TOOLS FOR A PROMPT COWSIDE DIAGNOSIS: 
WHAT CAN BE IMPLEMENTED BY THE BOVINE PRACTITIONER?

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1. INTRODUCTION

On the field, bovine practitioners must often take decisions promptly, not only about individual sick animals but also more and more on a herd basis. Fortunately, they can rely on a subtle clinical experience to fix the prognosis and diagnosis before possibly treating diseased animals. They can also use different clinical scoring systems to evaluate feeding efficiency, locomotion and reproduction performances at herd level (Zaaijer & Noordhuizen, 2003). For instance, body condition, rumen fill and faeces quality scores are now become unavoidable management instruments to evaluate feeding efficiency.

However, when a doubt remains, it is valuable to be supported by tools usable in the field. Ideally, in food animal practice, test procedures should provide rapid and reliable results, require minimal and robust instrumentation and be inexpensive.

Such essential tools available for the practitioners will be reviewed in this paper, emphasizing every time on the principal indications for use in cattle practice.

2. REFRACTOMETER

Since their introduction in the 1960’s, medical hand-held refractometers are largely used in veterinary practice, mainly for rapid determination of urine solute concentration and protein concentration in serum, plasma and body cavity fluid samples (George, 2001). Refractometry on serum or plasma obviously require a preliminary sample processing with a centrifuge (manual or electrical).

Many different refractometer models exist and it is not always so easy to understand his own tool very well. In fact, such instruments measure the index of refraction (n) of any liquid material, based on the principle that the light changes its speed and, consequently, its direction as it passes from a vacuum to materials of different densities. The n of an aqueous solution is influenced by the solute, its concentration and the temperature of the solution. If temperature increases, n decreases due to...
solvent volume expansion. It is the reason why refractometers with either automatic (“Goldberg refractometer”), next less expensive but also a little less accurate refractometers equipped with a bimetallic plate that bends with temperature changes) or manual temperature compensation (by setting the zero value manually) were introduced in the 1960’s. But many practitioners use uncompensated refractometers in locations with limited temperature control. Before achieving a measurement with such a clinical refractometer, the 1.000 density reading must be validated with distilled water (Braun et al. 2001). Simultaneous measurement of both the sample and distilled water reduces any error caused by slight variations in temperature.

Every solute has a characteristic n per concentration in g/dl (termed specific refractivity). The n for a solution containing a mixture of solutes with similar specific refractivities is proportional to the concentration of the total dissolved solids, irrespective of their proportions.

The angle of refraction produced by a serum or plasma sample is due to the combined concentration of all its solutes, also called “total solids”. Protein is the predominant solute, but non-protein substances, primarily electrolytes, urea, glucose and lipids, contribute to the angle of refraction. Therefore, accurate protein determination by refractometry implies these non-protein solutes to be relatively constant and to contribute to the measured n in a predictable manner. Practically, very high concentrations of glucose (6.5 g/l), urea (2.7 g/l) or NaCl (250 mmol/l) are needed to cause factitiously high refractometric protein measurements (+ 4 to 5 g/l) (McSherry & Al-Baker, 1976). However, protein and total solids are not interchangeable terms as well and some authors mistakenly use the term “total solids concentration” when they report protein measured by refractometry. The confusion is born when some refractometers were named “TS meter” although they were calibrated to report protein concentration. In reality, serum or plasma total solids concentration is approximately 15 to 20 g/l greater than protein concentration in health.

Other sample-related causes of error in protein determination by refractometry were considered, excess EDTA in plasma samples due to underfilled blood collection tubes (Dubin & Hunt, 1978), hyperbilirubinemia (Sutton, 1976), hemolysis (Sutton, 1976) and variation in the Albumin/Globulin (A/G) ratio (Rubini & Wolf, 1956), but only the first of these proved to be pertinent.

Depending on the refractometers manufactures, 2 different conversion factor, one fixed by Wolf and the other by the Atago Corporation, are used for converting n to serum protein concentration. Protein results from refractometers based on the Wolf’s conversion factor are consistently higher than results from refractometers based on Atago conversion factor that give approximately 0.5 g/dl lower protein results, mainly in the 0.5 to 3.0 g/dl range of measurement. Nevertheless, most authors report good correlation between refractometry and biuret techniques for determining total serum protein in cattle samples (McSherry & Al-Baker, 1976; Sutton, 1976; Green et al. 1982).

