



Pharmaceuticals and Sport

by Dr Albert Dirix

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His numerous scientific papers have been translated into several languages and have been the subject of lectures given in the various continents.

We thank him cordially for allowing us to publish his study on pharmaceuticals and sport.

Introduction

Pharmaceuticals are being used more and more often in sport. It is primarily a matter of studying the use of these substances with a view to helping athletes in their efforts. "Biological preparation" is the administration, particularly before a competition, of certain substances, in addition to those found in food, with a view to improving performance.

This study seeks to analyse the advantages and disadvantages of the substances used by studying their biochemical, pharmacodynamic and, where applicable, toxicological properties.

Despite the wide scope of the subject, an overall study of the problem is envisaged. Its aim is to draw practical conclusions for the physician who accompanies athletes.

The analysis will deal successively with vitamins, minerals, cardiovascular and respiratory drugs, psychotropic drugs,

hormones, special cases and sundry subjects. Biological preparation as practised by the author will then be explained.

The author's personal experience has been compared with that of numerous sports' physicians of eminence whom he has had the privilege of meeting during great world competitions. A considerable number of references have been consulted and the work of Creff and Bérard has been used for the two first sections and that of Noirfalise, Heusghem, De Vleeschlouwer and Moerman for the others. The paper does not cover certain means used to improve physical performance, such as psychological techniques and hypnosis, and physical techniques, such as chafing, heat therapy, electrotherapy, mechanical therapy and massage, or courses of treatment at high altitude.

The use of medicaments as means of treating illnesses or injuries is not dealt with in this paper.

Finally, it must be pointed out that the effects of the products analysed will be studied objectively but no opinion will be expressed as to whether or not they should be considered as doping agents.

I. Vitamins

Generally, in countries where the diet is varied there are no vitamin deficiencies.

However, considerable effort may increase the amount of vitamins required and increased intake of vitamins may have pharmacodynamic properties stimulating the metabolism.

1. *The biological analeptics* are the vitamins in the B group (B1, B6 and B12) and vitamin C.

1.1 *Vitamin B1 (thiamine)*

Numerous authors seem to agree that vitamin B1 has valuable tonic properties leading to better performance, with a decrease in recovery time, reduction in fatigue, and disappearance of muscular cramps.

Other authors however are much more cautious and claim that extra vitamin B1 has no effect. These differences of opinion arise from the fact that some individuals are saturated in thiamine, whereas in others there is a direct deficiency, which is rare, or an indirect deficiency, which is far from exceptional: it may arise in the case of diets containing too much refined sugar or

after excess intake of alcohol, in certain types of chronic colitis and sometimes after administration of antibiotics resulting in changes in the intestinal flora.

There is a danger of a toxic effect being caused by massive doses (e.g. 2 g), and intravenous administration may cause shock.

1.2 *Vitamin B6 (pyridoxine)*

This improves muscular metabolism, particularly in the heart muscle.

Chailley-Bert and Plas have demonstrated that the functional disorders accompanying peculiarities of the electrocardiographic trace in the S-T segment regress following rest, a diet rich in carbohydrates, and administration of vitamin B6.

Intolerance has been reported following a high dose of 1 g given intravenously.

1.3 *Vitamin B12 (cyanocobalamine)*

There is no fear of deficiency. Its tonic protein effect may be sought when there is a problem of enlarging the muscular mass. Use of this vitamin is justified in certain types of anaemia.

1.4 *The B complex*

Numerous experiments have given divergent results which may be ascribed to the differences in the nutritional status of the person concerned. Nearly all authors advocate a moderate intake during muscular exercise with a view to alleviating certain inapparent deficiencies.

1.5 Vitamin C (*ascorbic acid*)

Vitamin C plays an important and many-sided biological role. Through its redox properties it catalyses cellular respiration and regularizes various enzyme systems. Through its action on the bone marrow and on iron resorption it stimulates the production of red blood corpuscles and haemoglobin. Through its decisive influence on the formation of collagen, ossein and dentine it plays part in the formation and repair of the tissues of the skin, bones and teeth.

Finally, through its role in antibody formation and the part it plays in the phagocytic activities of leucocytes and in the production of the adrenal hormones, vitamin C participates very closely in the protection of the body against infection, toxic agents, and antigenic effects, and contributes to resistance to fatigue and adaptation to cold. Excessive intake of the vitamin may cause diarrhoea, insomnia, excitation, acidotic disorders, bradycardia, and cramps.

