and provide insights into the effects of on-farm practices.

One of the greatest sustainability issues that the cattle industry needs to overcome is the gap in knowledge and understanding between the producer and the consumer, which, when hitherto-underknown practices are exposed, may lead to accusations that farmers lack transparency or are cruel to animals. This is challenging in an era where television, internet and social media have overtaken traditional print media and literature as information sources and arguments against livestock production that appeal to aesthetic or ethical values are sometimes more successful than science-led information. Rather than trying to combat anthropomorphic or ethical claims with scientific facts, we need to combine the two, acknowledging that we share consumer desires for affordable healthy food, excellent animal health and welfare and reduced environmental impacts, and demonstrating a clear commitment to systems and management practices that promote these.

Ultimately, consumer trust is key to maintaining the social acceptability of cattle production. A sustainable future for cattle production will be independent of either economic viability or environmental responsibility if the market ceases to exist for milk and meat. However, if we improve livestock productivity, technology adoption and data recording in conjunction with improved consumer communication, we should be able to balance the three pillars of sustainability and ensure that milk and meat are still on the menu in years to come.

K74

Livestock and climate change – Facts and fiction

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Animal agriculture is often shouldered with a large part of the blame when it comes to climate change, and that's in part to the fact that we haven't been looking at all greenhouse gases correctly. While methane – the main greenhouse gas associated with animal agriculture – is a potent climate pollutant that we can and need to reduce, it warms our atmosphere differently than other gases because of its short lifespan. Methane persists in our atmosphere for about a dozen years before it's broken down via oxidation, and it's that atmospheric removal that is often neglected when trying to characterize methane's warming impact. Furthermore, if we can reduce methane emissions to the point where more is being broken down in the atmosphere than is being emitted, we'll see animal agriculture go from being blamed for climate change to being recognized as a major climate solution. By rethinking methane, we can see that animal agriculture's path to climate neutrality is within reach as scalable solutions offer the global community tools to fight global climate change.

Surgery

K76

Cesarean section in cattle

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Introduction: Dystocia in dairy and beef cattle are fairly common (1.1-6.8% of all calvings). Vaginal manipulation can resolve the dystocia. However, in cases of fetal disproportion, cervical inertia, malformation or complicated malposition, a c-section will be necessary.

Preoperative treatments: Preoperative antibiotics, such as procaine penicillin, should be given. It is also appropriate to give a NSAID, such as meloxicam. The surgery site is clipped and prepared appropriately for surgery (washed and scrubbed). Most c-sections are done with the cow standing and restrained in a contention chute. Sedation is rarely needed.

For a standing procedure, the flank is anesthetized by paravertebral block (proximal or distal), inverted L or line block. The technique chosen is often based on surgeon experience.

Surgical approaches: Typically, the left paralumbar fossa is used to access the uterus. From this approach, the rumen acts as a barrier to keep the jejunum in the abdomen. Exteriorization is crucial with a dead calf. However, with a live calf that had minimal obstetrical manipulation, the uterus can be opened within the abdomen.

Ventral approaches are possible in cattle. They are usually performed on dead or emphysemateous calves. The ventral-midline and the right paramammary have been described in beef cattle. Those are more difficult to execute on dairy cattle because of the size of the udder and the massive vascular network. The para-mammary/inguinal approach can be used in dairy cattle. The ventral approach provides a more direct access to the uterus.

Surgical techniques: Hysterotomy is performed on the greater curvature. The calf is extracted gently to avoid tearing the uterus. With the uterus still exteriorized, the uterus is checked for another calf. The placenta, if detached, is removed. If it is still attached, scissors are used to remove the part that comes out of the hysterotomy. A double inverting pattern is the technique of choice for closure of the uterus. The patterns that can be used are continuous Utrech, Cushing or lembert. On the second layer, it is important to burry the knots to avoid adhesions. Absorbable suture material of USP 1 is appropriate. Some advocate the use of monofilament instead of multifilament to decrease the drag effect. If the latter is used, it is important to push the tissue over the suture rather than pull the suture through the tissue to avoid the dragging effect and tearing of the uterus.

Before being returned in the abdomen, the uterus is cleaned of blood clots and debris. If the surgery was contaminated and if possible, the abdomen should be thoroughly lavaged with sterile isotonic solution. Ideally, the lavage solution is evacuated, by massage or by suction prior to closing the abdomen.

Postoperative treatments

Antibiotics should be continued and readjusted according to the surgical findings (live vs dead calf, clean contaminated vs contaminated surgery) and any co-morbidities occurring (mastitis, metritis, etc). NSAID should be given as needed and according to the general status of the cow.

The postoperative period following a c-section performed to extract an emphysematous fetus is challenging. Intravenous fluids, broad spectrum antibiotics and oral transfaunation are often necessary for the first postoperative days.

