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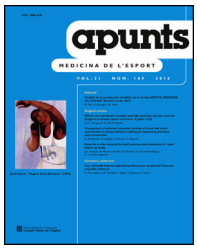

EDITORIAL

Support strategies for high competition performance

Estrategias de ayuda al rendimiento de alta competición

Introduction

In high-level competition sports one of the most important aims throughout the season is that the player is able to recover as fast as possible to his or her physical and mental baseline condition after exercise so as to safely tackle their sport anew.

Advances in technology and the availability of increasingly more precise diagnostic tests (obtained from blood, urine or saliva samples) have led to a personalised approach to the sportsperson and individualised study of the training/match-recovery balance from a different, more realistic outlook of the situation.

Global optimisation of adaptation to exercise and the type of training is sought, with consideration of the changes occurring during the season. The parameters which may be measured are biochemical, genetic, metagenomics in stools or even urinary metabolites associated with individual exercise and which are encompassed by the new ''omics'' of sports or ''sportomics''.

Measurement of these parameters at different times during the season offers a more accurate overview of the player, their baseline values, their best values, and also the changes which may appear in each sportsperson during the preseason and competition. This control is particularly important during the busiest periods, when they may compete up to 3 times per week, with trips that involve time changes and when there are under 72 h between matches, with the difficulty this entails for adequate physical and mental recovery.

The ability for fast recovery after different types of exercise or **resilience** differs between players or even in the same player at different times, and is currently one of the key aims for improvement and under study. It encompasses many aspects of both external and internal load control which may be modified and trainable for improved condition of the sportsperson.

One of the new challenges in the area of sports medicine is to identify and measure potential causes of fatigue and use them to design a plan or strategies for the individual. The approach may therefore differ depending on their genetics, but especially on the appropriate expression of these genes **or epigenetic,** which includes evaluation of the different effects of workloads on physical performance parameters measured using GPS, body composition, healthy diet, rest and mental control, producing the sportsperson's phenotype.

There are increasingly more biomarkers to assess whether appropriate adaptation to exercise has been made, which demonstrate progressive improvement or, on the contrary, an increase in inflammation indicators, over-training, and risk of lesion.

It is important not to evaluate the different markers independently and separately from one another, but to assess the situation globally, taking measurements at the most appropriate moments, taking into account any changes made at each moment and any inter-individual differences.

Rest periods, pre-seasonal periods, the different moments of the competition and the scheduled 2–3 matches per week are situations in which the objectives and results obtained should be evaluated differently and the strategies to apply must also be personalised at these times.

Applicability of concepts

One practical example of the applicability of the explained concepts may be the family of cytokines of which interleukin 6 (IL-6) is one. With its duel significance dependent upon

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Table 1 Observe the tendency to increase the inflammatory biomarkers such as IL-6 from mid season (blue) up to the weeks of maximum competition (red).

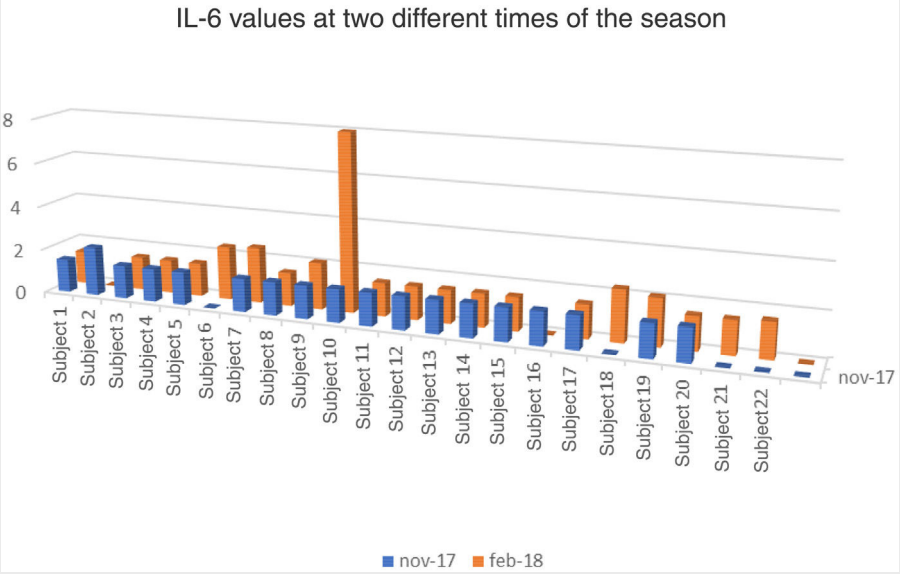

Table 2 Practical examples of the function of different biomarkers and their practical application.