2. *The other vitamins*, including vitamin P.P., pantothenic acid and folic acid are of less interest.

Vitamin B2 or riboflavine is used in muscular cramps.

3. *Fat-soluble vitamins*

Increase of the intake of these vitamins in the diet of athletes and games players seems to be of no particular urgency, especially since an excessive intake may present real dangers.

Vitamin A can be recommended for night work.

There is no reason to increase the intake of vitamins D, E, and K in adult athletes and games players.

An excess of vitamins A and D may have harmful effects.

Conclusion

Athletes are now being given high doses of vitamins and this may have certain disadvantages.

Under normal conditions of good health and correct nutrition there will be no vitamin deficiency.

However, a deficiency may arise as a result of disorders of absorption, and increased vitamin intake is then indicated, as it is in the case of intense physical exercise.

The author prefers the polyvitamins, which are synergic, associated with minerals during the period before the competition and with vitamin B complex and vitamin C during the period of intensive training and the competition itself.

II. Minerals

Absolute deficiencies are rare and relative deficiencies a little more common.

1. *Sodium and chlorine* fall markedly after copious perspiration, protracted physical effort and in hot weather, thus causing fatigue, cramps, and insomnia.

Under these circumstances previous taking of salt increases endurance.

Losses of *potassium* must also be compensated by administration of

that element, which is also indicated in hypoglycaemic conditions following intense muscular fatigue.

2. *Magnesium, phosphorus, sulphur, and iodine* are found in normal quantities in a balanced diet.

3. *The trace elements*

Fluorine, zinc, cobalt and other substances, including copper and manganese, are also found in normal quantities in a balanced diet.

4. *Calcium*

Young persons whose calcium requirements are large may find a deficiency if their intake of dairy products is inadequate.

5. *Iron*

This is indicated in cases of inapparent anaemia, which are more common than is generally believed, and also when sport is practised at high altitudes, and sometimes in women during their menstrual periods.

III. Medicaments affecting the cardiovascular and respiratory systems

1. *Respiratory tonics* such as camphor and its substitutes, lobeline, Micorene, etc. are used with a view to stimulating the respiratory centre. It is extremely doubtful whether they are of any value.

2. *The bronchodilators*, such as adrenalin and isoprenaline, often produce untoward reactions such as palpitations, arterial hypertension and hypotension, etc.

3. *Cardiotonics*, particularly the digitalis heterosides, only have an effect in incipient heart failure.

4. *The cardiac stimulants* (camphor, nikethamide) have a stimulating effect on the heart through the bulbar centres. They are of no value for athletes.

5. *Vasoconstrictors*, such as adrenalin and its derivatives, are primarily used in cases of general hypotension and collapse. Their hypertensive effect will hardly be of any value during or after physical exhaustion in an athlete.

In normal individuals they are altogether inadvisable.

6. *The vasodilators* (nitrites and derivatives of nicotinic acid) are inadvisable because of their hypotensive effect, and their untoward indirect effects on the heart may bring about circulatory collapse.

7. *Beta-adrenergic blocking agents* reduce exercise tachycardia and stress in ski jumpers.

IV. Psychotropic drugs

A. *Psychoanaleptics*

1. *Psychostimulants*

1.1 Cocaine stimulates the cerebral cortex and brings about a short-lived improvement in the physical and psychic processes but its side effects (hallucinations) present serious dangers.

1.2 The methylxanthines (caffeine and theophylline) increase physical and mental activity and reduce fatigue. At high doses they have unpleasant effects.

1.3 The phenylamines (amphetamines and methylamphetamines) have marked excitatory effects. Like ephedrine, the amphetamines are indirect sympathomimetics and have a marked effect on the central nervous system. Ruptures of tendons are said to be more frequent after use of these products.

Their physical effects are numerous: euphoria and disappearance of a feeling of tiredness.

These medicaments are dangerous and may cause death and addiction. Mention should also be made of mephenteramine (Wyamine), phenmetrazine (preludina) and a theophylline-amphetamine complex (Captagon).

1.4 The piperidines (Rilatine) have a stimulating effect on the central nervous system but are less dangerous. Opinions are divided concerning their effect on performance.

