Racehorse and precision techniques: state of the art and perspectives

Claire Leleu – Equi-Test

Summary

Precision training can be defined by the coordinated use of sensors to measure physiological or biomechanical parameters and new communication technologies to exchange, transform and return this information to the coach to help him in his decision-making, in addition to his own observations. Faced with the rise of new digital equine tools, a reminder of the applied research works initiated in this area is proposed. The principle, the interests and the limits of certain innovative systems are mentioned. Finally, the benefits of precision training, at the individual or collective level but also a point for consideration on the prerequisites for its development are proposed.

Key-words: racing industry, sensors, connected device, digital transition

Introduction

At present, the challenges faced by the racing industry are in part similar to those faced by other animal production chains: securing economic performance (most often by increasing the number of animals while limiting staff costs) but also meet growing societal demands for animal welfare. It is in this context that the precision training tools applied to racehorses are developed.

Precision training can be defined by the coordinated use of sensors to measure physiological, biomechanical, behavioural parameters or environmental characteristics (temperature, hygrometry ...) and information and communication technologies (ICT) for exchange, store, transform and return this information to the coach to assist in his decision-making in addition to his own observations. The use of connected automation to free the trainer and his staff from certain demanding tasks (food and water distribution) can also be associated with precision training.

In recent years, many precision systems applicable to the racehorse have been developed. Some are common to other animal productions, mainly bovine or porcine, and others are specifically intended for equine athletes. From non-exhaustive examples, the operating principles of these systems, their practical interests and their limits for socio-professionals are mentioned.

1. Precision techniques common to other animal species

1.1. Electronic identification

The electronic identification by implantation of a transponder was made progressively obligatory in equidae between 2003 and 2008. The transponder used is of RFID-FDX type (Radio-Frequency Identification, Full DupleX). It consists of an electronic chip encoding a unique number, a capacitor and a coil acting as an antenna, all wrapped in a biocompatible inert glass capsule. With a size of 11 mm by 2 mm, it is implanted in the adipose tissue of the cervical ligament, at the upper third of the neck, about 3 cm from the base of the horsehair. The transponder is read using a reader that activates the chip (uplink) and retransmits the unique number (downlink) allowing control of the identity of the animal. The RFID's interest in equine identification lies in its reliability, inviolability and also in the future possibilities of coupling with other technologies (temperature).

1.2. Distribution of concentrates

Unlike other animal sectors, the equine sector is very little automated and horse feed is almost exclusively done manually. However, technical solutions exist to automate this task: they are automatic concentrate feeders. Used for decades in dairy farming, concentrate feeders now arrive in the stables. These systems, such as Equidistrib® from ABSI or Hippomeal® from Ineatech, include a 60- to 80-liter stainless steel tank that contains concentrated feed for five to seven days of feed. The latter is connected to an electrical box allowing centralized programming of distributions.

Photo I: Equidistrib System®

For the coach, the advantages of concentrate feeders are economic: saving time saves labour but also zootechnical. Automated distributions allow for better precision and individualization of rationing. The frequency of meals can be considerably increased (up to 10 meals a day), which is beneficial on the digestive (lowering the prevalence of gastric ulcers) and behavioural (reducing stereotypes). Although replacing the groom in the distribution task, automation obviously does not exempt him from observing the feeding behaviour of horses, a crucial element in the evaluation of the response to training. On the contrary, the time gained by the grooms can be reinvested in the careful observation of the athletes and their care. However, for now, installation and maintenance costs seem to be the main limitations to the development of these automated and connected systems.

1.3. Control of the watering

Another key element of the racehorse's diet is that drinking water can also be controlled automatically and its consumption accurately assessed. The Blue Intelligence® system at La Buvette is based on the combination of several elements: the Blue Intelligence® waterers or pre-existing waterers, a management box, a weather station and the management software on its tablet PC. It allows to monitor in an automated and centralized way, the water consumption of each horse and to be alerted in real time in case of abnormal watering behaviour, which can be a harbinger of a health problem.

