital. Ketamine should be avoided due to its increase in intra-cranial pressure. The placement of an intravenous catheter is strongly recommended in any recumbent patient. This will ease drug administrations and blood collection.

Prior to examining the recumbent patient, an accurate history and patient details should be obtained. The history should address questions related to possible trauma, acute versus gradual onset of disease and progression of disease. It is important to determine whether the horse makes attempts to stand and if the horse is still able to eat, drink, defaecate and urinate.

A thorough physical examination of the recumbent patient should include heart and respiratory rates, rectal temperature and assessment of mucous membranes and capillary refill time. The horse should be examined for evidence of fractures, swelling or trauma and for the presence of haemorrhage and acute abdominal distension. If possible the horse should be encouraged to stand in order to examine posture and gait and perform a thorough neurological and lameness examination. The neurological examination of a recumbent horse should include the assessment of mentation, posture, cranial nerve function, muscle mass and tone, sensation, deep pain, and reflexes. Recumbent horses do generally need to be flipped over in order to evaluate both sides.

Diagnostic work-up

Tests that should be considered in recumbent horses include:

- Comprehensive blood work including complete blood count (CBC) and biochemical panel. This will allow you to determine if an inflammatory process is present or if the condition is related to a metabolic or muscular derangement.
- Imaging modalities such as endoscopy, radiography, computed tomography or magnetic resonance imaging. Most of the conventional imaging techniques can be done on site, i.e. neck and distal limb radiographs, endoscopy, etc.
- Cerebrospinal fluid analysis should be considered for neurological conditions and the site should be chosen based on the neuroanatomical location of the disease process.
- Further, specific antigen and/or antibody detection tests are available to help with the diagnosis of selected infectious organisms.

Management of the recumbent horse

The management of recumbent horses combines intensive supportive care and specific treatment aimed at the underlying disease process. Once the patient has been evaluated and the primary disease process recognised, there are three main directions that should be considered: (i) euthanasia of the horse if the condition is severe and bears a poor prognosis or if financial limitations are associated with the case; (ii) referring the case to a hospital for further work-up, support and treatment; and (iii) initiating treatment.

If the horse needs to be transported a few factors should be taken into consideration. The patient should be stable to be transported and depending on the underlying condition, emergency treatment should have been initiated (addressing hydration status, NSAIDs, stabilising fracture, etc). A recumbent horse should be transported in lateral recumbency and all attempts should be made to minimise self-trauma. This is best achieved by bandaging distal extremities and using a helmet (this will protect head and eyes from injuries). Deep bedding or padding is important to minimise musculoskeletal injuries during transportation. The use of a sled or board can be helpful in moving the recumbent patient into a trailer but also to mechanically restrain the patient during transportation. Last but not least, the level of sedation needs to be adjusted to the horse’s condition and temperament.
Treatment of the down horse
Specific treatment of recumbent horses varies with the organ system(s) involved. Cardiovascular and respiratory disorders leading to recumbency often require intranasal oxygen supplementation, fluid administration and other cardio-supportive drugs. Orthopaedic conditions other than fractures are often best treated with supportive care, NSAIDs and analgesics. Muscular diseases, such as rhabdomyolysis, are best addressed with NSAIDs, intravenous fluids to maintain perfusion but also prevent nephropathy, muscle relaxants and analgesics. Mainly organ support is needed for metabolic conditions. Patients with such diseases often require intravenous fluid supplemented with electrolytes and enteral or parenteral nutrient. For neurologic recumbent horses, the treatment is generally aimed at reducing intra-cranial pressure and inflammation. This is best achieved with the use of NSAIDs with or without corticosteroids, free-radical scavengers, anti-oxidants and specific medication such as antimicrobials, antiviral or antiprotozoal drugs.
Care of acute and chronic starvation cases

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Many acute and chronic starvation cases that come under veterinary care will form part of an RSPCA prosecution therefore an essential aspect of the nursing care is accurate record keeping. This will include daily feed charts, medication, anthelmintics, regular recording of weight and body condition score and may involve photographic evidence [1]. All feed should be recorded in kilograms and not as scoops/bales. Part of a successful prosecution for neglect is demonstrating that correct feeding, dental care and deworming results in weight gain.

Initial assessment
- Establish accurate weight and body condition score [2,3].
- Time course of weight loss and starvation prior to admission is helpful.
- Dental examination to ensure the horse is able to eat the foods offered.
- Identify underlying diseases. Hepatic disease is common, especially pyrrolizidine alkaloid toxicity, as starved horses on poor grazing are forced to eat ragwort.
- Identify causes of increased calorie demands such as pregnancy, lactation or growing youngster.
- Assess adult worm burden and likelihood of encysted cyathostome larvae. If using moxidectin ensure accurate weight/dosing to prevent toxicity issues [4].

Blood sampling
Haematology and biochemistry parameters are vital in assessment of any welfare case to help differentiate chronic starvation from clinical disease [5]. Starvation often produces a normocytic, normochromic anaemia and may be accompanied by a haemodystonic, systolic heart murmur. A low albumin to globulin ratio is common and can reflect chronic inflammatory disease or protein losing enteropathy.

Refeeding syndrome
When first exposed to starvation the horse metabolises stores of fat and carbohydrate which are then replaced when the horse is fed. If food deprivation continues these stores become depleted and the body resorts to utilising protein as an energy source. As protein is found in most tissues, this process of catabolism affects not only skeletal muscle but also structures such as the heart and intestine.

A sudden reintroduction of feeding leads to a rapid rise in blood glucose which is followed by a surge in insulin. The insulin drives glucose and potassium into the cells and also promotes the synthesis of glycogen, protein and fat. Vital minerals such as magnesium and phosphorus are needed to complete these complex pathways. Due to starvation the body already has depleted levels of electrolytes and minerals and their sudden movement from the circulation into the intracellular space puts the horse at risk of cardiac, respiratory, renal failure and death. This syndrome manifests between Days 3 and 7 post feeding [6,7].

Predicting survival
Whiting et al. [8] studied 45 horses during a refeeding period of 50 days following seizure for chronic starvation. Despite a careful refeeding plan of 10 days free choice hay before the addition of supplementary barley corn silage, 20% of the horses died. An association between initial body condition score and survival was identified with those horses of BCS 1 or less (Henneke [2]) having a decreased chance of survival. Horses died at an average of 7.9 days post feeding.

It is reported that when a horse loses more than 50% body weight the prognosis for survival is poor [6].

Feeding recommendations
Witham and Stull [9] looked at three potential diets for feeding of acute and chronic starvation cases each of which was given for a 10-day period on a matched calorific basis. A complete feed (19% starch) led to the release of high levels of insulin and a reduction in magnesium and phosphorus potentially leading to refeeding syndrome. The diet of oat hay (7% protein and high fibre) had a less dramatic impact on blood insulin but contained levels of phosphorus and magnesium too low to be supportive. Oat hay can also be bulky and may cause diarrhoea in the starved horse. Alfalfa hay (20% protein, 3% starch) proved the most successful diet with minimal impact on the insulin balance and good provision of magnesium and phosphorus. Oil can be added to safely increase the calorific value of the feed however this does not add to the magnesium or phosphorus intake and may prove unpalatable.

Although alfalfa hay is difficult to come by in the UK many alfalfa feeds are available and can be used in conjunction with good quality hay [6] and a balancer. Feeding should start at 50% of the digestible energy requirement [6,10].

Additional nursing care
- Establish a warm environment to reduce calorie expenditure. This is preferable to multiple rugs which will burden a weak horse.
- Use of a sling may be necessary.
- Pad and treat wounds over bony prominences.
- Hand walking and access to companions improves demeanour and appetite.

References
Dystocia and care of the post parturient mare
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Dystocia is defined as any problem that interferes with the normal birth of a foal. It is recognised as being one of the true emergencies in equine practice and requires immediate obstetric intervention. It is worth noting that the vast majority of mares, of all breeds, foal without difficulty. Dystocia is also more common in maiden mares compared with those that have had multiple foals.

Ultimately, the aim in correctly managing the mare with dystocia is to save the life of the mare and the foal, and preserve the future fertility of the mare.

Even though it may be a rare situation in equine practice, it is important to have the equipment, drugs, supplies and staff organised and at hand for the arrival of a mare with dystocia.

Even though only 1–2% of mares will present with dystocia, it is still essential to have all the required equipment readily available and in good working order. To include:

- anaesthetic drugs and equipment
- sterile foaling ropes
- wooden handles for foaling ropes
- sterile fluid pump
- sterile stomach tube
- 4–5 bottles of obstetrical lube
- skin disinfectant
- clean buckets (for fresh warm water/lube mixture)
- paper towel rolls
- disposable vaginal speculum
- torch
- tail bandages
- surgical scrub and swabs
- i.v. catheter kit

- large bath towels
- 8 metric nylon suture
- large curved surgical needles
- needle holders
- large artery forceps
- curved Mayo scissors
- rectal gloves
- bailer twine (for tying up placenta)
- surgical blades and handles

When a live foal is delivered there will be another emergency situation that needs immediate attention – foal resuscitation. This can be started while the foal is in the birth canal with endotracheal intubation and oxygen therapy. A separate team of people and specialist equipment (e.g. foal ET tubes, Ambu rebreathing bag, resuscitation drugs, heat pads, etc.) will be required for treating the foal while others are attending to the mare.

General nursing care of the post partum broodmare
Intensive care monitoring of the mare recovering from dystocia may be required for at least 48 h until the vet team feels that no complications have occurred. Monitoring to include:

- regular checks of vital signs
- checking for retained foetal membranes
- monitoring for signs of haemorrhage, post foaling trauma and colic
- daily uterine lavage
- antibiotic and anti-inflammatory therapy
- monitoring for signs of laminitis.

NOTES
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Proceedings of the British Equine Veterinary Association Congress, 2015 - Liverpool, United Kingdom
Atypical myopathy – masquerading as colic for years or an emerging disease?

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Chronology and characteristics of outbreaks

The earliest UK cases of atypical myopathy, formerly known as atypical myoglobinuria, were described in the veterinary literature in the early 1940s, but the condition was probably encountered long before this according to historical veterinary texts in the preceding decades. In the early 1980s an outbreak of myopathy amongst grazing horses was reported in Scotland, and investigators of this outbreak defined atypical myopathy as a specific disease. The clinical signs reported in these earliest cases were associated with postural and respiratory muscle failure, and horses demonstrated biochemical evidence of a myopathy (elevated creatine kinase and aspartate aminotransferase) and myoglobinuria.

The first large atypical myopathy outbreak in continental Europe occurred in Germany in the late 1990s; over the next few decades most northern European countries have recognised outbreaks with reported numbers of affected horses and mortality rates varying from year to year. Seasonal pasture myopathy, a degenerative muscle disease of grazing horses has been reported since the 1960s in midwestern USA and eastern Canada, and appears to have the same characteristics and aetiology. The rate of increase in case reporting worldwide might be partly associated with increased awareness of, and familiarity with, atypical myopathy amongst horse owners and vets. However, the magnitude of increase in cases and outbreaks would suggest a genuine increase in disease prevalence.