According to Segers et al., dextrorotatory amphetamine, when used in experiments, is found, beyond doubt, to be unfavourable to adaptation to effort, in regard both to physiological and biochemical indices and to changes in the electrocardiogram. Certain athletes claim that the effect may be temporarily beneficial in competitions of long duration. This is reasonable since the product diminishes the subjective feeling of fatigue. Autosuggestion may be important: in one case injection of

distilled water instead of amphetamine gave excellent results during a world championship.

2. *Antidepressants*

The mono-aminooxidase inhibitors (Marsilid, Marplan, Niamid, Sursum) combat anxiety and depression and induce euphoria and excitation, but also sometimes cause hypotension with collapse when certain other drugs are administered concurrently.

These inhibitors have been succeeded by derivatives of dibenzazepine (imipramine: Tofranil).

B. *Psycholeptics*

These reduce mental activity. Narcotics, hypnotic agents, and neuroleptics tend to reduce physical capabilities, (meprobamate, Atarax, Postafene, Librium, Valium) just as alcohol does in its second phase after causing transient excitation; they may however be useful in fighting insomnia.

V. **Hormones**

1. *Male hormones* or androgens: testosterone, methyltestosterone, etc. These natural or synthetic hormones contribute to the development of the muscular system and the secondary sexual characteristics.
2. *The anabolic steroids* derived from testosterone are regularly administered by certain people. These are protein anabolic agents which increase body weight and contribute to the development of the muscular system: although theoretically they have no androgenic activity, they may produce signs of masculiniza-

tion. They are used in competitions where increase in the size and strength of the muscles is important: weight-lifting, putting the shot, discus and javelin. Some authors ascribe to these substances the property of improving the effects of muscle training. It must however be pointed out that this effect must often, and to a large extent, be attributed to the training itself and to a protein-rich diet. In other branches of sport, increase in weight and water retention are harmful to performance. These hormones are also used in cases of emaciation and hypotension, in the latter case in combination with deoxycorticosterone.

The harmful side effects after administration of moderate doses are few, but abuse may give rise to pathological effects: obstructive jaundice, hypertension following water retention, and in man impotence, disappearance or reduction in spermatogenesis, and acne. In women it may take the form of hirsutism and disorders of the menstrual cycle, while in adolescents, premature closure of the epiphysial cartilages may arrest growth.

It is generally believed that these products are administered only during training periods. While that may have been the case, several years ago, at the present moment numerous athletes are said to take the products all the time.

3. *Female hormones*, oestrogens and progestative agents. These have the property of suppressing ovulation and modifying the menstrual cycle.

To determine whether they might be useful, it is necessary to know whether the athlete's performance is diminished or increased during the menstrual period, since this problem is extremely individual.

4. *Adrenocortical hormones*

Administered by some people, the natural glucocorticoids and their synthetic substitutes have a powerful effect on the carbohydrate metabolism, possess anti-inflammatory and antishock properties, and stimulate the central nervous system. Untoward effects may arise from protracted use: metabolic and neuropsychic disorders, gastric ulcers, aplasia of the adrenal cortex, etc.

No favourable effect on the cardiovascular system has been demonstrated in normal persons and there are no experimental results concerning their effect on athletic performance.

5. *Pituitary hormones*

A.C.T.H. (hypophysial adrenocorticotrophin) stimulates the adrenal cortex. The product is administered to some racing cyclists.

Conclusion

The use of hormones is indicated in certain pathological conditions. In the training of athletes they may be of no value in certain cases, or have a beneficial effect or yet again be completely contraindicated in other cases.

These substances are in no way without pathological side effects and for that reason are often considered as doping agents.

VI. Special and sundry cases

1. *Strychnine*

This stimulates the senses, and increases the reflexes and muscle tone. High doses are toxic.

It is still widely used in sporting circles but less so than a few decades ago.

2. *Ibogaine*

This is an extract of oriental shrubs and contains three alkaloids which excite the central nervous system.

3. *Placebos*

These have moderate value and untoward side effects despite their inert nature. The frequency of their useful effects is balanced by the frequency of the untoward results obtained. The number of cases where they make no difference is quite high.

While the effect of a placebo is primarily psychological, the influence of psychogenetic circumstances, such as the people surrounding the athlete, competition and encouragement, is not without its value but may also have harmful effects. Possibly the valuable effects of meprobamate are partly due to the inhibition of phenomena of this kind (Seegers et al.).