Refractometers come with numerous combinations of built-in scales that may include serum protein concentration, urine specific gravity, or refraction. Only the most expensive models include all 3 scales. Models with a refraction scale are the most flexible because users are not limited to the company’s conversion factors.

A frequent application of refractometry in rural veterinary practice is the measurement of serum or plasma protein concentration to assess passive immunoglobulin transfer status in neonatal calves. Reid and Martinez (1975) described a method for use on the farm with heparinised capillary tubes and a microhaematocrit centrifuge. Naylor et al. (1977) used this method in 76 Holstein-Friesian female calves and found an increment of plasma total protein of 2.03 ± 0.61 g/dl after colostrum feeding. They suggested that calves should attain a plasma protein concentration of at least 6 g/dl after ingestion of colostrum to prevent diseases and mortality. More recently, Calloway et al. (2002) compared 3 different refractometers, including a nontemperature-compensating instrument, in the measurement of serum protein concentration to assess passive transfer status in calves. They found
that all 3 refractometers performed similarly for detecting failure of passive transfer (FPT defined as serum IgG concentration < 1,000 mg/dl determined via RID). They also determined the effect of different test endpoints on the performance of each of these refractometers. Serum protein concentration test endpoint of 5.2 g/dl resulted in a sensitivity and a specificity ranging from 0.89 to 0.93, and from 0.80 to 0.91, respectively, in function of the refractometer. The endpoints 5.0 and 5.2 g/dl corresponded to the highest proportion of calves correctly classified, with a prevalence of 50% of FPT in this study. But it should be borne in mind that the proportion of calves correctly classified will vary with the prevalence of FPT.

Refractometry is also the method of choice for determination of protein in peritoneal, pericardial and pleural fluids, but not by using the specific gravity scale. Indeed, the refractometer specific gravity scale is calibrated specifically for urine and gives falsely high results for body fluids. Urea, the primary solute in urine, produces a smaller angle of refraction for each g/dl in solution than does protein, the major solute of body cavity fluids (George, 2001).

Transudates and exsudates are usually characterized by a protein concentration less than or greater than 25 g/l, respectively.

Although the refractometer can also be used for determination of urine specific gravity as a measure of urine solute concentration, it may occasionally prove incorrect. Indeed, the refractometer’s specific gravity scale is based on experimental data from normal urine. But certain abnormal solutes alter the relationship between refractivity and specific gravity. For example, acetone is less dense than water and reduces therefore the specific gravity of urine. Now, acetone increases refractivity. It is the reason why Wolf (1969) proposed reporting urine refraction (r) because it is the actual physical characteristic being measured. However, his suggestion has not been adopted as common clinical practice. However, for most urine samples, refractometric measurement of specific gravity is closely related to the urine solute concentration provided that samples containing protein (whose myoglobinemia, hemoglobinemia), glucose, blood and acetone are excluded (Dorizzi et al. 1987).

3. PORTABLE pH METER - PH INDICATOR PAPER

The pH measurement of different body fluids like blood, urine and ruminal fluid is often useful for bovine practitioners.

- measurement of blood pH is especially important in diarrheic calves since their physical examination alone proves sometimes to be inadequate to predict the severity of the associated metabolic acidosis,

- determination of urinary pH is profitable to verify the efficacy of parturient paresis prevention with anionic diets in pre-fresh dairy cows but it also generally reflects the acid-base status of an animal if one excepts paradoxical aciduria,

- assessment of ruminal fluid pH is important for identifying microbial fermentation disturbances in cattle: simple indigestion, subacute ruminal acidosis (SARA), grain overload, and rumen alkalosis due to either urea intoxication or putrefaction of ruminal ingesta. Especially SARA is a common problem in dairy cows and fattening cattle. Used in conjunction with clinical observations and ration analysis, rumen fluid analysis can aid in making the diagnosis of SARA.

To measure blood pH in calves, Nappert and Naylor (2001) found that a portable pH meter gave significantly higher values in comparison with a blood gas analyser, although there was a significant relationship between the two measurements ($r^2 = 0.866, P < 0.001$). They explain part of
the discrepancies between results from both methods by the loss of CO\textsubscript{2} from the aerobically handled samples with the portable pH meter, whereas blood samples were handled anaerobically with the blood gas analyser. The portable pH meter cannot either correct the sample to body temperature. That implies that blood pH values obtained with such a portable pH meter could be difficult to interpret by an inexperienced operator. This kind of pH meter is relatively easy to use but, before testing, it must be carefully calibrated against standard pH 4.00 and 7.00 solutions.