Complications and Prognosis: The status of the calf has an impact on the severity of the postoperative complications. The most severe complication would be peritonitis. Retained fetal membrane is another complication. It needs to be treated more aggressively because the hysterotomy site can be an opening and cause secondary peritonitis. According to Lyons et al, the presence of retained membrane has a negative impact on the survival of cows 14 days after the procedure.

According to Lyons et al, exteriorizing the uterus and removing the abdominal blood clots during surgery has a positive impact on the survival of the cow. Also, c-section done because of feto-pelvic disproportion of a female calf has a positive impact on cow survival.

Tenhagen et al, showed that cows undergoing a c-section produce less milk at the beginning of lactation and are more likely to be open at 200 DIM. Therefore, they are more likely to be culled when compared to a control group.

K77

Surgical management of common intestinal conditions in adult cattle

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The objective of this presentation is to present some basic intestinal conditions that can be handled in field situation with emphasis on duodenum and jejunum.

Surgical approach: The most common surgical conditions reported in the literature are: intussusception, volvulus of the jejunum, incarceration and jejunal hemorrhage syndrome. Other less frequent conditions are: gut tie in steers, duodenal obstruction, trichobezoar, ileal impaction and sigmoid flexure volvulus of the duodenum. Since the last few years, we have more sigmoid flexure volvulus than any other intestinal surgical condition combined. Intestinal surgeries are performed usually through a right flank incision while the animal is standing. Preoperative analgesia is provided to the patient before invading the abdomen. Mild sedation might be necessary. Broad spectrum antibiotics must be given before the surgery. The flank is anesthetized by linear infiltration of lidocaine or with a paravertebral block.

In cattle, the mesentery is short and fatty rendering vessels ligation difficult. It is recommended to infiltrate the mesentery with lidocaine before resection to alleviate the pain from pulling on the mesentery. Only the affected portion of the intestine is exteriorized. End-to-end anastomosis is more commonly done than side-to-side. Doyen forceps, silicone or rubber tubing, and umbilical tape have been used to keep the resected section tight while suturing. The anastomosis is sutured with one layer of full thickness simple interrupted sutures with 2-0 absorbable suture on a swaged on needle. Simple continuous suture can be used but should be interrupted at one point to avoid a purse string effect (2X 180º). The mesentery should always be sutured to avoid incarceration. **Specific intestinal diseases.**

Intussusception is reported to be more common in young cattle and Brown Swiss. The most common site of intussusceptions is jejunum followed by colocolic. Effective reduction of the intussusception in surgery is rarely feasible therefore, surgical resection is indicated. The prognosis is fair.

Intestinal volvulus is rapidly fatal if not treated. Volvulus can involve either the ileal flange of the jejunum or the root of the mesentery. Surgery is an emergency. Exteriorization of a portion of the jejunum is necessary to reduce the volvulus. Resection of the jejunum will be performed if the ileal flange underwent irreversible vascular damage. The prognosis is 86% if the ileal flange is involved and 44% with a volvulus of the root of the mesentery.

Jejunal Hemorrhage Syndrome has a high mortality rate (60-100%). Although medical assistance is necessary in all animals, surgery is indicated only if there are signs of obstructions: scant feces, distended jejunum with or without intraluminal mass at rectal palpation and transabdominal ultrasound findings. Otherwise the animal is treated medically with 2-4 liters of mineral oil orally, IV fluids or blood transfusion and systemic antibiotics (β-lactam). The affected segment of jejunum is easily identified at surgery. There are 3 surgical options: aborad massage of the clot, enterotomy and resection anastomosis. Decision is based on the length of the clot and the integrity of the jejunal wall. Prompt laparotomy and manual massage had a higher survival rates in one study. Medium and long term survival rate was higher in cattle referred 24 to 48 hours after onset of signs. The recurrence rate although was high.

Duodenal obstruction should be suspected if there is a severe hypochloremic metabolic alkalosis with a small 'ping' behind the last right rib and absence of intestinal distension at the rectal palpation. If the cause cannot be determined, a temporary diagnosis of ileus is given and large volume of intravenous fluids is administered for 12 to 24 hours. Enterotomy can be performed on the cranial and descending duodenum to remove a foreign body or trichobezoar. However, any obstruction involving the sigmoid flexure of the duodenum is difficult because it cannot be exteriorized.

The volvulus of the sigmoid flexure of the duodenum is a surgical condition and diagnosis is confirmed during the laparotomy. The sigmoid flexure is severely distended with gas and a volvulus is palpated at its root close to the neck of the gall bladder on the visceral part of the liver. The volvulus is reduced and cranial duodenal content is milked through the flexure to ensure that it's functional. The prognosis is good if the sigmoid flexure is not necrotic.