Likely cause

Ingested environmental toxins were long considered the likely causative agent in atypical myopathy due to the trend for multiple co-grazing horses to be affected, and because epidemiological studies revealed common pasture characteristics (sparse grazing, trees surrounding pasture) and feeding practices such as lack of supplementary forage.

Horses with atypical myopathy (and seasonal pasture myopathy) have an acquired multiple acyl-CoA dehydrogenase deficiency. Analysis of urine and blood from affected cases demonstrated the presence of hypoglycin A as a metabolite of sycamore [1]. European horses probably acquire atypical myopathy via ingestion of hypoglycin A in the seeds (in autumn/winter) and seedlings (spring) of the tree Acer pseudoplatanus (European sycamore). When seeds from sycamore trees on the pastures of affected horses were analysed, variable concentrations of the toxin were found within and between trees on the same pasture [2]. The factors affecting the concentration of hypoglycin A in a particular seed or tree are yet to be established.

Epidemiological studies have identified horse management practices associated with an increased risk of atypical myopathy. These factors probably influence the likelihood of toxin exposure, e.g. inclement weather causing seeds to fall onto pasture, or ingestion, e.g. inactive horses, lack of provision of supplementary forage, time spent on pasture vs. stabled.

Clinical presentation

Atypical myopathy results from a deficiency of the fatty acid oxidation pathway, which is the primary energy source in type I muscle fibres. Hence, clinical signs relate to postural and respiratory muscle damage and failure. Cardiomyopathy is also present in many cases. The spectrum of clinical signs reported probably depends on the degree of intoxication and the point at which veterinary attention is sought. Clinical signs include lethargy, stiffness, reluctance to move, muscle tremors, and increased recumbency and tachypnoea. Tachycardia is often present and may result from anxiety, pain, hypovolaemia, and intrinsic cardiac pathology. Some horses have a persistent low head carriage resulting in pharyngeal and generalised head oedema, partial respiratory obstruction and an increase in the degree of respiratory distress. Increased vocalisation and head-tossing are also recognised. Occasionally, affected horses present with oesophageal obstruction.

Frequently atypical myopathy cases have myoglobinuria that is recognised practically as dark red/brown and concentrated urine with high specific gravity (5G) and positive dipstick for blood and no/few erythrocytes. A horse with cardiovascular compromise or hypovolaemic shock from another cause (strangulating intestinal obstruction/enterocolitis) will have concentrated dark brown urine with a high 5G but is unlikely to have a positive dipstick for blood/myoglobin.

Blood sampling and biochemical analysis (CK and AST) of co-grazing horses is helpful to identify sub-clinical cases and to confirm the need to remove grazing horses from those fields or provide supplementary forage.

Case management

It can be assumed that all cases of atypical myopathy are in need of adequate analgesia. Treatment with non-steroidal anti-inflammatory drugs should be accompanied by appropriate isotonic fluid resuscitation, to minimise the risk of acute kidney injury. Additional analgesia such as opioids and constant rate infusion of lidocaine should also be considered. Parenteral nutrition (minus lipid component) may be required if oral intake is unlikely to meet daily caloric requirements. The importance of intensive 24-hour nursing care cannot be overemphasised - recumbent horses require turning to minimise ischaemic muscle damage, horses with low head carriage require head/neck support and those with inappetence/dysphagia require assistance with enteral feeding or provision of parenteral nutrition. It is no surprise that one recent study identified an increased rate of survival in horses that received hospitalised veterinary care compared with those managed ‘in the field’.

Prognosis

Prognosticating atypical myopathy is a challenge - survival rates vary year on year, and initial presentation and vital parameters do not necessarily correlate with survival. Large epidemiological studies have identified negative prognostic factors such as tachycardia, tachypnoea, respiratory acidosis, and prolonged recumbency. Recently, Votion
and colleagues identified significant differences in the biochemical metabolic profiles (acyl-CoA and markers of fatty acid metabolism) between survivors and nonsurvivors [1]. This promising research may offer much needed accurate prognostic information to better inform owners of the probability of survival.

References


Dealing with the difficult and dangerous horse: a behaviour based approach

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Veterinarians, nurses and support staff all recognise the challenges, frustrations and potential safety implications of trying to treat a horse exhibiting unwanted behaviours. In order to deal with these horses more effectively and safely requires an understanding of the basic learning processes horses utilise. These include:

Classical conditioning
This gives the horse the ability to associate two events and therefore predict what will happen next. A horse may associate entering examination stocks with being doused in cold alcohol (for abdominal ultrasonography). This may result in them being reluctant to enter the examination stocks.

Counter conditioning is a form of classical conditioning whereby the event or stimulus that predicted the second event can be retrained to predict an alternative one. So in the same example, if every time the horse entered stocks they received a food reward then entering stocks predicts a positive outcome (food) rather than a negative outcome (cold alcohol) and so they are more likely to walk in willingly.

Operant conditioning
This gives the horse control over their environment and can be broken down into four further sections:

1) Positive reinforcement
As in the mathematical sense of the word, this literally means addition of something pleasant when the desired behaviour occurs, that makes the behaviour more likely to be repeated in the future. Scratching a horse around the base of the neck/wither region is relaxing and can lower the heart rate by up to 10 beats/min [1]. By scratching an anxious horse in this region each time they allow themselves to be caught in them being reluctant to enter the examination stocks.

2) Negative reinforcement
Again in the mathematical sense of the word this literally means removal or subtraction of something aversive when the desired behaviour occurs, that makes the behaviour more likely to be repeated in the future. A needle-shy horse will find raising of the jugular vein aversive. If they throw their heads back this removes what they perceive to be the aversive stimulus (the hand). Even if it is only removed for a fraction of a second this is inherently rewarding and therefore the behaviour is more likely to be repeated in the future. On the other hand, if the vet touches the neck in a spot the horse finds less aversive and can keep their hand in contact whilst the horse throws their head back this behaviour will not be rewarded. Most importantly here if the vet then removes their hand as soon as the horse is still then they will be rewarding the behaviour of keeping the neck still. In a surprisingly short number of repetitions the horse then learns that to remove the aversive stimulus (the hand raising the vein) they need to keep their neck still, making them much easier to inject.

3) Positive punishment
This is the addition of an aversive stimulus during or after an unwanted behaviour has occurred to make it less likely to be repeated in the future. The difficulty here is that horses have an incredibly short, short-term memory and so any punishment delivered even a few seconds after an unwanted behaviour has occurred is unlikely to be effective. It is more likely the horse will simply associate a fear response with the person (vet!!), making them more difficult to handle in future encounters.

4) Negative punishment
This is the removal or subtraction of something pleasant from the horse when an unwanted behaviour occurs. Like positive punishment, this has no real place in correct training.

Shaping
When training a horse a new behaviour, such as training a needle-shy horse to keep their neck still during venipuncture, it is important to shape the behaviour progressively. The horse is unlikely to offer the final correct response immediately. By initially rewarding the most basic response, such as removing the hand from the neck when the horse keeps its head still, the horse will quickly start to offer more of the correct response under increasingly difficult circumstances. For example the first step may be to keep the hand anywhere on the neck, then in each step the hand gets progressively closer to the jugular, once the jugular can be raised without the horse moving, the capped needle can be gently placed against the neck and then more pressure applied via the cap each time. Once the horse remains still with a moderate amount of pressure exerted through the cap of the needle they are unlikely to react to the needle being inserted.

This talk will demonstrate, through video footage of cases, how behaviour modification can be quickly and efficiently utilised in every day scenarios within an equine hospital.

Reference
Horse owner approaches to equine health and the role of veterinary advice

Claire Scantlebury
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This talk will explore the evolving role of veterinary advice, and the influence this can have on horse owner understanding of, and approaches to horse health. By considering colic and laminitis as examples of key equine health concerns, the presentation will discuss research findings, and consider comparisons with medical sociology. This talk aims to highlight how professional and lay expertise interacts and contributes to decision making in equine health management.

Horse owners as gatekeepers to equine healthcare

It is recognised that horse owners/carers are important in detecting changes in the health status of their horse and in initiating veterinary assistance. The decision and timing of when to consult the veterinary surgeon may differ depending upon the situation and the individual involved, and may be moderated by personal experience along with advice received from other sources [1].

Veterinary advice is just one of many sources of information available. The relative position that veterinary advice holds in comparison with other sources may vary between individuals [2,3], and information sources may be selected based on factors including: ease of access or proximity, experience, personal preference, cost, and confidence in the source. The equine community and social networks within which horse owners are a part, also have an important role in shaping knowledge and practices [4].

The increasing availability of veterinary information on the internet may impact upon client expectations of veterinary services. The internet provides a forum for seeking advice from others within the equine community [3] and presents both opportunities and challenges for veterinary surgeons at the point of consultation, and as a medium for distributing information and representing the veterinary profession [5–8].

Health sociology research has demonstrated that understanding of health and illness is constructed by people based on their experiences and interpretation [9–12]. Conrad and Barker [13] identified three main premises: “Some illnesses are embedded in cultural meaning; all illnesses are socially constructed at the experiential level and; medical knowledge is not ‘given’ by nature but is constructed and developed by individuals”. This talk will discuss how horse owner understanding of equine health and disease may be constructed in a similar way within the equine community, with potential impact upon how people act in response to equine health and disease issues.

Vets as advisors, facilitators and educators

Veterinary surgeons and nurses have a great opportunity to shape owner approaches to disease prevention. This talk will examine what part vets can, and do play, with examples grounded in research. It will discuss issues such as the timing of advice, and potential opportunities where vets can expand their role in preventive medicine.

An essential component to practising evidence-based medicine is incorporating individualised care. The veterinary role requires flexibility and responsiveness during consultation with horse owners [14], to assist owners through decision making and times of uncertainty. There may be individual factors that affect decision making (e.g. decisions around surgery and euthanasia), and specific situations where owners may face practical challenges such as box rest, adjusting feed, soaking hay, providing sufficient turnout or exercise.

Underpinning all of this is the diverse range of people who keep horses with varying knowledge and expertise. This variety means that different people may approach the care and management of their horses differently. An understanding of owners’ experiences, and the challenges, promoters, and context of decisions made, provides a vital contribution to the development of veterinary advice.

References

Euthanasia – supporting the bereaved equine owner

Angela Garner
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Introduction
The loss of a beloved equine can be a life-changing event, and to be able to offer meaningful bereavement support, we need to endeavour to see things from the grieving owner’s perspective.

This presentation comes from many years of first-hand experience in supporting people through animal loss, and of listening and responding to their needs through compassionate and effective communication.

The talk has two parts:
• How to effectively support the owner before, during and after equine euthanasia, taking into consideration the effects of grief and what people have said they feel about losing a beloved companion animal.
• Organisations and resources which offer animal bereavement support.