Measuring urine pH with narrow range (scale of 0.3 unity of pH) pH indicator paper is sufficient except if a greater precision is desired. A calibrated portable pH meter could then be used. Since an optimal milk fever prevention will be attained with an urinary pH between 6 and 7, an evaluation of the mean urinary pH in a group of pre-fresh cows is the most appropriate interpretation. A recent meta-analysis of previous studies even suggests that a group mean urinary pH of about 7.0 would be a reasonable goal when feeding low DCAD diets because acidification beyond this value could further decrease dry matter intake without much additional benefit toward milk fever prevention (Charbonneau \textit{et al.} 2006).

A minimum sample size of about 8 pre-fresh cows that have been on an anionic diet for more than 24 h is necessary for urinary pH testing. In small herds, it is obviously difficult to have the adequate sample size. Additional cows should then be tested as they move into the eligible group and results interpreted when enough tests have been achieved (Oetzel, 2004).

The main obstacle to measure ruminal pH is to obtain a right sample. Oral collection of ruminal fluid with various types of stomach tubes is certainly less invasive and more ethical than rumenocentesis but it is nearly impossible to avoid contamination with variable quantities of saliva which limits their value for evaluating SARA (Duffield \textit{et al.} 2004). Rumenocentesis procedure includes of course some risks of localized abscesses or peritonitis but most of the authors even so consider it a viable diagnostic procedure in cattle (Garrett \textit{et al.} 1999; Kleen \textit{et al.} 2004; Enemark \textit{et al.} 2004). It is important not to use too large needles (1.6 mm outer diameter) nor needles with side fenestrations near its point to avoid peritoneal contamination. Cows must also be correctly restrained to avoid violent reactions that could be the source of rumen lacerations. Sedation (residues !) or local anaesthesia (painful reaction that put the animal on its guard) are not advised. Filtration or aspiration of ruminal fluid has no effect on pH (Garrett \textit{et al.} 1999).

Rumen fluid should be sampled when rumen pH is likely to be near the lowest point of the day, that is to say 2 to 4 h after the primary concentrate of the day in the case of a ration fed as separate components, and 6 to 8 h after the cows get access to the total mixed ration (Oetzel, 2004).

A portable pH meter can accurately measure the pH of a very small volume of ruminal fluid, providing not working at cold temperatures. The low cost, ease of use and accuracy of the portable pH meter make it practical for use under field conditions. pH indicator paper is not accurate enough and is influenced by the green colour of the ruminal fluid.

It has been demonstrated by Garrett \textit{et al.} (1999) that, at a ruminal pH \(\leq 5.5\) (rumenocentesis), cows are at greater risk for SARA, with subsequent rumenitis and other complications. This pH value is thus proposed as the cut point taken into account to determine the proportion of cows with a ruminal pH below this value. A sample size of 12 cows is needed, applying an alarm level of 25% (3 cows/12). In dairy herds, SARA can be investigated in the early post-partum period (0-30 DIM), when cows are confronted with a rapidly rising energy-content of the ration, and in mid-lactation (30-200 DIM), then almost exclusively related to management errors (Kleen \textit{et al.} 2003; Enemark \textit{et al.} 2004). However, the rumenocentesis technique has limitations in small or medium-sized herds due to difficulties in selecting sufficient numbers of cows in the respective groups at risk (Enemark \textit{et al.} 2004).
Due to its higher sensitivity at marginal SARA values (pH 5.8), Duffield et al. (2004) propose that rumenocentesis be used to rule-out rather than confirm SARA. However, the lower cut point of pH 5.5 could always be used to confirm SARA because the specificity improves as rumen pH declines.

4. **HARLECO SYSTEM - MICRO CO₂ APPARATUS**

The Harleco CO₂ apparatus is a quick, reliable and inexpensive method that measures in the field the total carbon dioxide (TCO₂) liberated from a blood, serum or plasma sample on addition of a strong acid (lactic acid). The CO₂ liberated is derived from bicarbonate and from dissolved CO₂, but there is so little dissolved CO₂ in blood that the TCO₂ may be taken for clinical purposes as a measurement of plasma bicarbonate concentration. In fact, it gives values which are similar to blood bicarbonate concentrations obtained with a blood gas analyser.

Naylor (1987) tested the Harleco system in diarrheic and healthy calves and found very good correlations between TCO₂ on the one hand, and blood bicarbonate and base excess measured with a blood gas analyser, on the other hand. Grove-White and White (1993) also validated this apparatus on calves in the field and still confirmed its utility more recently (Grove-White & Michell, 2001).