K78

Distal Limb Fracture and Pin Casting

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Limb fractures are frequent in cattle. They often involve the metacarpus and the metatarsus, but they can occur in all long bones of cattle.

A pin cast is a modified type II external fixator. The commonly used sidebars are replaced by casting material made of fiberglass. A pin cast can be used on fractures involving the metacarpus and metatarsus and the distal radius and tibia.

Surgical Preparation: The procedure is performed with the animal under general anesthesia or under sedation with regional anesthesia (brachial plexus bloc, epidural, or IV under tourniquet). The position varies according to surgeon preference and the equipment available. The surgery site is clipped, cleaned and prepared for surgery. Preoperative antibiotics and an NSAID is given prior to the surgery.

Pin Selection and Surgical Planning: Smooth and positive profile centrally threaded Steinmann pins are available from 2 mm to 6.4 mm. The threaded pins have a better holding power. However, they can be difficult to insert in older animal with thick cortices. The size of the pins should not exceed 20% of the diameter of the bone. A minimum of 2 pins are needed proximal to the fracture. They are inserted in the proximal or distal metaphysis and diaphysis. The middle of the bone needs to be avoided. The distance between the pins needs to be at least 6 times the size of the pins. To increase the distance between the pins in small fragment, the pins can be placed in a divergent plane.

Insertion Technique: A stab incision of the skin down to the bone is realized. The appropriate drill bit is used to create the pin hole. In older animals with thick cortices, the drilling needs to be done in steps to avoid overheating the bone. The drill bit is flushed with cool saline during drilling. If a threaded pin is used, the thread will be created with the appropriate tap. When the drill bit reaches the far cortex, it is found under the skin and another stab incision is created. When the pins are all in place, they are cut with a bolt cutter, leaving approximatly 3 cm out of the skin. A light bandage is placed over the pins. A bandage is then applied as is done for a standard cast application (stockinette, felt over bony prominences, etc.). Finally, the casting material is applied while traction and support are provided to the fracture. Most of the cast material is pushed through or wrapped around the pins to create a solid construct. For the last roll of casting material, the material is placed over the sharp edges of the pins to cover them completely. The hoof has to be included. It is important that the cast end is not too close to the last pin, to avoid creating a leaver that can stress the bone and cause a catastrophic fracture.

Postoperative Care and Follow-up: Systemic antibiotics and NSAIDs are used in the early postoperative period. The animal is confined to a stall. In calves, the cast is changed after 3 to 4 weeks. The pins are removed by rotating them out. The holes are cleaned and flushed. A second cast is then applied. In older animals, the first cast and pins are kept in place for 4 to 6 weeks if the animal is comfortable.

Complications and Prognosis: Pins and bone fractures at the pin/bone interface is a catastrophic complication. Pin loosening and ring sequestrum (osteitis) at the insertion site is a frequent complication that is secondary to overheating of the bone during drilling. It may cause discomfort to the animal. However, it usually resolves with removal of the pins. Delayed healing can be seen when pins are kept for a prolonged period of time. Other complications are associated with coaptation of the limb.

In a retrospective study by Lozier et al, looking specifically at fractures fixed with a pin cast in ruminant (cattle, goat and sheep), 79% of the cases survived to the removal of the coaptation. At long-term follow up, 85% of the cases were performing according to the owners' expectation despite the fact that 45% of the animal had some degree of lameness.

K79

Clinical management of septic arthritis

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Septic arthritis can be caused by a direct trauma to the articulation (primary), an adjacent infection to the articulation (secondary), a systemic infection (tertiary). Direct trauma is a common cause of septic arthritis in adult cattle. Calves with infected umbilical infection or adult with endocarditis are at risk for polyarthritis from a remote site. Septic arthritis in cattle is of bacterial origin. Bacteria isolated from the articulations will depend of the cause of infection. The most common in adult are: *Trueperella pyogenes, Escherichia coli*, and other environmental bacteria. In calves, a recent study found that *Streptococcu*s spp followed by *Mycoplasma bovis* were the most common bacteria isolated in septic joints.

Diagnosis: Adult cattle affected of septic arthritis are severely lame. During the physical examination, emphasis should be on investigating the origin of the septic arthritis with a very special focus on the umbilicus in calves. The most frequent joint involved are the carpus, tarsus, stifle and fetlock. Arthrocentesis can be easily done. Macroscopic examination of the fluid is often diagnostic (increased turbidity, decrease viscosity, fibrin). Bacterial isolation and identification are possible in only 50 % of the samples submitted. Radiographic examination helps the clinician to specify his diagnosis, and to establish a prognosis. Soft tissues are better evaluated with ultrasound examination. In our clinics, we've been using ultrasound to determine the presence and location of fibrin in the joint helping the clinician in his choice of treatment.