Photo II: Blue Intelligence® system

In addition to the financial investment to equip the stables, one of the limits could be that these watering control systems can only be used for horses at the box 24 hours a day. But it is common, in trotting stables and secondarily in that of the obstacle, that the horses spend a great deal of time in the paddock.

1.4. Body weight monitoring

Weight tracking is without a doubt one of the precision techniques that racing professionals have adopted most easily. Although rarely digitized, these weight data allow the trainer to determine a top fitness weight more accurately than by a simple visual appreciation, this top fitness weight being defined as the optimal weight reached during a period of sports performance. Knowing precisely that weight makes it possible, for example, for a horse in training recovery and overweight, to plan the return to the competition more efficiently by better adapting the work and the ration. Conversely, earlier detection of weight loss limits the risk of overtraining in a horse in a very intense competition phase.

Another interest of regular weighing is to quantify the impact of competitions on the horse's body and to follow the recovery of this weight of form. Indeed, in the athlete horse, the maximum exercise induces dehydration at the origin of a variable weight loss. The time to recover weight after a race is an important element of medico-sport monitoring because it conditions the resumption of intensive training or competition.

In a recent retrospective study, the factors of variation related to race-induced weight loss and pre-stroke weight recovery time were studied in Trotter (Leleu et al., 2017). Based on daily weight monitoring in a trotting horse team and the analysis of 648 competitions, it appears that individual factors (age, temperament) and environmental factors (external T ° and duration of transport) have a significant impact on weight loss and recovery time.

Practically, weight monitoring is facilitated by acquiring a scale connected to a specific horse weight management software such as the EquiTop Weighing system from ABSI or HippoWeight from Ineatech allowing systematic recording of data and their graphic rendering.

Photo III: Weight management by EquiTop Pesée®
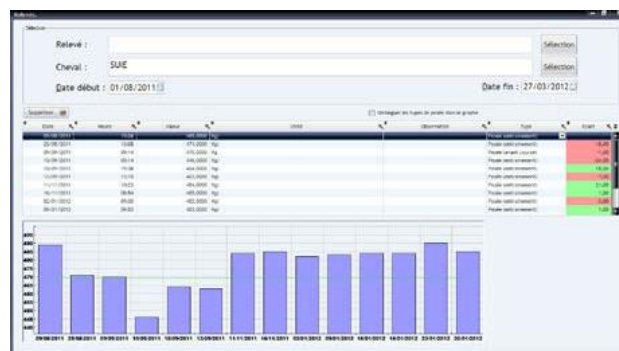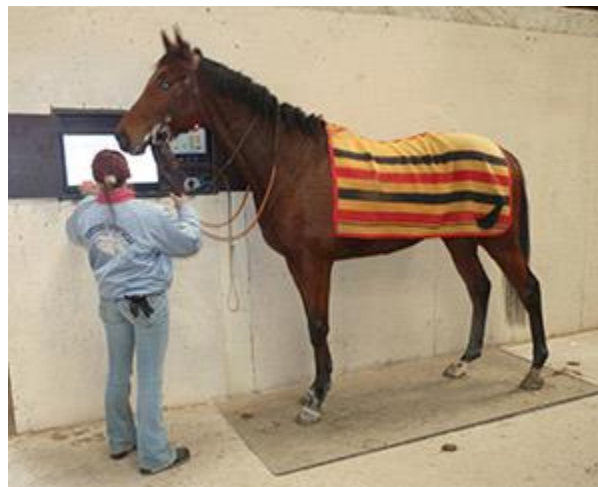
1.5. Body temperature

At the end of 2017, the company Allflex put on the French market transponders associating identification and measurement of body temperature for pets. The advantage of these systems lies in the ability to easily detect hyperthermia without rectal temperature. Therefore, in the horse, the use of these temperature RFID transponders is at the experimental stage on livestock populations under the Equi-detect project. As with other measurement systems, the practical use of these sensors requires a thorough knowledge of the sensitivity and specificity of these measurements under actual conditions of use. In practice, it might be interesting to quantify the maximum exercise-induced hyperthermia in the field and to monitor its normalization during the recovery phase.