This CO₂ micro-system can also be used for diagnosis of acid-base disorders in cows with abomasal displacement and diagnoses alkalosis as reliably as acidosis (Schade et al. 1998). Consequently, it could be interesting for determining prognosis.

5. **URINE TEST STRIPS**

Protein concentration can be measured semi-quantitatively in urine or other body fluids by urine test strips (protein reagent patch). Their limit of detection may be as low as 0.3 g of protein/l but they cannot differentiate samples with protein concentrations > 5 or 20 g/l, depending on the urine dipsticks. Thus, by themselves, they cannot differentiate between transudates and exsudates but they can even so come in support of refractometry when low concentrations of protein are measured. The test strips also react more intensely with albumin than globulins (Braun et al. 2001). A source of error is that a false positive protein reaction may be noted if urine is strongly alkaline (common in ruminants, mainly with potassium rich diets).

Glucose is normally not found in the bovine urine unless the blood glucose level increases above the renal threshold that is thought to be around 100 to 140 mg/dl in ruminants (Smith, 2002).

6. **PORTABLE BLOOD GAS ANALYSER**

Nowadays, several portable blood gas analysers are available that allow the measurement of the pH and blood gases in venous or arterial blood on the field (Ometech Opti™ CCA, Ometech Inc., Roswell, USA, for example). Their measurement principle is based on optical fluorescence sensors (“optodes”) that have nothing to do anymore with classical electrodes. Conceived at the beginning for continuous measurement of chemical concentrations in vivo by patient-attached devices, the concept has rapidly been applied for near patient testing in human medicine. Now, these apparatuses are also extensively used in veterinary medicine. Their cost is affordable, as much at the time of acquisition (± 10,000 €) as when functioning (± 10 €/blood sample). Based on the same principle, other measurements have been added to pH and blood gases: ions like sodium, potassium, ionised calcium and chloride, and haemoglobin. From these parameters, a list of other data are obtained by calculation, whose the Base Excess (BE), bicarbonate concentration, packed cell
volume (PCV) and oxygen saturation of haemoglobin (SO₂). Blood gases values have to be corrected for the temperature of the patient.

To assess the metabolic and the respiratory components of the acid-base balance together, it is absolutely necessary to sample arterial blood in a heparinised syringe to be sealed, while minimising restraining and stressing of the animals. In the newborn calf, we recommend to sample blood in the artery axillaries (Uystepruyst, 2000). In adult animals, the artery coccygea can be punctured but it is more uncertain than in the artery auricularis caudalis (Nagy et al. 1994).

7. GLUCOMETER

Many different models of hand-held portable glucometers are available for the glycaemic auto-control in diabetic humans. Most recent models measure glycaemia in 5 seconds and need only a small drop of whole blood (< 1.0 µl). Apparatuses (± 50 €) and test strips (± 0.75 €/test) are not very expensive. They can also be used in veterinary medicine in general and in cattle in particular, with the nuance that they are a little bit less accurate for measuring very low glycaemias such those that can be met in ruminants. Their main interest is found in neonatology and every time a glucose-containing solution is infused intravenously. Indeed, the renal threshold of glucose is lower in ruminants than in other mammals (Smith, 2002). On the other hand, glycaemia is not a very good indicator of the energetic status of dairy cows but could be helpful for diagnosing and differentiating types I and II ketosis.

8. LACTATOMETER

Different portable lactate analysers (Accutrend®, Accusport®, …) also exist on the market but they all measure only L-lactate. Consequently, they can be used to assess physiological and pathological phenomena that favour anaerobic metabolism but they present little concern for diarrheic calves, since a recent study has demonstrated that serum L-lactate concentrations were similar in diarrheic and healthy calves (Ewaschuk et al. 2004). Moreover, a severe dehydration is required to produce only a mild L-lactic acidosis in calves (Walker et al. 1998). On the other hand, D-lactic acidosis plays an important part in the development of acidemia in diarrheic calves. It is to be regretted that no tool exists to measure D-lactate on the field yet.

However, such a portable analyser measuring plasma L-lactate concentration (Accusport®) proves to be useful for more precisely stating the prognosis of calves suffering from acute bronchopneumonia, although it slightly overestimates its concentration (+ 0.412 mmol/l) in comparison with the reference method (Coghe et al. 2000). With this apparatus, a plasma L-lactate concentration higher than 4.0 mmol/l appeared to be a reliable prognostic indicator for mortality within 24 h.