Supporting the owner before, during and after equine euthanasia
Discussing euthanasia is clearly stressful for both owner and vet personnel; however, a quiet and unhurried approach will help the bereaved cope with the emotional turmoil that distressing news engenders. Examples of ways to facilitate difficult conversations:
• Find a quiet, uninterrupted and private place for end-of-life discussions.
• Give people time so that they don’t feel rushed.
• Ensure that you’re both at the same eye level so that they don’t feel ‘talked down to’.
• Be aware of the tone and speed of your voice, soften the voice and speak a little slower if needed, as this will enable people to take in what you’re saying more easily.
• Encourage them to ask questions and to air their concerns and fears so that you can address these at the point and thus prevent them from worrying unnecessarily afterwards.
• Show that you are listening and hearing what they’re saying, so they know that their feelings are being respected.
• Continue to be warm and open in your approach, even if they seem distant and cold or appear withdrawn, as this helps to keep the lines of communication open.
• Show that you are not fazed by any emotions they express, offering reassurance that it is normal to feel upset.
• Be prepared to repeat and clarify issues if they find it difficult to absorb what is being said.

Those offering support often worry about what to say to comfort the bereaved, for example, during the process of euthanasia when the owner is likely to be highly distressed. However it is easy to underestimate the effect of our approach and what we convey in our behaviour. Genuine compassion, consideration and warmth are core components which we can offer. It is interesting that during one-to-one bereavement support sessions, whilst talking about the experience of their pet’s euthanasia, owners tended to reflect more about how they felt, how the vet team handled things and how they were spoken to, rather than exactly what had been said to them.

After euthanasia people can be taken aback at the depth of despair they feel. Grief can be likened to the sudden shattering of one’s normal, dependable every day routine, resulting in shock, pain, confusion, anguish and sometimes anger. Owners may say things such as, “I feel my life has fallen apart” or “I don’t think I’ll ever get through this”. The loss may be compounded by other challenging issues in their life, or may rekindle previous unresolved grief, and therefore it is best to ‘expect anything’ rather than be taken aback by unexpected reactions. In the light of this, it is important to assess the owner’s reaction so that you can offer the best response, for example:
• They may feel numb as they have yet to comprehend what has happened and therefore will need to sit quietly for a time.
• They might appear cold and aloof but this could be because they are in shock, or trying to hold back their tears until they are alone – not everyone is comfortable showing their raw emotions, so this needs to be respected by offering a balance of warmth and understanding alongside a practical approach.
• There could be unresolved issues that they need to talk through to help alleviate the feelings of guilt that often arise within the grief process.
• You may need to offer further reassurance that euthanasia was the right decision for their horse.
• They will need a safe and nonjudgemental situation to allow them to express their emotions freely – ‘to feel what they feel’.
• Although people generally know that it is natural to feel upset, it can help to reiterate that this is completely normal whatever their age and gender.

Useful follow-up information can be given before the client leaves, or could be sent with a sympathy card, for example:
• Details of whom to contact at the surgery if they have questions or worries about what has happened (they may need further reassurance that they did the right thing and that it was the correct time, or be worried that they didn’t do enough for their horse themselves).
• Where they can access further bereavement support.

Organisations which offer animal bereavement support
www.ease-animals.org.uk: Offers a wide range or pet bereavement support resources covering different aspects of grief, including a Children’s Pet Bereavement Activity Book – available as free printable downloads or to listen to recordings online (podcasts)
www.bhs.org.uk: Friends at the End Scheme – The British Horse Society will ensure that no horse owner has to face the loss of their equine companion alone
www.bluecross.org.uk: Pet Bereavement Support by telephone and email
http://departedfriend.wordpress.com/about-df/: Support by telephone, email or letter and newsletter

Further reading
Coping with client complaints
David S. Green
The Veterinary Defence Society, Parkgate Estate, Knutsford, Cheshire, WA16 8XZ, UK

Even in the best organised practice, with the best will in the world, client complaints are a fact of veterinary life – from quibbles over bills to serious accusations of incompetence or misconduct. It is how you handle those complaints that determines whether the problem is resolved informally or snowballs to end up affecting both practice reputation and staff morale. There is no doubt that complaints can be time consuming and stressful for members of the practice team; however, if the challenge of handling complaints is met head on it can be emotionally and financially rewarding.

Client feedback comes in three varieties: compliments, comments and complaints. All three are worth recording as they act as pointers to what’s going right or wrong within your practice.

Compliments should rightly be celebrated – although they sometimes seem to be a rarer species than the other two! But more negative comments – even the briefest remarks – are worth of attention too. They can be useful early warnings of dissatisfaction or a weakness in the system and a niggle ignored can soon boil over into a full-blown complaint and take up much more of your time and energy than if you had addressed it at the comment stage. It is important to remember that whoever receives a complaint is the client’s first point of contact. If that person is genuinely concerned and interested in helping to resolve the matter, they will win brownie points both for themselves and for the practice.

This presentation will describe common and/or recurring themes related to client complaints in equine practice. The issues will be discussed under the following broad headings:

What is a complaint?
A complaint is a clear expression of dissatisfaction with the practice service. It may be:
• A verbal comment serious enough to demand a direct response
• A letter from a client or a friend of the client
• A letter on behalf of a client – probably from a solicitor or the Royal College of Veterinary Surgeons (RCVS)/the Veterinary Council of Ireland.

The initial response
When a client complains to you in person or by phone, the most important thing is to make sure they feel you’re really listening. If you can take the time and space to listen properly first time around, it may well save a lot of extra time and trouble later on! Once you’ve listened carefully, express regret that the client is dissatisfied. A prompt and thorough explanation can work wonders too.

When the client isn’t satisfied with the initial response?
• If the client isn’t satisfied, ask if they wish to take the complaint further and explain the complaints procedure. Give them a copy of the practice complaints leaflet, if you have one.
• Agree a plan within the practice of what action will be taken, by whom and by when.
• Tell the client which member of the practice team is going to deal with the complaint and by when.

Three stages of resolving a complaint
Stage 1
Informally within the practice, usually by the front line staff who have received it. If staff know how to defuse a complaint at this stage, they can often stop it escalating.

Stage 2
Still within the practice but more formally, in writing and via the Complaints Procedure. This covers any written complaints or serious unresolved issues, which should be acknowledged promptly in writing. The Client Care Manager or whoever is responsible for dealing with complaints should launch an immediate investigation.

Stage 3
When a client takes their complaint outside the practice and contacts the RCVS/the Veterinary Council of Ireland and/or a solicitor to seek redress. Sometimes a letter from the RCVS/the Veterinary Council of Ireland or a solicitor will be the first a practice knows about the problem, other times this will be the latest stage in an unresolved case.

Setting up a complaints procedure (checklist for investigating a complaint within the practice)

How to respond in writing (checklist for writing a letter of response to a complaint)

Staff training and support

Learning from complaints
Basic approach to investigation of wounds
Padraig G. Kelly
Philip Leverhulme Equine Hospital, University of Liverpool, Neston, Wirral, CH64 7TE, UK

Introduction
Wounds are a frequent occurrence and appropriate assessment and treatment are required to minimise the associated morbidity. In general, the objective of assessment is to identify any factors that may negatively impact healing and treatment is then targeted at removing these factors. If this is appropriately achieved there is frequently little requirement for additional ‘stimulators’ or ‘accelerators’ of healing.

Knowledge of factors that can negatively impact on wound healing is therefore essential and these can be divided into three groups:

1. **Patient factors**
   a. Physical/nutritional status
   b. Concomitant disease

2. **Wound factors**
   a. Location
   b. Movement
   c. Underlying structures
   d. Type of injury
   e. Wound orientation
   f. Tissue deficit
   g. Trauma to surrounding tissues
   h. Contamination/foreign bodies
   i. Infection
   j. Chronicity

3. **Iatrogenic factors**
   a. Cytotoxic/pro-inflammatory agents
   b. Inappropriate dressing
   c. Poor suture choice/technique
   d. Poor bandaging/splinting - ongoing trauma

Assessment of the wound

The initial assessment should follow a logical consistent stepwise approach:
1. General clinical assessment of patient
2. Visual inspection of wound
3. Consideration of adjacent/compromised structures
   a. Synovial structures
   b. Tendons/ligaments
   c. Neurovascular structures
   d. Vital organs
   e. Sinuses/oral cavity
4. Culture/sensitivity
5. Wound/patient preparation
6. Palpation/wound exploration (if appropriate)
7. Further imaging/investigation

The requirement for further investigation should be considered in light of the findings acquired during the initial assessment. If injury to underlying structures is suspected, diagnostic imaging including radiography, ultrasonography, computed tomography or magnetic resonance imaging should be performed and localisation of the wound with a marker appropriate to the modality can be informative. Treating a wound without consideration for and treatment of the underlying structures will inevitably result in failure.

Surgical intervention can be of considerable diagnostic and therapeutic value, and when performed this should be done with all due consideration for the principles of surgery (Halsted’s principles). The benefits and risks of the procedure performed in the standing vs. the anaesthetised patient should be assessed. In some cases general anaesthesia is contra-indicated and patients that have undergone significant trauma may be systemically compromised and therefore represent high-risk anaesthetic candidates. However, general anaesthesia may allow more accurate and complete assessment and treatment. While this may appear a more expensive treatment option, decreased morbidity and duration of treatment can significantly reduce the total cost.
Intravenous catheterisation refers to the insertion of a needle or cannula into a vein for the administration of fluids, medications, and blood sampling. It is a common procedure in veterinary practice, especially for horses, due to their large and superficial veins. However, it carries risks of complications, including thrombophlebitis and sepsis.

**Intravenous catheter placement, care and complications**

**Sarah Ross**  
*School of Veterinary Sciences (Langford Veterinary Services), University of Bristol, Langford, North Somerset, BS40 5DU, UK*

Intravenous catheters have a myriad of uses in equine practice. These include administration of fluids, parenteral nutrition, anaesthetic agents, intravenous infusions and serial intravenous medications as well as collection of blood samples or blood for transfusion purposes.

Catheter placement is a routine procedure. However there are a range of recognised complications associated with intravenous catheterisation and as such careful consideration is required before we begin placement.

**Location**

The jugular veins are the obvious and often preferred choice for placement of intravenous catheters. The jugular vein is well suited to catheterisation owing to its superficial location, ease of accessibility and straight course. It also has a relatively long length which facilitates replacement of a catheter in the same vein, if required. In the event of a problem with a jugular vein, the lateral thoracic vein can be catheterised in order to preserve the contralateral jugular. In foals the cephalic vein may be the preferred vessel of choice as placement in this location may be associated with decreased movement of the catheter [1].

**Type of catheter**

The type of catheter selected will depend on the intended use and expected duration of use in that patient. Options include short stay vs. long stay options and ‘over-the-wire’ vs. ‘over-the-needle’ catheters. An intravenous catheter is essentially a foreign body and as such its presence alone can incite inflammation. However, some materials have a greater propensity for inducing inflammation and thrombosis formation than others. For example polyurethane is considered to have relatively low thrombogenicity whereas polytetrafluoroethylene is considered to have higher thrombogenicity [1,2].