2. Precision techniques specific to the racehorse

2.1. Gait analysis

The quality of the sporting gait is an obvious factor in the performance of racehorses. Conversely, lameness is the first cause of underperformance during the race. Accelerometery is one of the most studied gait analysis techniques in equine applied research because of its practicality and the ability to quickly obtain biomechanical data in the field.

2.1.1. *The normal gait*

Developed in the 90s within the INRA, the Equimétrix® system is based on the recording of accelerations along three axes (vertical, longitudinal and lateral) from an accelerometer located at the strap, that is to say to the nearest center of gravity of the moving horse. The analysis of the recordings makes it possible to quantify among others the frequency and stride length, indices of symmetry and regularity, levels of activity in the three dimensions. In Trotters, the locomotor test has been validated by video-accelerometric correspondence protocols and temporal and spatial reproducibility (Leleu et al, 2004a). The acquisition of the sporting gait and mechanization of young horses have also been described (Leleu et al, 2004b), such as increasing the length and length of the stride, improving the symmetry and regularity or the reduction of thoracic displacements in the three dimensions. Finally, a study comparing elite trotters with mid-level trotters reveals that good performers have stride frequencies, longer propulsive times associated with lower lateral displacements (Leleu et al., 2005a). In the flat races, stride frequency is also positively correlated with performance level (Barrey et al, 2001). However, if the interest of this system in applied research is real, the practical applications for the professionals of the sector remain to be highlighted.

2.1.2. *The pathological gait*

The detection and quantification of lameness is a major challenge for the veterinarian responsible for diagnosing locomotor disease in sport horses. The use of a sternal accelerometer or two accelerometers (sternal and sacral) followed by the calculation of indices of symmetry and regularity is not very correlated with the clinician's evaluation (Weishaupt et al., 2001) and does not contribute sufficiently sensitive information for clinical use. However, another accelerometric system is now appearing in veterinary clinics: the Lameness Locator® from Equinosis LLC. This system, developed within the University of Missouri, allows an analysis of objective locomotion in field conditions and in real time. This system consists of 3 inertial sensors fixed on the right pastern, the neck and the rump, transmitting Bluetooth information to a tablet. Differences in head and sacrum heights during the locomotor cycle are derived from complex algorithms. The asymmetries anterior and / or posterior are proportional to the difference of the minimum and maximum heights respectively of the neck or the sacrum and quantified on this principle. Validation protocols (Keegan et al 2012, McCracken et al 2012) confirm that, used in addition to visual evaluation, the system thus makes it possible to obtain quantified data on lameness.

Photo IV: Lameness Locator® sensors and results sheet

2.2. Physio-sports measurements

The training of the racehorse is most often intuitive, based mainly on the impressions and experience of the coach. In the 90s, the physiology of exercise applied to the trotting horse, through the creation of a standardized stress test protocol, made it possible to objectify a certain number of characteristics such as cardiac capacity or aerobic capacity, strongly predictive of the level of performance (Demonceau and Auvinet, 1992). These criteria are based on reliable measurements of speed, exercise heart rate and lactate dosage.

2.2.1. *Speed*

In trotting industry, measuring speed during training sessions is a very common practice and is almost systematic in competition. Traditionally and still currently, this measurement is done by timing over a given distance to calculate an average speed over this distance, most often expressed in time necessary to cover one kilometre. Each trotter who has run on a homologated track is thus characterized by its record time per kilometre, partial witness of its sporting quality.

Then the use of electromagnetic tachometers from the cycling environment has developed. These systems included a magnet fixed on a radius of the sulky wheel and an electromagnetic sensor connected to a display fixed in front of the driver. The principle was based on the calculation of a velocity derived from the product of the circumference of the sulky wheel by the number of turns detected by the sensor. These systems avoided the manipulation of a stopwatch and made it possible to observe instantaneous measurements provided that the circumference of the wheel was accurately measured ...

In the 2000s, the arrival of GPS (Global Positioning System) makes it even easier to access this fundamental data of training. Very easy to use, this technique also allows the measurement of the speed of mounted horses. However, loss of accuracy can be observed in covered terrain or on tight turns. Progressive technological improvements now make it a speed measuring tool that is precise enough for an application to racehorse training.