9. KETONE COWSIDE URINE TESTS

The gold standard diagnostic test for subclinical ketosis (SCK) is the measurement of β-hydroxybutyrate (BHB) in serum or plasma because of its stability (Duffield, 2000). The most commonly used cut point for SCK is ≥ 1,400 µmol/l of blood BHB. Oetzel (2004) suggests using 10% as the alarm level for herd-based SCK testing (minimum 12 cows). Clinical ketosis generally involves much higher levels of BHB (3,000 µmol/l or more).

A great variety of cowside tests are available for SCK monitoring of dairy herds but none of these has perfect sensitivity and specificity in comparison with blood BHB. However, they are particularly useful for making or excluding a clinical diagnosis of ketosis in individual sick cows (Oetzel, 2004).
Urine can be used for cowside ketosis testing. However, to collect an urine sample is not the least practical difficulty in the field. Moreover, urine ketone tests, on the whole, have a reputation for very poor specificity. It is clearly the case of nitroprusside tablets (Acetest, measuring acetoacetate) that have on the other hand an excellent sensitivity (100%). This makes it a useful test for evaluating individual sick cows but not for herd monitoring. An exception is a semi-quantitative dipstick that also measures acetoacetate (Ketostix). It is the best cowside urine ketone test, as much concerning specificity as sensitivity (Carrier et al. 2004; Oetzel, 2004). Using the lower Ketostix cut point (that has the best sensitivity) is useful if the goal of the test is to identify the maximum of cows with SCK with a view to treat them.

10. KETONE COWSIDE MILK TESTS

Ketone milk tests have the obvious advantage of the ease of sampling but they are generally not as sensitive as urine tests in detecting SCK. Nitroprusside powders that qualitatively test milk acetoacetate lack sufficient sensitivity, excluding them as well for herd monitoring as for clinical diagnosis.

A strip detecting BHB and marketed under various names (Ketolac BHB, Keto Test) has been reported to be the most accurate cowside test available when used on milk (Geishauser et al. 1998 & 2000). Since then, numerous studies have evaluated the sensitivity and specificity of this test strip. Pooling these data, using the cut point of ≥ 200 μmol/l reduces test sensitivity (54%), and hence the benefit for diagnosing ketosis in individual sick cows, while it increases specificity (94%) and its interest for herd monitoring (Oetzel, 2004).

On the contrary, using a lower Ketolac threshold such as ≥ 100 or 50 μmol/l would increase sensitivity (83 or even 89%) but would also lower specificity (82 or even 77%) (Oetzel, 2004).

High milk SCC and feeding malfermented silages containing increased amounts of butyric acid may confound the results with milk ketone tests.

11. ON-SITE TEST FOR NEFA IN BOVINE SERUM

Measuring serum or plasma NEFA concentration in dairy cows 2 to 14 days from calving can prove to be interesting for determining whether the postpartum ketosis is due to pre-calving negative energy balance (NEB). It is also a metabolic predictor of left displaced abomasum (LDA) in dairy cattle (LeBlanc et al. 2005). Best samples are those taken just before feeding, corresponding to the peak NEFA value. Recently, a spectro-photometric method has been marketed to determine NEFA concentration in bovine serum on-site (DVM NEFA test, Veterinary Diagnostics, Newburg, Wisconsin, USA). It works with serum (a centrifuge is necessary) and requires about 30 minutes to analyse 10 to 20 samples. The initial equipment and the reagents for 20 blood samples cost 190 and 65 €, plus shipping, respectively. The reagents have to be cooled constantly.

The DVM NEFA concentrations correlate passably well with laboratory results taken as gold standard (R² = 0.6822). Using 350 samples drawn within 14 days prepartum in dairy cows and a cut point > 0.4 mEq NEFA/l for both tests to identify excessive NEB, the sensitivity and specificity of the DVM NEFA test were 84% and 96%, respectively. LeBlanc et al. (2005) propose a cut point ≥ 0.5 mEq/l for predicting subsequent LDA. The alarm level proposed by Oetzel (2004) for the proportion of animals above the cut point is > 10% and the minimum sample size for herd-based tests with proportional outcomes is 12 cows.
Therefore, this tool is chiefly suitable for large herds. Moreover, in many smaller herds, the cost of pre-fresh NEFA testing cannot be justified. Indeed, in these smaller herds, herd recommendations can be adequately supported by clinical observations and the evolution of the blood BHB results in cows during the post-fresh period.