**Preparation**

Aseptic preparation is imperative. A wide area around the intended site should be clipped and aseptically prepared using a surgical scrub solution, e.g. chlorhexidine.

**Aseptic technique during placement**

Sterile gloves should be worn and aseptic technique adhered to. The shaft of the catheter should not be touched with the gloved hand at any point.

**Catheter care**

Indwelling catheters should be inspected at least twice daily for evidence of heat, swelling or discharge. The position of the catheter should be checked for kinking or evidence of movement. If any abnormality is detected the catheter should be removed. If the catheter becomes detached and is carried in the blood stream until it lodges elsewhere, usually the heart or a distant site, then the problem is recognised immediately the jugular vein should be promptly occluded proximally to trap the offending fragment and allow attempted removal. Successful removal of catheter fragments via jugular venotomy has been previously described [7].

**Thrombophlebitis**

Thrombophlebitis refers to vein thrombosis with mural thickening and is considered the most common complication associated with intravenous catheters in horses [1,3,4]. Reported incidence of catheter associated thrombophlebitis in horses varies greatly. A 29% occurrence was reported in a relatively old study which looked at horses which were treated with i.v. fluids for 24 h or more [4]. A more recent study found lower rates of thrombophlebitis even in high risk cases, with 8.3% of horses recovering from colic surgery developing thrombophlebitis [5]. Confounding risk factors for thrombophlebitis include the presence of endotoxaemia and hypoproteinaemia which increase the odds of developing thrombophlebitis by 18 and 5 times, respectively [6].

Clinical signs of thrombophlebitis include heat, pain and a firm swelling of the vein with diffuse swelling of the surrounding tissues [6]. The vein may become ‘slow to raise’ and may lose patency. In cases of septic thromboembolism signs of systemic infection may manifest as pyrexia and/ or leucocytosis.

Diagnosis of thrombophlebitis can be based on clinical signs and/or ultrasonographic changes. Ultrasonography is very useful in terms of monitoring progression and response to treatment [3].

**Thromboembolism**

Thromboembolism can occur secondary to thrombosis of the vein [1]. A serious consequence of septic thrombophlebitis is haematogenous spread of the infectious process to distant sites.

**Blood loss and air embolism**

Blood loss secondary to an extension set becoming dislodged is possible. Placing a catheter ‘down the vein’ may ameliorate the risk of this, however aspiration of air and subsequent air embolism then becomes more likely.

**Catheter embolism**

Catheter embolism can occur when a fragment of the catheter becomes detached and is carried in the blood stream until it lodges elsewhere, usually the heart or a pulmonary artery. If the problem is recognised immediately the jugular vein should be promptly occluded proximally to trap the offending fragment and allow attempted removal. Successful removal of catheter fragments via jugular venotomy has been previously described [7].

**References**

Abdominal ultrasonography: principles and getting the best images

Rachael Conwell
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Indications for abdominal ultrasound include weight loss, acute or chronic/recurrent colic, pyrexia of unknown origin, diarrhoea, primary hepatic or renal disease and following palpation of an abnormality per rectum. Abdominal ultrasonography should always be assessed in context with other clinical findings, and repeated when necessary as abnormalities can both be missed or over-interpreted. Transrectal ultrasound should also be considered as a very useful additional imaging technique.

A quiet examination area where the lights can be dimmed is vital. Use of stocks is often down to personal preference; if used, the side bars should be moveable to allow comfortable scanning of both left and right lateral abdomen. Sedation should be used if required in fractious horses for the safety of both the ultrasonographer and the equipment.

Preparation of the patient is important to maximise image quality. Remove any dirt, then clip the hair if it is thick, followed by cleaning and rinsing of the skin with alcohol and application of ultrasound gel. In thin horses with fine haircoat, soaking with alcohol alone will save time and still provide a good image. Avoid rubbing the coat and disturbing the hair and use either a spray bottle or pour the alcohol directly onto the coat. Alcohol can be damaging to the ultrasound probe; it can be diluted or isopropyl alcohol may be a better alternative, but the probe should still be protected by use of gel and/or a suitable cover. Horses with coarse coats, thick skin and large amounts of subcutaneous fat will generate poorer quality images in spite of proper preparation.

A 3.5–6 MHz transducer will be needed to visualise the majority of the abdomen, with a displayed depth of 15–30 cm. The depth should be changed throughout the examination according to the region examined, with the area of interest in the mid-field. Higher frequency probes are useful for more superficial organs in thin or small horses and have better resolution, but less penetration for deeper structures.

Smaller footprint probes give a better image due to the smaller area of contact; linear probes, such as used for reproductive ultrasonography, may make good skin contact more difficult and lose part of the image at the edges. Curvilinear probes are preferred as they give optimal resolution and enhanced repeatability. The use of different probes is likely the reason for reported variability in normal intestinal wall thicknesses in different studies.

Adopt a systematic approach, for example start on the left hand side in the paralumbar fossa and image dorsal to ventral and move cranially, rib space by rib space. Then scan the ventral abdomen before moving to the right hand side and repeating as for the left side. When an abnormality is found, scan in at least two planes to determine whether this is a true finding or artefact; artefacts are usually only seen in one plane. Be consistent with the probe orientation, so that the dorsal aspect is consistently displayed on the same side of the screen.

Sufficient time should be allowed to perform a full, systemic abdominal scan. In acute colics, a much more focused approach allows rapid identification of abnormalities consistent with a surgical lesion.

Further reading
Radiography: reaching the parts other nurses can’t reach

Katherine King
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Radiography of certain parts of the horse’s anatomy can be troublesome due to their size and the practicalities of getting a large machine close enough to a large animal! The aim of this presentation is to concentrate on 4 parts that are difficult to reach: caudal head; shoulder; hip/pelvis and lumbar spine, and provide some handy hints and tips on how to produce diagnostic quality radiographs of these areas.

Some useful exposures, based on an average sized horse, are shown in Table 1.

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<thead>
<tr>
<th>Body part</th>
<th>kV</th>
<th>mAs</th>
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<td>Caudal DV head</td>
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<td>25</td>
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<td>Shoulder lateral</td>
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<td>Lumbar DSPs</td>
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<td>Lumbar vertebral bodies</td>
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<td>Lumbar articular facets</td>
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<td>Hip</td>
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<td>Tuber coxae</td>
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Orthopaedics

Chaired by Raphael Labens

Sponsored by HBLB

09.00–09.15

The use of electromyography including interference pattern analysis to determine muscle force of the deep digital flexor muscle in case of equine laminitis

L.C. Hardeman1,4, B.R. van der Meij1, W. Back1, J.H. van der Kolk1,5 and I.D. Wijnberg1

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Reasons for performing study: In cases of laminitis, an increased muscle force or contraction of the deep digital flexor muscle (DDFM) is suggested, but evidence-based research is lacking. Objectives: To test if the DDFM of laminitic equines shows an increased muscle force detectable by needle-EMG including Interference Pattern Analysis (IPA). Study design: Cross-sectional study. Methods: Three groups consisted of Group 0 (control): 6 Royal Dutch Sport horses, 3 Shetland ponies and one Welsh pony (healthy, sound adults, mean ± s.d. weight 411 ± 217 kg). Group 1: 3 Royal Dutch Sport horses, one Friesian, one Haflinger, one Icelandic horse, 2 Welsh ponies, one miniature Appaloosa and 6 Shetland ponies (adults, mean ± s.d. weight 310 ± 172 kg) suffering from acute or chronic laminitis. EMG measurements including firing frequency (F) and IPA parameters Turns/Second (T), Amplitude/Turn (M) and Ratio M/T (R) were performed. ANOVA was used to analyse data. P values of P<0.05 were considered significant. Results: Mean ± s.d. F of Group 0 and Group 1 was 53 ± 11 and 72 ± 21 Hz, mean ± s.d. T was 112 ± 57 and 106 ± 42, mean ± s.d. M was 284 ± 51 and 254 ± 38 µV and mean ± s.d. R was 0.39 ± 0.17 and 0.42 ± 0.16%, respectively. The firing frequency of Group 1 was significantly higher compared to Group 0 (P = 0.02), whereas other differences were not significant. Conclusions: In human medicine, an increased firing frequency is a characteristic of increased muscle force [1,2]. Thus, the increased firing frequency of the DDFM in case of laminitis suggests an elevated muscle force. As all parameters show a high variance, a repeated study including a larger test group is advised. Ethical animal research: Data collection from controls was approved by the Animal Welfare Committee of Utrecht University, approval number 2008.III.07.061 and 2013.III.01.012. Clinical cases were privately owned and written owner consent was obtained. Source of funding: None. Competing interests: None declared.


09.15–09.30

A retrospective study of sagittal plane slab fractures of the third carpal bone in racing Thoroughbred horses

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Reasons for performing study: Sagittal plane slab fractures of the third carpal bone are a recognised injury in the racehorse. One study [1] reported 32 horses with sagittal fractures, 69% raced again. Surgical management appeared beneficial, with all horses that underwent interfragmentary compression racing again. Objectives: To document the success rate following sagittal slab fracture of the third carpal bone in UK-based racehorses, and to compare conservative and surgical management. Study design: Retrospective study. Methods: Inclusion criteria were Thoroughbred racehorses with a simple sagittal slab fracture of the third carpal bone. Exclusion criteria were comminuted fractures, radial carpal bone fractures and short incomplete linear lucencies. Fractures were classified as complete, incomplete or uncertain. Time from injury to next race was recorded. Success rates were compared by Fisher’s exact test. Results: Forty horses were identified. Two were subjected to euthanasia and 3 have <6 months follow-up. Eleven were managed nonsurgically of which 4 (36%) were complete (5 uncertain) and 7 (64%) raced, 154–508 days following injury (median 242 days). Twenty-seven horses underwent surgery to place a single 3.5 mm (n = 26) or 4.5 mm (n = 1) lag screw under arthroscopic guidance, of which 18 (67%) were complete. Thirteen (48%) raced again 147–711 days following surgery (median 256 days) P = 0.48. Of 23 horses with complete fractures 13 (57%) raced again, compared with 5/15 (33%) horses with incomplete fractures P = 0.2. Of horses with complete fractures, 10/18 (55%) underwent surgery and raced again compared to 3/4 (75%) horses managed conservatively P = 0.62. Conclusions: The results confirm that the prognosis for athletic function is favourable but do not suggest that surgery is beneficial, or necessary for complete fractures. The numbers managed conservatively are small and it was not clear radiographically if the fracture was complete in 5/11 horses. Ethical animal research: Research ethics committee oversight not currently required by this conference: retrospective study of clinical records. Explicit owner informed consent for inclusion of animals in this study was not stated. Source of funding: None. Competing interests: None declared.