Biomarker	Function	Interpretation
Growth hormone	Promotes protein synthesis	Chronic low levels could reflect lower potential of adaptation to training[1]
Insulin-like growth factor 1 (IGF-1)	Anabolic mediator of the growth hormone in the skeletal muscle. Indicator of restful sleep	Prolonged low levels could affect training or changed muscle adaptations to training[2]
Testosterone	Induces protein synthesis, reduces muscle catabolism, promotes production of red blood cells and replacement of glycogen	Prolonged low levels may affect training or altered anabolic potential[3]
Cortisol	Catabolic hormone with immunosuppressant action. Increases during exercise and 2–3 h afterwards leading to infections. Presents a circadian rhythm which changes with matches, trips, etc.	Continuously raised levels affect training, inadequate recovery or inadequate protein synthesis[2]
Testosterone/cortisol ratio	Anabolic/catabolic balance	Chronically reduced ratio may affect training, proteolysis or lowering of protein synthesis[3]
Dehiyroepiandrosterone (DHEA)	Precursor hormone of androgens which counterbalances the effects of the cortisol	Chronically low values may indicate over-training[1]
Sex-hormone binding globulin (SHBG)	Testosterone and estradiol transporter	Chronic increase or reduction could lead to inappropriate recovery, over-training or inappropriate adaptation to training[2]
Luteinising hormone (LH)	Reproducer	Continuously low levels could indicate over-training[1]
Creatine kinase (CK)	Muscle enzyme	Muscle damage or raised training load[4]
Tryptophan	Amino acid	High levels indicate central fatigue or suboptimal adaptation to training[5]
Ureic nitrogen	Metabolite of muscle degradation	Increase indicates muscle catabolism[1]

Table 2 (*Continued*)

Biomarker	Function	Interpretation
Glutamine	Amino acid which participates in protein synthesis, immunity and neuronal plasticity	Continuously low levels could reflect fatigue or poor adaptation to training[1]
Glutamine/glutamate ratio	Ratio which reflects glutamine degradation	Chronically low levels could reflect poor adaptation to training and catabolism[1]
Inflammatory cytokines (IL-1b, TNF-a, IL-6, IL-8, IL-10)	Inflammatory mediators	Inflammatory mechanisms of adaptation to training, on training or lesion[1]
Acute-phase proteins (reactive C protein, E-selectin, P-selectin, Von Willebrand factor Fibrinogen)	Inflammatory response markers	Inflammatory mechanisms of adaptation to training, over training or lesion[1]
Homocysteine	Marker of the methylenetetrahydrofolate reductase (MTHFR) in the metabolism of vitamins B9 and B12	High levels may indicate mutation C677T of the methylenetetrahydrofolate reductase (MTHFR)[6]
CYP1A2 polymorphism of cytochrome P450 and ADORA2 of the adenosine receptor	Metabolism of caffeine	Determines the individual effect to caffeine due to changes in its pharmacokinetics and pharmacodynamics[7]
Anti-transglutaminase antibodies (IgA and IgG) and anti-peptide antibodies of deaminated gliadin (anti DGP)	Serological markers of celiac disease	Positives in celiac disease[8] **The combination of analyses and genetic tests enables differential diagnosis to be made between celiac disease and non celiac sensitivity to gluten.*
Genotype DQ 2,DQ8	Genetic markers of celiac disease	If they are negative rarely is a celiac disease present. Positives indicate higher predisposition to but not the disease[8]
Polymorphism allele 13910C/T of the lactase gene	Genetic marker of intolerance to lactose	Genotype 13910C/C is associated with low lactase activity[9]

time of measurement, it is a stimulus for muscle recovery immediately after exercise, but is also an indicator of accumulated inflammation when it progressively increases over time.

Table 1 demonstrates how as the season progresses and training sessions and matches accumulate, markers such as IL-6 which presented low values in most of a team at the beginning begin to increases despite providing recovery strategies such as nutrition and supplements with complementary antioxidants such as curcumin or tart cherry juice.

Another example could be raised levels of homocysteine which is an indicator of cardiovascular risk in the general population, but which has another significance as of yet unclear in sportspeople. In high-level competitive players this marker is often raised and high quantities of group B vitamins are required to control it. Its increase is often linked to unfavourable genetic variants of the methylation MTHER gene, and its determination may be useful for personalised supplementation with these vitamins. Other examples may be seen in Table 2.

The player trains and competes for limited periods of time when exercise provides global and major stimulus for the body, with a marked inflammatory, hormonal and immune response. However, for the rest of the day the opportunity arises to control basic aspects such as rest, diet and digestion, among other factors, which may help to optimise adaptation and progressive improvement of the sportsperson's performance.

In this regard, knowledge of genetic polymorphisms associated with individual sensitivity to, for example, caffeine, gluten or lactose may promote an individualised approach and specific personalised nutrition and medicine for the sportsperson.

During the season it is essential to be intimately aware of the player's development and their best values in order to work increasingly on the aspects which may specifically be improved.

Fatigue is regarded as the perceived incapacity to carry out planned exercise. Here not only muscle factors are considered to be reflected in the biomarkers showing the accumulation of lactate and acidosis, inflammation or immunity (peripheral fatigue) but on occasion the actual levels of these indicators may be high but well tolerated by the sportsperson thanks to their motivation and ability to cope with them due to their response or mental fatigue acting in a completely different way. For this reason information from isolated parameters such as high levels of CK or cortisol cannot be extrapolated as they may on occasion coincide with the player's maximum performance and it is a good idea to assess it comparatively with their individual profile and if possible with their historical value data.

It is not advisable to assess the player simply by the presence of some of these changes, but to try to make them meaningful by focusing on continuous adaptation and improvement against situations of controlled damage or **hormesis.**

An improvement in the individual's general condition is sought, on the understanding that to reach this may be different in each case, but that the goal is for each player to perform their best, thus leading to group improvement.

Conclusions

During the course of a season it is essential to control how sportspeople tolerate the different workloads which they endure. One of the main ways of doing this is a biochemical control of each individual sportsperson's state of fatigue and recovery at different times in the season.

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