12.  **SERUM CALCIUM MEASUREMENT**

In the field, clinical signs of parturient paresis are easily recognized and the diagnosis is usually confirmed by the rapid response to treatment. However, treatment failures are not uncommon, implying to consider the differential diagnosis: severe toxemia (mastitis, metritis, grain overload, ...), cows with advanced fatty liver, calving paralysis, ischemic muscle necrosis and skeletal injuries. Determination of total serum calcium concentration before treatment can help to differentiate these conditions. It can also allow to detect subclinical hypocalcemia during the early postpartum period. Serum ionised calcium concentration is clearly a more accurate measure of functional alterations of calcium metabolism in cows (Lincoln & Lane, 1990), but this analysis is reserved to off-site laboratories or to more expensive portable clinical analysers like the Osmetech Opti™ CCA described above.

Different methods for measuring total blood calcium concentration have been described. EDTA-based methods provide rapid estimate of serum calcium concentration in the field (Mayer et al. 1965; Sandholm et al. 1979). Their principle is that calcium ions are necessary for coagulation of blood and that chelation of calcium with EDTA will prevent coagulation. However, results are semi-quantitative. Using this method in their study, Martig et al. (1974) succeeded to differentiate all hypocalcemic from normocalcemic cows.

More recently, Matsas et al. (1999) successfully used a water hardness kit to measure more precisely serum calcium concentration and diagnose hypocalcemia in dairy cows in the field. Results are obtained in less than 5 minutes at a very inexpensive cost price (less than 1$ /sample). The inconvenience of this test kit is that it requires a relatively large volume of serum (until 7 ml) that represents at least 20 ml of blood to centrifuge.

13.  **SUMMARY**

Clinical experience is undoubtedly a very powerful and accurate diagnostic tool. However, several cow-side tests can be utilized by the practitioner in his daily routine to effectively confirm diagnosis at the herd or animal level. Refractometry is valuable to confirm maternal transfer of immunity to the newborn calf, but can also detect presence of proteins in the pericardial, peritoneal or pleural fluids. As group medicine becomes central for veterinarians, tools for the evaluation of the nutrition status are necessary. Measures of the pH of urine and rumen fluid as well as evaluation of the presence of ketone bodies in the urine or milk of dairy cows is an efficient way to monitor nutritional status. More performant apparatus such as portable blood gas analysers have proved very useful in predicting outcome of diarrhea in calves and helping correct blood electrolytes imbalances. Prognosis of the outcome of respiratory disease in calf can be improved on the farm with the help of a lactatometer and treatment be implemented only in those animals with good chances of cure.

All theses approaches, their limits and relevance in daily bovine practice are reviewed in this paper.

14.  **KEY WORDS**

Cowside blood, urine, milk, rumen fluid tests.
15. RESUME

L'expérience clinique est sans aucun doute un outil diagnostic puissant et précis. Cette expérience peut-être secondée par de nombreux tests que le praticien peut mettre en oeuvre rapidement au chevet de l'animal pour confirmer son diagnostic individuel ou au niveau du troupeau. La refractométrie est utilisée depuis de nombreuses années pour s'assurer du bon transfert des anticorps maternels au veau nouveau-né, mais aussi, dans certains cas pour détecter la présence de protéines dans le péricarde, péritoine ou au niveau de la plèvre. La médecine de troupeau devenant une activité majeure pour les vétérinaires, des outils d'évaluation du statut nutritionnel des animaux sont essentiels. Mesurer le pH de l'urine, du fluide ruminal mais aussi l'évaluation de la présence de corps cétoniques dans l'urine ou le lait des vaches laitières permet une approche efficace du statut nutritionnel. Les analyseurs portables des gaz sanguins, qui constituent une gamme d'appareils plus performants, sont irremplaçables dans un but pronostic pour les diarrhées du veau ; leur utilisation permet aussi de mettre en œuvre des traitements permettant de corriger le plus exactement possible les déséquilibres en électrolytes sanguins. Le pronostic des affections respiratoires du veau peut lui aussi être rendu plus précis grâce à l'utilisation d'un lactatomètre portable ; les traitements ne sont alors mis en place que chez les veaux ayant une chance de guérir.

Tous ces outils diagnostiques, leurs limites et leur pertinence dans la pratique vétérinaire quotidienne sont discutés dans cet article.

16. MOTS CLÉS

Tests sanguins, urine, lait, tests du liquide du rumen.

17. REFERENCES


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