09.30–09.45

**Plant thorn synovitis caused by Prunus spinosa (blackthorn) penetration in 35 horses**

_N.M. Ashton and J. Doles_

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**Reasons for performing study:** Blackthorn (Prunus spinosa) is recognised as causing infections and tissue reactions. **Objectives:** To describe the presentation, diagnosis, treatment and outcome of blackthorn plant synovitis in the horse. **Study design:** Case series. **Methods:** All cases in this prospective study presented with acute onset synovitis within 24 h of thorn penetration, had a standardised clinical assessment, surgical treatment and aftercare. Surgical treatment was performed within 24 h of presentation under general anaesthesia, using a 2-stage procedure: Stage 1: perisynovial technique. Ultrasound guided placement of a 20 gauge 35 mm needle marker that is used as a guide for electrodissectional dissection on perisynovial thorn fragments. Stage 2: endoscopic technique. Using standard and novel portals to locate and remove thorn fragments and debris from synovial structures. **Results:** Thirty-five cases met the study inclusion criteria over a 24 month period. Mean lameness score on presentation was 4/5 (range 1–5). The most commonly affected structures were fetlock joints (11/35) and tendon sheaths (10/35). Mean synovial fluid total protein was 50.5 g/l (range 18-116), and TNCC was 158 x 10³ (range 21-412) on presentation and 12. x 10³ (range 1–46) at 48 h post operatively. All synovial fluid cultures were negative. All horses were sound (grade 0) at 5 days post operatively and all returned to full work. **Conclusions:** There are a limited number of case series of blackthorn injury in humans; however, the consensus is that surgical treatment is required for a successful outcome. The 2-stage surgical procedure described, achieved accurate identification and removal of thorn material in all cases. In contrast to previous studies on synovial sepsis, these cases had a positive outcome despite high pre- and post operative synovial fluid total protein and TNCC. These findings suggest that thorn synovitis cases have a different aetiology from synovitis originating from sepsis or contamination. **Ethical animal research:** The study was reviewed and approved by the Ethics Committee, School of Veterinary Medicine and Science, University of Nottingham. Owners gave informed consent for their horses’ inclusion in the study. **Source of funding:** None. **Competing interests:** None declared.

09.45–10.00

**The effect of three different shoeing conditions on tendon strain in the Thoroughbred forelimb**


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**Reasons for performing study:** Previous studies show the effect of toe or heel wedges on tendon strain but there is little understanding of the effect of other shoe types. **Objectives:** To quantify the effect of different shoeing conditions on the strain in the superficial digital flexor tendon (SDFT), deep digital flexor tendon (DDFT), distal check ligament (ALDDFT) and suspensory ligament (SL). **Study design:** Controlled experimental study. **Methods:** Twelve equine cadaver forelimbs were loaded onto a force plate mimicking stance phase. Markers were placed proximally and distally in each tendon structure and tracked using a motion capture system and strain was calculated. Tendon strain was determined for the following conditions: barefoot, glue on heart bar and aluminium racing plates with and without packing material. Data were analysed using a mixed effects model. **Results:** Significant variation in strain was observed between tendons. The DDFT had the lowest strain, then the ALDDFT, SDFT and SL. Glue on heart bars significantly increased SDFT and SL strain compared to barefoot for the same leg force. Aluminium racing plates without packing material increased ALDDFT and SDFT strain and with packing material increased ALDDFT and SL. **Conclusions:** Shoe selection should be based on minimising strain in the tendon with greatest injury risk. Aluminium racing plates with packing material may be most appropriate for the majority of racehorses as they do not significantly increase SDFT strain. **Ethical animal research:** Research ethics committee oversight not currently required. **Study design:** The study was performed on material obtained from an abattoir. **Source of funding:** The authors would like to thank the Horserace Betting Levy Board for their support of this project. **Competing interests:** None declared. **Acknowledgements:** We thank Peter Day, Carl Bettison, Chris Pardoe, Marianna Biggi and Emily Sparkes.

10.00–10.15

**Outcome and owner perception of conservative and surgical management of fracture of the ulna in 20 horses**

_S. Ladefoged, J. Wallin, T. Toth and P.H. Andersen_

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**Reasons for performing study:** While open reduction and internal fixation is the treatment of choice for most ulnar fractures conservative treatment is sometimes chosen due to financial constraints. Additional motives for the choice of treatment may be present, and the clients perception is therefore of interest. **Objectives:** To compare survival and outcome between horses treated for an ulnar fracture, either surgically or conservatively and to assess clients perception of treatment. **Study design:** Retrospective study. **Methods:** Medical records and radiographs of horses treated between January 2002 and December 2012, with a diagnosis of ulnar fracture were reviewed. Information regarding short- (within a 1-year) and long-term (>1 year) outcome and owner satisfaction with treatment was obtained via telephone questionnaires. Differences between groups were investigated using a chi-square or Fisher’s exact test. **Results:** Fracture types included 11 type 4, 7 type 5, one type 2, and one type 1b fracture. Eleven horses were treated surgically (Group 1). Nine horses were managed conservatively (Group 2). Group 1: 7/11 (64%) survived >1 year, 5/11 (45%) returned to previous athletic level. In Group 2: 6/9 (67%) survived >1 year, 4/9 (43%) returned to previous athletic level. No significant difference in outcome could be detected. There was no difference in the total treatment cost for horses that stayed at the hospital (P = 0.22). Owners in Group 1 expressed more satisfaction with the treatment than owners in Group 2. Several of the latter expressed welfare concerns regarding the prolonged
A preliminary study of the effect of manual chiropractic treatment on the splenius muscle in horses when measured by surface electromyography

**J. Langstone**, **J. Ellis** and **C. Culiffe**

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**Reasons for performing study:** A quantifiable measure of muscle activity related to the cervical spine may provide further understanding and evidence based support for chiropractic techniques. Surface electromyography (sEMG) is a noninvasive method of measuring muscle activity of the splenius muscle when the horse is at rest. **Objectives:** To determine if there is a relationship between objective measurable muscle parameters and misalignments and muscle tension in the equine cervical spine. **Study design:** Controlled paired randomised study. **Methods:** Privately owned horses (n = 14), of mixed sex, age and mean height 157.8 cm were selected and assigned a group by matching work, management regime, age, sex and breed. The treatment group (n = 7) underwent manual chiropractic treatment following palpation. The control group underwent palpation only. A Delsys 4 sensor system was used for data collection. Probes were positioned on the muscle halfway between CI/C2 joint and the crest on the left and right sides, between the tendon insertion and the motor point to maximise signals. sEMG readings were taken at immediately before (0) and after palpation (PP) and 30 min later (30). Data were tested for normality and variance by one-way ANOVA and paired t test. **Results:** Post treatment, there was a significant decrease (P<0.01) in sEMG activity for treatment group at 0 to 30 and PP to 30. There was a significant decrease (P<0.05) in sEMG for right side for treatment group at 0 to 30 and PP to 30. There were no such significant effects for the control group. The majority (83%) of horses had atlas rotation and tilt to the right. **Conclusions:** This preliminary study supports use of sEMG as a means of assessing muscle activity of equines and suggests a statistically significant reduction in splenius muscle activity is observed following manual chiropractic treatment although the benefit to the horse is unknown. **Ethical animal research:** The study protocol was reviewed by the College Research Ethics Committee before commencement of the study. Owners gave informed consent for their horses’ inclusion in the study. **Source of funding:** McTimoney College of Chiropractic assisted with the hiring of the equipment. **Competing interests:** None declared.

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10.15-10.30

**A comparison of a 4% modified fluid gelatin and a 6% hydroxyethyl starch on haemodilution, colloid osmotic pressure, haemostasis and renal parameters in healthy ponies**


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**Reasons for performing study:** Adverse effects on renal health and haemostasis have been documented in human patients administered hydroxyethyl starches (HES). Gelatins could provide useful substitutes for HES should similar adverse effects be identified in horses. **Objectives:** To compare the effects of a 4% modified fluid gelatin (MFG) with a 130/0.4 6% tetrasratch (TES) on haemodilution, colloid osmotic pressure (COP), haemostasis and renal parameters in healthy ponies. **Study design:** Randomised crossover. **Methods:** Three treatments (A = 10 ml/kg bwt TES, B = 10 ml/kg bwt MFG and C = 20 ml/kg bwt MFG) were administered to 6 healthy ponies with a one-week washout period. Packled cell volume (PCV), total serum protein (TSP), COP, platelet count, fibrinogen, prothrombin time (PT), activated partial thromboplastin time (aPTT) and thromboelastography (TEG) were measured at baseline and at multiple time points up to 24 h post infusion. Serum creatinine, urine specific gravity (USG), urine protein:creatinine (UPC), urine GGT:creatinine (UGC) and urine sediment examination (USE) were performed before and 24 h after each treatment, and one week after the final treatment. **Results:** All treatments caused significant haemodilution and increases in COP with treatment C having a significantly greater effect on PCV than other treatments. The platelet count decreased with all treatments and was significantly lower for treatment C compared with treatment B. No significant differences were observed in any TEG parameter within or between treatments. No significant differences in PT, aPTT or fibrinogen were observed between treatments. Serum creatinine, UGC and UPC did not change significantly pre- and post study. USG and USE remained within normal limits. **Conclusions:** 4% MFG could be considered as an alternative to 130/0.4 6% TES for volume expansion and oncotic support. Neither MFG nor TES were associated with clinically significant adverse effects on haemostasis or renal parameters. **Ethical animal research:** This research was approved by the University of Pretoria’s Animal Ethics Committee. The animals used in the study were part of a research herd belonging to The University of Pretoria. **Sources of funding:** The Department of Companion Animal Clinical Studies, Faculty of Veterinary Science, University of Pretoria, South Africa.
Yellow fat disease (steatitis): description of 20 cases with emphasis on typical ultrasonographic findings

G. van Loon, L. Lefèvre, C. Bauwens, K. Kleyn, B. Broux, D. De Clercq and P. Deprez

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Reasons for performing the study: Yellow fat disease or steatitis is characterised by a local or general inflammation of fat tissue and is occasionally found in horses. Diagnosis is challenging because of the wide range of nonspecific clinical signs. 

Objectives: To describe clinical signs, treatment, outcome and ultrasonographic findings in horses with steatitis. 

Study design: Retrospective study (January 2008 to January 2015). 

Methods: History, clinical signs, ultrasonographic findings, diagnosis, treatment and outcome were recorded. 

Results: Twenty cases (18 horses, 2 donkeys; 9 mares, 9 stallions; 2 geldings) were retrieved from 13,707 patient records. Mean age was 1.6 (± 0.8) years (range 1 month–3.5 years). All cases appeared between October and February except for one (August). History included dullness, recumbency, decreased appetite and weight loss. Fever, ventral oedema, stiff/painful gait and painful neck were found. Low haematocrit, low vitamin E and selenium and increased levels of creatinine kinase and particularly lactate dehydrogenase were almost consistent findings. On ultrasound, ventral oedema was found. Subperiosteal, perrineral, mesenteric, coronary and caudal mediastinal fat showed homogenously increased echogenicity. Especially the subperiosteal fat was surrounded by oedema or free fluid. Increased amounts of abdominal, thoracic and pericardial fluid were often found. Fat biopsies were taken in the neck or from the retroperitoneal fat in the ventral flank. In all horses where fat biopsy was taken (n = 13), steatitis was confirmed. Treatment consisted of selenium and vitamin E (intra-muscular injection followed by oral treatment) supplementation and anti-inflammatory treatment (dexamethasone or prednisolone parenteral or oral) for at least 1–4 weeks. Fourteen animals (70%) survived. Full recovery took about 2–6 months. 