2.2.2. *Exercise heart rate*

Key organ of the motor performance, the heart ensures the circulation of the blood, bringing oxygen and nutriments to the muscular tissue and evacuating the metabolic waste and the carbon dioxide. At rest, the heart rate is usually between 20 and 40 beats per minute. It increases linearly with the intensity of the exercise until reaching maximum values of 220 - 250 bpm. Little modified by training, resting and maximum HR are of limited interest in the evaluation of the physical condition and athletic ability of

the racehorse. On the other hand, the heart rate during exercise is significantly modified by training: for a given intensity of effort, it is even lower than the horse is trained. Therefore, this easily measurable parameter is frequently used to appreciate the physical condition of a given individual. In addition, exercise heart rate is related to performance level in middle distance disciplines. In the racehorse, the measurement of the V200 (speed inducing a heart rate of 200 beats / min) during a stress test can be predictive of the level of performance and is therefore of interest for individual selection. Finally, an abnormally high heart rate at work may be a harbinger of pathology and therefore a warning signal for the coach. World leader in heart rate monitors, Polar has developed since the 90s equine cardiac data acquisition and analysis systems, validated scientifically (Holopherne et al 1999). Currently, Polar heart rate monitors commonly used in tracking trotters include a textile strap on which attaches a transmitter communicating via Bluetooth with a receiver, displaying heart rate and GPS speed.

Photo V: Polar Trotting M450 system

The appropriation of this material by racing professionals has remained low for many years due to, among other things, technical shortcomings of the electrodes and belts under real conditions of use of a stable. Thanks to the development of a robust strap that is perfectly adapted to everyday use, the number of coaches using these sensors has increased significantly over the past four years.

Associated with this measurement system, Polar offers a web service: Polar Flow® intended for human athletes allowing the transfer, the storage, the reading of the cardiac data but no analysis software adapted to the horse and to the collective management of the data of a stable is currently not available.

To overcome this lack of specifically equine digital tools to store, exchange, analyse the physiological data to the effort, starts up appear such as Arionéo, Waook or Paris Turf group. In 2018, Arionéo launched on the market its Equimètre®, a connected box providing the acquisition of speed, heart rate and biomechanical data (frequency and stride length). The associated web service enables data analysis and graphical visualization of training and data plots such as V200, velocities and HR max or inter and intra individual comparisons. The same year, Waook launches the iPhone / iPad Waook® iPhone / iPad application for trotting stables, which uses Polar technology to display, record and instantaneously analyse speed and heart rate data. In addition, this software incorporates other variables of interest such as lactatemia and contains an algorithm for interpreting physiological data.

2.2.3. *Lactate*

Parameter of major interest in the monitoring of sports horse medico-sport, the evaluation of lactate after a standardized effort allows an evaluation of its aerobic capacity. Vla4, (rate corresponding to a lactatemia of 4 mmol / l), is a variable strongly modified by training level and which thus makes it possible to follow the effects of it. It is also highly correlated with trotting performance (Couroucé, 1999, Leleu et al 2005b) and predictive of the future performance of young horses (Leleu et al.2004c). The determination of lactatemia requires the performance of a blood test just after exercise and a rapid analysis after sampling. The development of new, reliable and validated lactate analysers in the equine species such as EKF Lactate Scout + or Lactate Pro 2 by Akray now provides reliable results in seconds.