4. *Aspartate*

In normal non-fatigued subjects who have to make an effort, aspartate has quite a moderate favourable effect and harmful effects of almost equal extent.

The frequency of indifferent results is very high. The substance seems to be useful during recovery.

5. *A.T.P.*

It is extremely doubtful whether this substance could have any real value as an agent against fatigue.

6. *Oxygen therapy*

In the form of inhalation of pure oxygen, this may be of value after exhausting physical effort. The acidosis that develops during peak muscular effort is the manifestation of an oxygen deficiency. The intake of pure oxygen may, under these circumstances, reduce the duration of this phase of metabolic acidosis and thus shorten the period required for physical recovery.

7. *Prevention of injuries*

Hyposideraemia has unfavourable effect on the occurrence of tendinitis.

8. *Diuretics*

These are used to reduce weight and eliminate the need to urinate during the competition.

9. *Alkalis*

These are designed to bring about alkalosis before physical effort but seem ineffective.

10. *Analgesics*

Acetylsalicylic acid and other substances which act against pain or inflammation may be useful in the prevention of muscle pains.

11. *Dietary products*

These may be useful when protein intake must be increased or when the meal schedule is disrupted.

Biological preparation of athletes

When we accompany teams going to the important international competitions, such as the World Championships or the Olympic Games, we administer the following products:

1. *In the period before the competition*

Polyvitamins combined with mineral elements: one dose daily for three months with interruptions. In the case of a deficiency detected by complete biological testing, other substances must also be administered. Thus, in several cases of moderate anaemia, antianaemic agents and iron have been administered.

2. *Period of the competition and intensive training*

Vitamin B complex (B1 - 100 mg plus B12 - 15 y plus B6 - 150 mg). One dose a day in addition to 1 g per day of vitamin C.

When it is very hot and in cases of copious perspiration, potassium and salt must be added.

For protracted competitions like cycling road races, coffee or tea as well as dextrose are useful.

3. *Period between and after competitions*

Alkaline agents may be administered, together with agents to combat fatigue, such as the aspartates.

Conclusion

The aim of this paper is to summarize the physiopathological aspects of the biological preparation of athletes in order to provide objective information both for the doctors concerned with preparing athletes for competitions and to those given the extremely complicated task of drawing up a list of doping agents.

A multiplicity of products is used: some of them markedly under the influence of a vogue whereas others are left aside immediately when the athletes know that they are forbidden and can be identified by laboratory examination.

All the substances, even those which are harmless, may have a favourable psychological effect. Dangerous substances may be dangerous in the long term (amphetamines) or in the long term (amphetamines and hormones).

The part played by the physician is most important since he is the one who establishes good or bad habits among the athletes. He must consider, before deciding, whether the administration of certain substances is useful or dangerous, and must not let himself be guided by considerations of a financial nature, personal prestige or excessive nationalism. The physician's assistance to the athlete will spread over the domains of hygiene, dietetics, biological preparation and psychology, all in cooperation with the trainer. Under such conditions an improvement in the performance and health of the athlete can be counted upon within reasonable limits.