Conclusions: Yellow fat disease may be underdiagnosed because of the nonspecific clinical signs. Ultrasound was extremely helpful for making a diagnosis. Recovery was rather slow but was achieved in 70% of the animals. 

Ethical animal research: Research ethics committee oversight not currently required by this conference: retrospective study of clinical records. 

Conflict of interests: None declared.

Antimicrobial resistance of aerobic respiratory isolates from young New Zealand horses

L.J. Toombs-Ruane1, C.B. Riley1, S.M. Rosanowski1, A.T. Kendall1,2 and J. Benschop1

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Reasons for performing study: Decreased efficacy of veterinary antimicrobials and increased prevalence of multi-drug resistance (MDR) is of concern, but little is known of antimicrobial resistance encompassing the New Zealand


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None declared.
(NZ) equine population. Recent concerns have arisen over the emergence of multi-resistant bacteria [1], especially on NZ stud farms where antibiotics are frequently used for respiratory disease without veterinary input [2]. Objectives: To describe bacterial culture and antimicrobial sensitivity results from respiratory samples submitted of young horses (4 weeks to 3 years old). Study design: Retrospective study of clinical pathology records. Methods: A database search for isolates and sensitivity of respiratory samples from young horses (April 2004–July 2014) was conducted. The results of in vitro sensitivity testing by Kirby-Bauer disk diffusion were tabulated for major bacterial species isolated. Multiple correspondence analysis was used to describe clustering of multi-drug resistant (MDR) and selected demographic variables. Results: 237/289 eligible respiratory samples had at least one aerobic bacterial isolate. Most of the 774 bacterial isolates were Gram-positive (68%). Streptococcus species were the most common genus isolated (40% of isolates). Sensitivity of Streptococcus spp. to penicillin, gentamicin and ceftiofur was >85%, but only 53% to trimethoprim-sulfamethoxazole. Gram-negative sensitivity to cefotirax, tetracycline, and trimethoprim-sulfamethoxazole was <75%. MDR was found for 16% of isolates and in 39% of horses. Conclusions: Penicillin is an appropriate first-line antimicrobial for use in most NZ young horses with suspected bacterial respiratory infection. However, based on findings of MDR, submission of samples for culture and monitoring of sensitivity should be used to inform antimicrobial selection. Ethical animal research: Not applicable. Sources of funding: Massey University McGeorge Fund; New Zealand Equine Research Foundation. Competing interests: None declared.


11.45–12.00
Development and evaluation of a molecular diagnostic method to rapidly detect Histoplasma capsulatum var. farciminosus (causing epizootic lymphangitis) from equine clinical samples

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Reasons for performing study: Histoplasma capsulatum var. farciminosus (HCF), causing epizootic lymphangitis (EZL), is endemic in parts of Africa including, Ethiopia, Senegal and Gambia. Despite its high prevalence, impact on animal welfare and socio-economic importance, there is little evidence upon which to build practical disease control strategies. The performance and availability of diagnostic tests currently used by clinicians is problematic. Methods such as pattern recognition of clinical signs and microscopy lack specificity and other reported methods are either not commercially available or not readily feasible in these settings (e.g. culture). This is a significant barrier to further understanding this disease within endemic countries. Objectives: To validate a nested PCR method to confirm the presence of HCF in equine clinical samples. Study design: Cross-sectional. Methods: Twenty-nine horses with suspected EZL were included from topographically varied regions of Ethiopia. Clinical data, lesion location drawn onto equine silhouettes, blood samples and aspirates of pus from cutaneous nodules were obtained before treatment provided by SPANA clinic. Blood and clinical data were collected from a further 20 horses with no cutaneous EZL lesions. Giemsa stained impression smears of pus were examined microscopically. Aliquots of heat-inactivated pus and blood were inoculated onto Whatman FTA cards and imported to the UK with Defra approved licensing. A nested PCR targeting the ITS region, was used to identify samples containing HCF and PCR products were sequenced. Results: HCF was confirmed in heat-inactivated FTA card pus samples from 24 horses, additionally, 23 blood samples were positive from EZL suspected cases. Bioinformatic analyses suggested that there was diversity within the ITS region among these HCF products. Conclusions: These PCR techniques allow the rapid diagnosis of HCF directly from equine clinical samples. The identification of HCF in blood raises questions about the pathogenesis of HCF in horses and warrants further investigation. Ethical animal research: Ethical approval for the project was awarded from the University of Liverpool and The College of Veterinary Medicine and Agriculture, Addis Ababa University. Sources of funding: SPANA UK (registered charity), the Institute of Infection and Global Health, University of Liverpool and an Sfam studentship. Competing interests: Dr Stringer was veterinary director at SPANA while this project was conducted and provided consultative and logistical input. Acknowledgements: We thank the SPANA Ethiopia team; participating cart-horse owners; the Ethio-Belgian project; Addis Ababa University; Gabrielle Lang and the PHe UK Mycology reference laboratory.

12.00–12.15
A neglected and emerging helminthosis: a case of equine fasciolosis

M.A. Getachew1, G. Innocent2, S.W.J. Reid3, F. Burden1 and S. Love4

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Reasons for performing study: Although fasciolosis is an important livestock disease worldwide, the public health importance of human fasciolosis has increased in recent years and it is recognised as an important re-emerging zoonotic disease. Its epidemiology and pathogenicity in donkeys, and the epidemiological role they may play have not been determined. Objectives: To investigate the epidemiology and pathogenicity of fasciolosis in donkeys. Study design: Cross-sectional coprological and retrospective post-mortem study. Methods: Faecal samples collected from 803 randomly selected working
donkeys from the central region of Ethiopia were analysed by a sedimentation-centrifugation-flotation technique. Further data on liver-flukes and associated pathologies were obtained by routine post mortem examinations of 112 donkeys, subjected to euthanasia on welfare grounds or died. Data were analysed using a generalised linear model and multivariate binary logistic regression in R statistical package with significance level of statistical tests set at P<0.05. Results: Infection prevalences of 44.4% and 41.9% were obtained in coprologically and post mortem examined donkeys, respectively, irrespective of their age. Both Fasciola hepatica and Fasciola gigantica were identified with the mean infection intensity of 30 flukes. Older donkeys (28 years) were found harbouring a significantly higher worm burden (P<0.0001). Gross and histopathologies of hyperplasia and thickening of the bile ducts, fibrosis of large portal areas and irregular bile duct proliferation and hypertrophy were noted. Conclusions: The high infection prevalence of fasciolosis and the associated hepatic pathologies in working donkeys shows not only the susceptibility of donkeys and the impact it has on their health, but also indicates the important role they can play in the epidemiology of both livestock and human fasciolosis. These further demonstrate the need for these animals to be considered in the overall epidemiological studies and for sound control strategies and prevention of fasciolosis. Ethical animal research: The research underwent ethical review and the use of animals was approved by the Directors of The Donkey Sanctuary. Consent of the owners was obtained to use their animals. Source of funding: The Donkey Sanctuary. Competing interests: None declared.

12.30–12.45
Detection of the toxin hypoglycin A in pastured horses and in the European sycamore maple tree (Acer pseudoplatanus) during two outbreaks of atypical myopathy in Sweden

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Reasons for performing study: Hypoglycin A (HG) appears to cause atypical myopathy (AM), but to our knowledge, detection of HG in affected and unaffected horses and concurrently in plants that they were exposed to has not previously been reported. Objectives: To investigate HG in samples from horses exposed to Acer pseudoplatanus (European sycamore maple) and in such plant material, at the time of clinical cases of AM in the herd. Study design: Cross-sectional study. Methods: Blood was collected from 2 horses with AM and 22 clinically healthy co-grazing horses in 2 Swedish farms within one week of onset of signs (May 2014) and one month later, after horses were moved to other pastures. Ten healthy control horses from unaffected farms were sampled once. Samaras, seedlings, flowers and leaves from Acer pseudoplatanus and from Acer platanoides L (Norway maple) were collected from affected pastures. Hypoglycin A was analysed using chemical derivatisation with dansyl chloride (DNS) and ultra high performance liquid chromatography-tandem mass spectrometry. Hypoglycin A was detected as derivatised compound HG-DNS [M+H]+ with selected reaction monitoring. Results: Hypoglycin A was detected in the horses affected with AM, and also in 20 out of 22 co-grazing horses. One month later, a surviving case horse and 9/20 co-grazing horses were still positive for HG. Controls from other farms were negative for HG. Hypoglycin A was detected in plant material from Acer pseudoplatanus, but not from Acer platanoides L. Conclusions: Horses grazing in pastures with HG-containing Acer pseudoplatanus were positive for HG in blood, and some showed severe signs of myopathy. Ethical animal research: This project was reviewed by the University of Nottingham Ethics and Welfare Committee. Explicit owner informed consent for inclusion of animals in this study was not stated. Source of funding: None. Competing interests: None declared.
12.45-13.00
Longitudinal observations of silent carriers of *Streptococcus equi* in a Swedish yard

**G. Gröndahl**, V. Båverud, H. Ljung, V. Melys, A. Aspän and M. Riihimäki

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**Reasons for performing study:** When managing strangles in horses, it is crucial to detect chronic infection with *Streptococcus equi* (SE), i.e. silent carriers. **Objectives:** Evaluate diagnostics for SE carriers over time in a farm. **Study design:** Longitudinal observational study. **Methods:** Sixty-three Icelandic horses isolated on an island were studied 4 to 26 months after remission of acute strangles, including repeated clinical examination and collection of blood, nasopharyngeal lavage (NPL), and guttural pouch lavage (GPL) samples. Twenty-two horses were treated with pencillin locally and systemically. Serology for *S. equi* was examined by iELISA [1]. Nasopharyngeal lavage and GPL samples were investigated for *S. equi* and *S. zooepidemicus* by real-time PCR [2]. **Results:** Thirty-three per cent were SE carriers after 15 months, despite repeated pencillin treatment. In 16/18 carriers, GPL samples were PCR-positive, but not NPL samples, whereas the opposite was true in 2 horses. Several carriers with persistent aerocystitis were not detected by 3 consecutive NPL samples. Five of 18 carriers were seronegative (27.8%) at 15 months. Following conservative treatment, 7 of these 18 carriers were still carriers at 20 months, 8 were negative, and 3 were lost for sampling. Only GPL samples were positive at this point, and only 1/7 carriers were seropositive. **Conclusions:** To detect chronic carriers of strangles, RT-PCR analysis from both GPL and NPL samples may be necessary. Serological screening at individual level often misses individual carriers in long-term cases. **Ethical animal research:** The testing was approved by the Swedish Ethical Committee on Animal Experiments and horse owners gave their informed consent for inclusion of animals in the study. **Source of funding:** The Swedish-Norwegian Foundation for Equine Research. **Competing interests:** None declared.