Photo VI : Lactate Scout + ® and its validation for equines
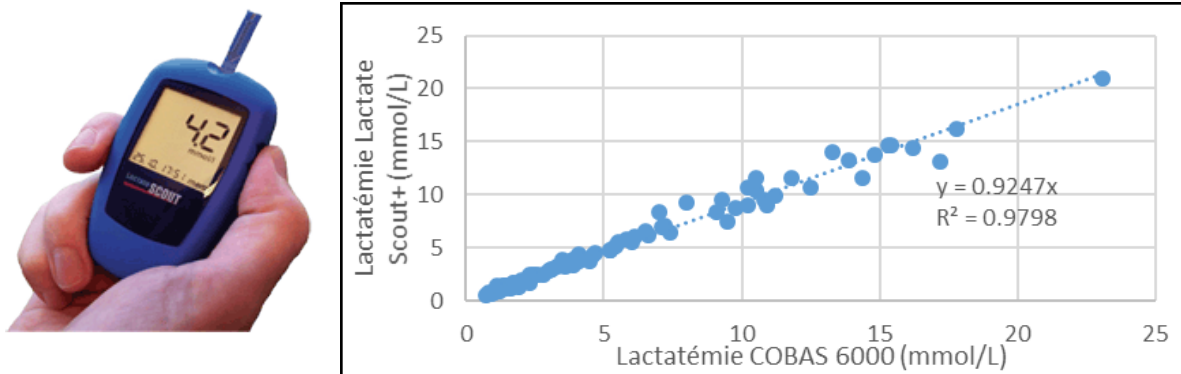
In the human athlete, non-invasive lactic monitoring systems, incorporating biosensors in a bracelet or cuff, are under development to limit the invasiveness of these follow-ups. It is likely that in future years these systems will be applied to equine athletes.

3. Perspectives

3.1. New opportunities

The new technologies applied to the race track will soon produce a very large variety and a large amount of data. This big data from precision training will have direct applications at the individual and collective levels.

At the individual level, for the coach, this data can be used as a decision aid for individual selection of young horses, determination of training load to avoid undertraining and overtraining, and warning in cas of abnormal response to training. For the breeder, these training data can also allow for example to characterize the physiological potential of a filly that has not run because early accident. Similarly, a future owner can "secure" his purchase by correlating the subjective opinion of the coach who advises him and the objective measures of a response to the exercise.

They can also, in a more collective way, allow the development of high-throughput phenotyping. Indeed, from the 2010s, the first genetic tests relating to the sporting performance appeared on the market for the discipline of the gallop (Speed Gene Test® of Equinome) and for the discipline of the trot (Synchrogait® of Equibiogenes). However, the development of knowledge on the equine genome will have to be accompanied by a better characterization of phenotypes, an essential step in the progression of genomic applications. Embedded sensors will have the advantage that data collection costs are low, that data is objective and frequently acquired. But it needs the reliability of measurement tools.

Applied research applications are numerous and should provide elements of answers to problems such as the relationship between workload of young horses and their longevity, between training loads and the incidence of overtraining or certain pathologies (locomotor or respiratory) etc.

3.2. Necessary conditions

The new digital tools of precision training require the use of fixed or mobile terminals (computer, tablet, smartphone ...) and access to the Internet or a telephone network to control the tools and / or use applications of analysis. Precision training therefore implies new connectivity needs. Access to the Internet or telecommunication networks in rural areas, which is sometimes a limiting factor, will have to be facilitated for the digital equine sector to develop.

Another fundamental element of the development of these tools and their applications is the quality of the measured data, among others, its precision that must be validated on several levels. The accuracy of

the sensor sending the signal should be compared to that of the reference measurement system (s). The accuracy of the algorithm transforming the signal into data will also have to be evaluated in terms of sensitivity and specificity. Finally, the validation of the practical interest of this data for the professional is obviously the sine qua non condition to the development of these tools. From an economic point of view, one of the peculiarities of the equine sector is that it constitutes a niche market compared to other agricultural sectors in digital transition. Thus, if the milk sector has about 3.8 million cows, the number of race horses under training in France is only 29 000 ... One of the consequences is that the volume of tools needed is extremely reduced, which increases the relative production cost. Moreover, the crisis also affects the race industry: the number of trainers fell by 5% at trot and 17% at a gallop between 2010 and 2015. The financial health of many structures is precarious. Thus, the financial capacity to invest in these new tools is one of the main limits to digitization.

On a law level, issues of data ownership and digital security will be particularly crucial in the race track. The latter is based on the organization of betting sports competition competitions generating annual sales of about eight billion euros. However, certain physio-sporting data have a short-term predictive interest in performance or poor performance. Voluntary or unintentional disclosure of the data could interfere with the choice of gamblers. Similarly, on a commercial level, the objective characterization of the athletes that these systems allow could influence the decision to buy, sell or negotiate the price.