Treatment: Basic principles have to be followed:1- control the infection, 2-drain abnormal joint fluid 3-control inflammation and 4-restore joint function. In any cases, primary cause should be treated; calves with omphalophlebitis have to go under surgery rapidly before other joint infections occur. The choice of the appropriate antibiotics is based on the microoganism suspected, route of administration, cost of the treatment and withdrawal in meat and milk. *Trueperella pyogenes* being

the most common microorganism isolated in cattle, penicillin procainic is often the first choice antibiotic. In the presence of a severely contaminated wound, antibiotics against gram negative should be considered. In calves with septic joints, the antibiotic chosen should have an effect on *Mycoplasma* spp if no organism is isolated and the umbilicus is unlikely to be the cause specially if there is a history of *Mycoplama* spp on the farm or clinical signs associated to it (otitis, pneumonia, arthritis, mastitis). The duration of the treatment should be 2 to 3 weeks after the beginning of clinical improvement. Other route has been described: intra-articular injection, intra-venous under tourniquet and antibiotics incorporated in a slow release medium. Removal of infected tissue, debris and inflammatory mediators in the joint is essential for normal return to previous function. The goals of joint lavage are to remove debris and dilute the abnormal constituent in the joint. Joint lavage is performed in different way: tidal, through and through and arthroscopy. The size of the needle used are 16 G to 14G in calves and 14G to 5mm canula in adult. Arthrotomy is performed if the medical treatment failed or the joint is filled up with fibrin or pus and through and through lavage is impossible. Sites of arthrotomy are the same as the arthrocentesis. The incision should be long enough to allow adequate drainage and introduction of a forceps to remove fibrin. More than one incision per joint is necessary to access the entire cavity and improve the debridement. The incisions are covered with a bandage or stents and additional lavage are performed if necessary. Arthrodesis is the final solution when no treatments were efficient or because of the chronicity of the disease, joint function will never be restored. Articulations of the distal limb are easily arthrodesed (fetlock, proximal and distal interphalangeal joints). Severe carpal infection has also been treated with arthrodesis.

Prognosis: In cattle, prognosis is generally good for a return to previous function and productivity. It will depends of the time of presentation, radiographic evaluation (bone lysis and proliferation), and degree of extracapsular ankylosis. If more than 2 joints are infected, the prognosis is poor. Animal with chronic septic arthritis with bony lesions do not have a good prognosis for complete recovery and becoming a productive animal.

Biotechnology

K80

Simplified superstimulation programs for in vivo and in vitro embryo production in cattle

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Knowledge of follicular wave dynamics obtained using real-time ultrasonography and the development of the means by which follicular wave dynamics can be controlled have provided practical approaches for the *in vivo* and *in vitro* production and transfer of embryos in cattle. Two very important factors influencing variability in superstimulatory response are the intrinsic number of antral follicles in donors, and the stage of follicular development at the time of initiating FSH treatments. Response can be predicted by antral follicle counts done with ultrasonography, or the measurement of circulating concentrations of anti-Müllerian hormone (AMH). High antral follicle counts have been associated with more ovulations and a greater number of transferable embryos following superstimulation with FSH than low antral follicle counts. Furthermore, the elective control of follicular wave emergence and ovulation has had great impact on the application of on-farm embryo transfer, especially when large groups of donors need to be superstimulated at the same time. Although, estradiol and progestins have been used for many years, practitioners in countries where estradiol cannot be used have turned to alternative treatments, such as follicle ablation or the induction of ovulation by the administration of GnRH for the synchronization of follicle wave emergence. Initially, attempts to synchronize follicular wave emergence for superstimulation with GnRH were unsuccessful because of failure to induce ovulation consistently when administered at random stages of the estrous cycle, but subsequent field data were more promising. In these cases, GnRH was administered 1.5 to 3.0 days after the insertion of an intravaginal progestin device which may have increased the probability of an LH-responsive follicle at the time of treatment with GnRH. Indeed, we have reported on the strategic use of PGF2α, a progestin device and GnRH to induce ovulation prior to initiating FSH treatments. Basically, a persistent follicle was induced by treatment with PGF2α at the time of progestin device insertion; following administration of GnRH 7 days later, ovulation occurred in more than 95% of animals. Superstimulation initiated 36 hours after GnRH (with the P4-device remaining in place) resulted in a superovulatory response that did not differ from controls superstimulated between Days 8 and 12 of the estrous cycle. More recently, a study performed with Angus donors reported no difference in superovulatory response whether GnRH was administered 2 or 7 days after insertion of a P4-device with FSH treatments initiated 2 days later.

In vitro embryo production (IVP) also benefits from the synchronization of follicle wave emergence prior to oocyte recovery. As *Bos indicus* cattle have high antral follicle populations, large numbers of oocytes can be obtained by ovum pick-up (OPU) without superstimulation. However, synchronization of follicular wave emergence and superstimulation is necessary