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### 13.45-14.00
Expression of insulin-related genes and release of non-essential fatty acids (NEFA) from neck crest fat compared to abdominal, mesenteric, and tail pad fat in horses

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**Reasons for performing study:** Regional adiposity on the neck crest has been linked to increased risk of developing equine metabolic syndrome (EMS). However, little is known about inherent metabolic differences between adipose tissues. **Objectives:** To investigate innate differences between adipose tissue from neck crest compared to abdominal, mesenteric, and tail head in horses with no diagnosis of EMS. **Study design:** Cross-sectional study. **Methods:** Seven horses with no history of metabolic disorders were subjected to euthanasia for nonclinical reasons. They were selected randomly (5 geldings/2 mares; age 6–26 years; 110–165 cm height; BCS 3–8) and included with owners’ consent. Adipose tissue was collected from neck crest, abdominal tissue, small intestine mesentery, and tail pad. mRNA expression of insulin-associated genes GLUT1, GLUT4, INSR and RBP4, and inflammation-associated genes SAA, TNFa, IL-1β, IL-6, MCP-1 and PAI-1 were investigated using RT-qPCR. Morphology and adipocyte size were investigated by histology. Release of non-essential fatty acids (NEFA) was investigated before/after adrenaline stimulation in 4 horses. **Results:** No significant differences were found in mRNA expression of metabolic and inflammation related genes between tissues. Adipose tissue from neck crest was more heterogeneous than abdominal fat (P = 0.001) and mesenteric fat (P = 0.01). Neck crest adipocytes were similar in size to abdominal adipocytes, and larger than adipocytes from tail head and mesentery. Basal levels of NEFA release were not different between tissues. Adrenaline stimulation caused a significant release of NEFA from visceral fat (abdominal P = 0.03; mesenteric P = 0.048). **Conclusions:** This preliminary study introduces new metabolic genetic markers and NEFA to the field of metabolic research. No innate differences were shown for neck crest fat except in history. Further studies in a case-control study design are needed to determine if neck crest fat is a risk factor for EMS. **Ethical animal research:** Horses were subjected to euthanasia according to Danish Law and Danish ethical regulatory guidelines. Samples were used for research purposes with owners’ consent. **Source of funding:** Hesteafgiftsfonden (Danish Horse Levy Board). **Competing interests:** None declared.
Thyroid hormone and thyrotropin concentrations and responses to thyrotropin releasing hormone in ageing horses

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Reasons for performing study: Thyroid hormones (THs) decrease with age in healthy dogs and cats, although they tend to remain within established reference ranges. Thyrotropin (TSH) is increased in elderly people, with or without mild alterations in THs. Objectives: To test the hypothesis that geriatric horses will have lower THs and/or higher TSH compared with younger horses. Study design: Cross-sectional study. Methods: Resting THs and TSH, and responses to thyrotropin releasing hormone (TRH) were compared between young and old horses. Data from 71 normal, healthy horses that had participated in prior research projects were examined, and found to contain 42 horses 3-10 years of age, 16 horses >15 years and 10 horses >20 years. All samples had been assayed in the same previously validated radioimmunoassays. Statistical analysis was performed with commercial software. Results: Although lower, THs were not significantly different between young and old horses when compared with the Mann-Whitney rank sum test. However, TSH concentration was significantly higher in horses aged >20 (median 52.52 ng/ml) or >15 years (4.44 ng/ml) compared to younger horses (0.33 ng/ml). TRH stimulation tests were performed in 19 of the younger horses, 7 of the horses >20, and 11 of the horses >15. Two-way repeated measures ANOVA on ranks revealed no significant differences in TH responses to TRH. The TSH response to TRH appeared to be slightly greater in the older horses, but did not quite reach significance (P = 0.06). Conclusion: Similar to reports in elderly humans, aged horses have higher serum TSH concentrations than younger horses. Ethical animal research: All horses in this study were part of a NCSU IACUC approved study. Owners gave informed consent for their horses’ inclusion in the study. Sources of funding: College of Veterinary Medicine North Carolina State University, USA Equestrian. Competing interests: None declared.

Basal insulin and insulin dysregulation in obese and non-obese Andalusian horses with and without cresty neck

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Reasons for performing study: Andalusian horses have been proposed as a breed predisposed to equine metabolic syndrome (EMS) phenotype [1] because they are prone to exhibiting regional, generalised adiposity and tendency to laminitis [2]. Insulin dysregulation represents the main pathophysiological cause for all the features of EMS, however there are no epidemiological studies in this breed. Objective: To assess insulin dysregulation through insulin proxies in Andalusian horses with different levels of obesity. Study design: Cross-sectional study. Methods: One hundred and sixty-four Andalusians (78 stallions and 86 mares, 2-15 years) were scored for overall (body condition score, BCS) and neck (cresty neck score, CNS) adiposity. Grain concentrate was withheld for 12 h before sampling. Blood samples were collected between 06.00-10.00 h for basal glucose, insulin concentrations, RISQI and MIRG proxies calculation. Conditions were defined as: obese horses (Ob), BCS≥7; cresty neck horses (CN), CNS≥2; hyperinsulinaemia, insulin ≥20 µU/ml; low insulin sensitivity, RISQI<0.32[µU/ml]0.5 and increased insulin secretory response, MIRG>5.6µmol/l/10.1mginsulin. Regarding BCS 2 groups were created: Ob and non-Ob. These groups were subdivided depending on CNS: with CN and without it (nonCN). Ob-nonCN group (n = 2) was excluded for the statistics due to the low number of horses. Results: Of the horses studied, 26.8% were Ob-CN, 42.1% were nonOb-CN and 31.1% were nonOb-nonCN. Ob horses presented higher insulin levels (P = 0.034) and lower RISQI values (P = 0.019) than all nonOb horses. When CN was considered, only RISQI was lower (P = 0.015) in Ob-CN group respect to nonOb-nonCN, however nonOb-CN group does not differ from the other 2 groups. Furthermore, the percentage of Ob-CN horses with hyperinsulinaemia (2.3%), abnormal RISQI (4.5%) and MIRG (9.1%) was very low. Conclusions: These results suggest that in Andalusians, increased adiposity was not clearly associated to insulin dysregulation and, similarly, to human beings, may coexist as a metabolically healthy but obese phenotype. Ethical animal research: Ethical University Committee approved all the procedures and owner informed consent was obtained. Source of funding: None. Competing interests: None declared.

Triamcinolone administration does not increase overall risk of developing laminitis

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Reasons for performing study: Triamcinolone is commonly used in equine practice for the treatment of orthopaedic conditions. A serious potential adverse effect of triamcinolone is laminitis. However, evidence for the risk of laminitis associated with triamcinolone use is limited. Objectives: To determine the risk of laminitis within 90 days of triamcinolone administration and compare with the risk of laminitis in a veterinary-attended horse population. Study design: Retrospective study of clinical records. Methods: Text mining and data extraction was performed using content analysis software (SimStat-WordStat v6) on a database of anonymous digital clinical records from a convenience sample of North American equine practices (n = 9). Medical records were retrieved using a dictionary of keywords for 3 groups of horses: 1) treated with triamcinolone, 2) age and practice matched control population (no triamcinolone) and 3) all laminitic horses. Records of horses within Groups 1 and 2 were mined for evidence of laminitis within a 90-day period of treatment or a random date respectively. Data manipulation and analysis was performed using R v3.0.0 (R Development Core Team). The prevalence of laminitis within all groups was determined and relative risk of developing laminitis determined by single logistic regression. Results: The clinical records of 225,777 horses were examined. Overall
prevalence of laminitis within the database was 1.1% (n = 2533). Triamcinolone was administered to 12.4% (n = 27,898) horses and 0.07% of treated horses (n = 20) developed laminitis. In the control population (n = 56,695), 0.2% of horses (n = 134) developed laminitis. The risk of developing laminitis was significantly lower in the triamcinolone treatment group than the control population (OR 0.3, 95%CI, 0.18-0.48 P<0.001).

Conclusions: Triamcinolone treatment does not increase the overall risk of a horse developing laminitis. However, further investigation of risk factors for laminitis in the 20 horses identified by this preliminary study is warranted to aid development of evidence-based treatment guidelines.

Ethical animal research: This study was approved by the Ethics and Welfare Committee of the School of Veterinary Medicine at the University of Glasgow. Owners gave informed consent for their horses’ inclusion in the study. Sources of funding: John Crawford Endowment Fund, University of Glasgow. Competing interests: None declared.

14.45-15.00
Informed hypothetico-deductive reasoning based on clinical signs for diagnosis of equine laminitis using decision tree analysis

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Reasons for performing study: Effective diagnosis of equine laminitis is necessary to allow prompt instigation of palliative and therapeutic treatments, yet there has been limited work regarding diagnostic accuracy. Objectives: To compare the prevalence of clinical signs in laminitis and non-laminitis lamenesses to evaluate the capabilities of discrimination for differential diagnosis. Study design: Analytical epidemiological study. Methods: Veterinary practitioners completed a pre-designed checklist of laminitis-associated clinical signs identified by literature review, for equine lameness of any origin. A case was defined as a horse/pony with veterinary-diagnosed, clinically apparent laminitis, attended by a participating practitioner. Associations between clinical signs and case/control status were tested by logistic regression with adjusted odds ratios and 95% confidence intervals, with veterinary practice as a fixed effect, and Wald P-value calculated. Multivariable analysis using graphical classification tree-based statistical models allowed comprehension of the prevalence in the data associated with particular clusters of clinical signs. Results: Data were collected for 588 laminitis cases and 201 non-laminitis lamenesses. The overall prevalence of specific clinical signs ranged from 2.7% for ‘sole prolapse’ to 85.0% for ‘lame at trot’. Differences in prevalence ranged from -14.1% for ‘lame at trot’ (more common in controls) to +71.9% for ‘short stilted gait at walk’ (more common in cases). Five clinical signs had a difference in prevalence of greater than +50%: ‘reluctance to walk’, ‘short, stilted gait at walk’, ‘difficulty turning’, ‘shifting weight’ and ‘increased digital pulse’. Bilateral forelimb lameness was the best discriminator (92% of animals with this clinical sign had laminitis). The additional presence of increased digital pulses improved this to 99%. Flat/convex sole, shifting weight and short stilted gait at walk were also useful discriminators. Conclusions: This is the first study to provide information aiding diagnostic hypothetico-deductive reasoning based on clinical signs to differentially diagnose laminitis from other lamenesses. Ethical animal research: Ethical approval obtained from Royal Veterinary College. Owners gave informed consent for their horses’ inclusion in the study. Sources of funding: Project funded by World Horse Welfare. C.E. Wylie currently funded by The Margaret Giffen Charitable Trust. Competing interests: None declared.