As in other sectors, the development of robotics and digital technology in the equine sector could have a professional impact with the reduction of certain repetitive tasks (feeding, watering), the improvement of the productivity of the work (earlier selection, individualisation of training) but also by a transformation of the nature of activities (monitoring and data analysis). At the same time, this technical revolution will have to be accompanied by a necessary evolution of the skills and know-how of the entire race industry: coaches and stable staff, veterinarians ...

The appropriation of these new technologies is underpinned by the establishment of initial and continuous training adapted to professional environments, by the existence of responsive and efficient technical support services. New trades could thus emerge.

4. <u>Conclusion</u>

The so-called precision training is made possible thanks to the arrival of new technologies. However, these are only warning or decision-making tools that will never replace the trainer's know-how and experience. Their appropriation by professionals requires that many conditions are fulfilled such as the validation of systems compared to reference methods, the demonstration of practical interests and benefits for the end user. The training of all professionals in these tools and the economic possibility of putting them into practice financially affordable systems, will also be necessary conditions.

References
Barrey E, Evans SE, Evans DL, Curtis RA, Quinton R, Rose RJ. 2001 Locomotion evaluation for racing in thoroughbreds. Equine Veterinary Journal Supplement (33):99-103
Couroucé A. 1999. Field Exercise testing for assessing fitness in French Standardbred trotters, The Veterinary Journal 157, 112-122.
Demonceau T., Auvinet B. 1992. Test d'effort de terrain pour trotteurs à l'entraînement : réalisation pratique et premiers résultats. In: Compte-rendu de la 18ème Journée d'Etude, CEREOPA, Paris, 120-132.
Holopherne D., Hodgson D., Rose R. and Couroucé A. 1999 Investigation on the accuracy of a new heart rate meter for use in exercising horses In Proceeding of 6th Congress of WEVA (World Equine veterinary Association) Paris
Keegan KG, MacAllister CG, Wilson DA, Gedon CA, Kramer J, Yonezawa Y, Maki H, Pai PF. 2012

Comparison of an inertial sensor system with a stationary force plate for evaluation of horses with bilateral forelimb lameness. American Journal Veterinary Research 73(3):368-74.

Leleu C., Bariller F., Cotrel C., Barrey E. 2004a Reproducibility of locomotor test for trotter horses. The Veterinary Journal, 168, 160 - 166

Leleu C., Cotrel C., Barrey E. 2004b Age and training related changes in locomotion of trotter race horses Equine and Comparative Exercise Physiology 1 (2); 107-117

Leleu C., Cotrel C. Barrey E. 2004c Predictive interest of physiological and gait variables in french Trotters performance in Proceeding of CESMAS (Conference on Equine Sports Medicine And Science) : "The elite race and endurance horse", Ed : A.Lindner. 189-193.

Leleu C., Cotrel C., Barrey E. 2005a Relationships between biomechanical characteristics and race performance in Standardbred trotters. Livestock Production Science 92, 39-46

Leleu C., Cotrel C., Couroucé-Malblanc A. 2005b Relationships between physiological variables and race performance in French standardbred trotters. 156, 339-42.

Leleu C., Miot M., Rallet N., Mailliot Pivan A.S. 2017 Perte de poids et délai de récupération post-compétition chez le Trotteur : analyse des facteurs de variation in compte rendu des Journées Annuelles de l'association des vétérinaires équins de France (AVEF)- Paris

McCracken MJ, Kramer J, Keegan KG, Lopes M, Wilson DA, Reed SK, LaCarrubba A, Rasch M. 2012 Comparison of an inertial sensor system of lameness quantification with subjective lameness evaluation. Equine Vet J.44(6):652-6.

Weishaupt MA, Wiestner T, Hogg HP, Jordan P, Auer JA, Barrey E. 2001 Assessment of gait irregularities in the horse: eye vs. gait analysis. Equine Veterinary Journal Supplement (33):135-40