A. D.

Bibliography

1. Beecher, H.K. and Smith G.M., Drugs and athletic performance. Doping. Pergamon, Oxford, pp. 133 - 146, 1965.
2. Blatter K., Imhof P., Il ruolo dei beta-recettori adrenergici nella tachicardia da stress emotivo: indagini radiotelemetriche in saltatori con lo sci. Schweiz. Zeitschr. & Sportmed. 17, 131, 1969.
3. Creff A.F., et Bérard L., Sport et Alimentation. Physiologie nutritionnelle et Diététique des activités sportives. Vigot Frères 1963.
4. Creff A.F. et Canu L., Les crampes. Médecine du Sport. No 3, 1970 p. 47-143, 52-148.
5. De Schaepdrijver A. Farmakologisch Vademecum. Drukkerij L. Vanmelle N. V. Gent 1968.
6. Schaepdrijver A. et Hebbelinck M., Doping, Pergamon, Oxford 1965.
7. Dirix A., Physio-pathologie de la préparation biologique. Cours International Assoc. Hellén. Sport - FIMS - Athènes 1970.
8. Dirix A., l'Alimentation du coureur cycliste sur route. Xlle Congrès International de Médecine sportive - FIMS - Moscou 1958.
9. Dirix A., l'Alimentation à l'âge scolaire et à l'adolescence et l'entraînement physique. Congrès Mondial d'Education Physique, Bruxelles 1958.
10. Hanekopf Günther, XVI. Weltkongress für Sport-Deutscher Ärzte-Verlag, Köln - Berlin 1966. medizin. Hannover.
11. Hendrick A., en De Moor P., Vitamines in de dagelijkse praktijk. Universiteit Leuven.
12. Imhof P., Les stéroïdes anabolisants sont-ils indiqués pour l'amélioration des grandes performances sportives? Médecine et hygiène. Genève 9 octobre 1968.
13. Kato Kitsuo. Sport Sciences 1964. Proceeding of International Congress University of Tokyo Press Hongo.
14. Kúcera M., Slezák Z., Praha. Die Verletzung von Achillessehnen bei den pharmakologisch behandelten Sportlern. Abstracta. Symposium de leasionibus tendinis Achillis apud athletas. Prague 17-18 XI 1966.
15. Lederer J. Diététique du Médecin Praticien. Masson et Cie. Editeurs Paris 1957.
16. Lucking Martyn. Summary on Anabolic Steroids. (IOC) 1966.
17. Metevier Guy. Enzymatic and ionic changes in man associated with physical work. Journal of Sports Medicine and Physical Fitness. Vol. 9. Nr. 2. 1969. P. 186.
18. Noïrfalaise A., Heughem C., De Vleschhouwer G. R. et Moerman E., Les substances dopantes. Extrait des « Annales de Biologie Clinique », Nr. 3-4 mars, avril 1968 (pp. 249-272).
19. Petit J.M., Delhez L., Pirnay F., Koninckx N., Action physiologique des drogues sur les facteurs limitatifs du travail musculaire et de la performance sportive. Institut Malvoz, Liège, Belgique, 1970.
20. Plas F., Surrénales et sport. Médecine et Hygiène. Genève Nr. 841-9 octobre 1968.
21. Poortmans J.F., Biochemistry of Exercise. Medicine and Sport. Vol 3, Karger, Bâle 1969.
22. Poiletman R. M., Miller H.A.—The influence of Wheat Germ Oil. Journal of Sports Medicine and Physical Fitness. Vol. 8 Nr. 1 Mars 1968.
23. Prokop L., Die Mineralstoffe der Milch. Österreichisches Journal für Sportmedizin - 1. 72. p. 19.
24. Prokop L., Multivitamine bei Spitzenathleten. Ärztliche Praxis 1969, Jg. 21, Nr. 52, S 3005.
25. Prokop L., Vitamine und Sportliche Leistungsfähigkeit. Österreichisches Journal für Sportmedizin - 1.71 P. 17-21 (Réf. 27).
26. Regozkin V.A., Application of Vitamine to speed up acclimatisation of Sportsmen to hypoxia. Journal of Sports Medicine and Physical Fitness. Vol. 9 Nr. 3 - Sept. 1969 P. 204.
27. Repertorium Verpakte Geneesmiddelen. Uitgeverij de Toorts, Haarlem. Nederland le Editie 1970.
28. Segers Prof. Dr. M. et collaborateurs. Travaux de Service d'études de l'INEPS. Vol. 1 - Bruxelles, Belgique. 1962.
29. Suchianu G. Alexandry, La preparación biológica del deportista. Medicina de la Educación Fisica y el Deporte. Nr. 15-1970-P. 39-48.
30. Van Rossum Prof. Dr. J. M. Vree, Drs. T.B. Doping middelen met centraal stimulerende werking. Nederlands Tijdschrift voor Geneeskunde. 1 Nov. 1969 Nr. 44.
31. Vorobiev A. Revue Olympique. Lausanne 34-35 1970.
32. Willems B. et Ostijn M., Travaux de la Société Med. Belge d'Education Physique et de Sports 1963. 16. p. 36-44. Invlved van ferro-aspartaat op de restauratie na lichamelijke nispanning.
33. Wuscheck H., Kempe G., Ahrendt E., Berlin. Hyposiderämie bei chronische Achillodynie. Abstracta Symposium de leasionibus tendinis Achillis apud athletas. Praege. 17-18. XV. 1966.

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