15.30-15.45
An anatomical study of the dorsal and ventral nasal conchal bullae in normal horses: gross morphology and histological features

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Reasons for performing study: The morphology of the dorsal (DCB) and ventral (VCB) nasal conchal bullae, including their cellulae, drainage and histology, are poorly described. The recent recognition that these bullae can become infected, causing chronic unilateral nasal discharge has stimulated interest in these structures. A more complete understanding of their anatomy would be useful in the diagnosis and treatment of their disorders. Objectives: To document the structure, drainage and histology of the equine DCB and VCB. Study design: Descriptive. Methods: Fourteen fresh cadaveric horse heads, were transected sagittally midline and dissected to expose the nasal conchal bullae. The dimensions of each bulla, the number of drainage apertures, the number of cellulae and orientation of the septae were recorded. Representative samples were collected for histopathology. Results: The mean lengths of the DCB and VCB were 77.7 mm (range 48-105 mm) and 57.1 mm (range 34–86 mm) respectively; equivalent to 13.8% and 10.2% of skull length, respectively. The mean widths of the DCB and VCB were 28.5 mm (range 21–35 mm) and 28.2 mm (range 13–41 mm) respectively; equivalent to 5.1% and 5% of skull length respectively. The median number of drainage apertures from the DCB and VCB were 2 and 1 respectively. The median number of cellulae within the DCB and VCB were 3 and 2 respectively. No communications were identified between the DCB and VCB and the adjacent...
of a completed postal questionnaire was taken as informed owner consent. Sources of funding: The original cohort study was funded by the Horse Trust and this study was funded by the Animal Health Trust. Competing interests: None declared.

16.00-16.15
Do BALF cytokine profiles vary depending on the sampled lung in horses with unilateral IAD-consistent cytology?

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Reasons for performing study: Little data on BALF cytokine profiles are available from racehorses with IAD; cytological diagnosis being most frequently made from one lung only per horse. Objectives: To compare cytokine mRNA expressions and protein concentrations in BALF from both lungs of horses with unilateral IAD-consistent cytology. Study design: Cross-sectional study. Methods: As part of a larger study, 250 ml saline was randomly instilled in one lung and 500 ml in the contralateral lung of 30 clinically healthy Standardbred racehorses. This procedure was repeated 72 h later, inversing the volume per lung. Cytological cut-off values for IAD diagnosis was neutrophil proportions >10% when instilling 250 ml. For these samples, mRNA expression and concentrations of IL-1β, IL-4, IL-8, IL-10, IL-17, TNF-α and IFN-γ were determined by RT-qPCR and ELISA. Results: Eleven horses had BALF with IAD- and CTL-consistent cytology from, respectively, each lung, and were enrolled in the study (22 samples). Data were not significantly influenced by the sampling day, and BALF total cell counts or cytokine concentrations were not significantly different among lungs. Relative mRNA expression of IL-1β (3.887 ± 3.082; P = 0.01) and IL-10 (3.225 ± 1.710; P = 0.005) were significantly higher in BALF of IAD- compared to CTL consistent lungs (respectively 1.408 ± 1.118 and 1.488 ± 1.393); and also correlated to neutrophil proportions (respectively r = 0.54; P = 0.01 and r = 0.65; P = 0.001). Conclusions: Differences in cytokine mRNA expression were associated with IAD- or CTL consistent BALF cytology in the same racehorses in training. These findings suggest that specific local immune reactions or regulation within the lower airways should be considered in IAD-like clinical animal research. The study was approved by the Regional Animal Ethic Committee, and informed consent was provided by all horse owners. Sources of funding: LABÉO, CISCO-Oniris and AVEF (French Association of Equine Practitioners). Competing interests: None declared.

16.15-16.30
Comparison of nanoparticulate CpG immunotherapy with and without allergens in RAO-affected horses

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1Centre for Clinical Veterinary Medicine, Equine Clinic, 2Small Animal Medicine Clinic, 1Department of Pharmacy, Université, ONIRIS, USP5 5304, Atlantpôle - La Chantrerie, BP40706, Nantes, F-44307, France; 3.887 ± 3.082; P = 0.01) and IL-10 (3.225 ± 1.710; P = 0.005) were significantly higher in BALF of IAD- compared to CTL consistent lungs (respectively 1.408 ± 1.118 and 1.488 ± 1.393); and also correlated to neutrophil proportions (respectively r = 0.54; P = 0.01 and r = 0.65; P = 0.001). Conclusions: Differences in cytokine mRNA expression were associated with IAD- or CTL consistent BALF cytology in the same racehorses in training. These findings suggest that specific local immune reactions or regulation within the lower airways should be considered in IAD-like clinical animal research. The study was approved by the Regional Animal Ethic Committee, and informed consent was provided by all horse owners. Sources of funding: LABÉO, CISCO-Oniris and AVEF (French Association of Equine Practitioners). Competing interests: None declared.

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Objectives: The aim of this field study was to compare the effects of a nebulised nanoparticulate Cpg immunotherapy (CpG-GNP) with and without specific allergens. Study design: Longitudinal clinical study comparing 2 therapeutic options. Methods: Twenty RAO-affected horses were divided into 2 treatment groups (CpG alone and CpG with allergens). Two specific allergens were selected for each horse according to anamnesis and a functional in vitro test. Treatments were given by nebulisation 7 times and the horses were examined 3 times: baseline (I), after the treatment course (II), and after 6 weeks later (III). Results: There were no significant differences in the results compared with CpG-GNP treatment alone. Conclusions: There were no significant differences between treatment groups. CpG-GNP immunotherapy alone produced a potent and persistent effect on allergic and inflammatory parameters and may have potential as for treatment of equine and human allergic inflammatory airway diseases. Ethical animal research: The study was approved by the regional legal authority for animal experiments of the Government of Bavaria, Germany (No. 55.2-1-54-2531-31-10). None declared.

16.45–17.00
Causes of pleural effusion in horses in the UK
I. Johns and T. McParland. Presented by T. Mair
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Objectives: To study PV anatomy and establish a standard approach for echocardiographic identification of the pulmonary veins in adult horses. Left oblique and short axis views were superior although right long-axis views also showed ostiums II and III. These data allow reference casts. Secondly, left and right parasternal ultrasound images and post mortem casts.

Results: Seventy horses were identified, of which 28 (40%) were neoplastic and 42 were infectious. Horses with infectious effusions were significantly younger (median 7 vs. 13 years; P = 0.002) and had significantly smaller volumes of pleural fluid drained at admission (9.8 vs. 32.3 l; P<0.001). Horses with infectious PE had a significantly higher rectal temperature (38.6 vs. 38.2°C; P = 0.03), fibrinogen, and total protein concentration (7.8 vs. 5.7 g/l; P = 0.02) and serum amyloid A concentration (223 vs. 104 mg/l; P = 0.02). Pleural fluid characteristics identified a significantly greater cell count and TP concentration in horses with infectious PE (47 x 10³ cells/l).
Post exercise cardiac troponin I release and clearance in normal Standardbred racehorses

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Reasons for performing study: There are currently no studies detailing cardiac troponin I (cTnI) release and clearance in normal horses post exercise using an analytically validated assay. These data are essential for selecting appropriate sampling times in equine athletes with suspected myocardial damage. Objective: To plot the magnitude and time course of cTnI release and clearance, using a validated cTnI assay, after maximal effort. Study design: Descriptive longitudinal study. Methods: Five clinically normal Standardbred racehorses in full race training were included in the study. Physical examinations were performed on subjects and blood samples were taken via jugular venipuncture pre-exercise. Horses were exercised in harness at race intensity in groups on a training track. A second blood sample was taken immediately post exercise and an intravenous catheter was then placed in a jugular vein. Hourly blood samples were taken for 24 h. All samples were collected in red top serum Vacutainer® tubes and allowed to clot for 30 min before being centrifuged and serum harvested. Serum samples were stored at -80°C until analysis. All samples were analysed using the Abbott ARCHITECT STAT High Sensitivity cTnI assay. Results: Mean resting cTnI level was 1.33 ± 0.6 ng/l (range, 0.82–2.33 ng/l). All horses exhibited an increase in cTnI level after exercise with peak elevation occurring 2–6 h post exercise (mean, 4.6 ± 1.7 ng/l). Mean peak increase in cTnI level was 11.96 ± 9.41 ng/l (range, 1.72–23.76 ng/l). All horses returned to baseline levels within 24 h. Conclusions: All horses experienced an increase in cTnI post exercise, with the peak occurring 2–6 h post exercise. Further studies are needed to determine the significance of these increases. Ethical animal research: The study protocol was approved by the University’s Animal Care Committee. Explicit informed consent was obtained in writing for all client-owned animals. Source of funding: Equine Guelph. Competing interests: Dr Kavsak has received grants/honoraria/consultant/advisor fees from Abbott Laboratories, Abbott Point of Care, Beckman Coulter, Ortho Clinical Diagnostics, Randox Laboratories, Roche Diagnostics, and the Canadian Agency for Drugs and Technologies in Health. He is listed as an inventor on patents filed by McMaster University related to laboratory testing in acute cardiac care. No funding was received from the manufacturer of the assay evaluated in this study.

Retrospective observational study on the outcome of medical treatment of atrial fibrillation

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Reasons for performing study: Atrial fibrillation is a common equine arrhythmia. Quinidine alone, or with digoxin are common treatments. Studies on outcome in Warbbled populations in which duration of the AF is often unknown are limited. Objectives: To identify the factors that are associated with the success of full treatment cardioversion with oral medication, and establish whether there are differences in these factors between institutions.

Study design: Retrospective case series using patient records of Equine University Clinic of Utrecht University and Rossdales Equine Hospital, Newmarket. Methods: Forty-nine horses treated with quinidine were identified (29 Warmbloods, 20 Thoroughbreds, 1 Anglo-Arabian). Details of signalment, history, duration physical examination and echocardiography including left atrial size and presence of mitral regurgitation were retrieved. Clinical details including mean weight, age and left atrial size were compared between clinics using independent samples t test. Association between variables and cardioversion were evaluated in a backwards logistic regression using Akaike’s information criterium (AIC) and odds ratios were calculated. Factors were sex, clinic, breed, mitral regurgitation, duration and poor performance. Covariates were age, weight and the size of the left atrium. Significance was set at 0.05.

Results: Fifty-one horses (mean age 8.8 s.d. 4.5 years) were treated with quinidine sulfate, 18 also received digoxin. Eighty per cent converted to sinus rhythm. In 8 horses the known duration was less than 3 months. The only factor associated with successful treatment was the use of digoxin in combination with quinidine sulfate (odds ratio 12.4; 95% CI 2.61 and 91.85 according to AIC analysis). Conclusions: In this retrospective case series, there is much potential for bias in the data; however, the use of digoxin in addition to quinidine was associated with improved conversion rates regardless of breed even though AF duration was unknown in most horses. Ethical animal research: Research ethics committee oversight not currently required by this conference: retrospective study of clinical records. Explicit owner informed consent for inclusion of animals in this study was not stated. Source of funding: None. Competing interests: None declared.