SPORT AS A MEDICINE

Lt-Colonel Dr. Peter Jenoure (SWI)

Health is not everything, but everything is nothing without health.

Arthur Schopenhauer

Introduction

For reasons probably connected above all with financial considerations, health problems have for some times ceased to be the exclusive concern only of the medical and paramedical professions. Politicians, economists and other specialists are now showing interest in the subject with the aim of maintaining good health and making it accessible to as many people as possible. From whatever angle these problems are looked at, almost everybody attaches the utmost importance to good health. For human beings, it represents essential "capital" enabling life's aspirations to be realised, and it is in everybody's interest that this "capital" should be preserved and, if possible, augmented.

Sport has long since evolved from an aristocratic hobby into a major social phenomenon involving all classes of the society. Its growth is not yet at an end, and it is reasonable whether there is in fact a limit to it. In the media, sport occupies a very prominent place, and when we consider how many columns in the newspapers and how many hours of broadcasting are devoted to it, we can unhesitatingly say that it seriously competes for public attention with politics, the economy, the sciences and culture. Where medicine is concerned, sport has become a true partner, not only furnishing doctors with material in the form of injuries, but – conversely- also constituting a valuable means of promoting health.

The significance of sports as a promoter of health was recognised very early on. The newly fledged discipline of sports medicine aims to act as the link or intermediary between health and sport. Particularly where prevention is concerned, sports medicine can – indeed must- play an important role. Prevention is the concept underlying the sport-health relationship, and there is a splendid opportunity for sport to make a welcome contribution in the battle against disease and degenerative processes in the human body. On the other hand, medicine can count itself fortunate in having found in sport an ally to help it achieve its ends.

Training

Specialists are often reproached – and rightly so- for taking too narrow a view of the world and its problems and perceiving only what is relevant to their particular field. This criticism applies with special force to doctors, who have a regrettable tendency to see everything from the biological standpoint. The same is true of sports doctors, who – few though they may be – regard sporting achievement as nothing more than the sum of physiological laws, biochemical reactions and biochemical principles. These they se as the explanation of event the most spectacular sporting successes. It may perhaps be an exaggeration to regard sporting activities from this aspect alone, but we cannot escape the fact that the human body capable of these spectacular achievements is a biological system whose functioning is undeniably dependant. On biological and medical parameters, whether these lie in the domain of physiology, biomechanics or elsewhere. An increase in sporting ability calls

for appropriate stimuli capable of inducing the desired adaptation in the system concerned. Such stimuli are characterised by their intensity, density (temporal relationship between the action and the recovery phase), their duration and amplitude (duration and number of stimuli per training period) as well as by the training frequency (number of training period per day or week). Decisive for the training effect is not only the quantitative but also the qualitative aspect of the training. The same applies to the recovery phase since the period of physical effort is followed by a temporary period of reduction in physical performance due above all to exhaustion of the body's energy reserves. The recovery phase, however, is marked by a renew increase in physical performance to a level higher than the initial level as a result of overcompensation. Optimum timing of the training stimuli brings the desired increase in performance.

The human body possesses an attribute of cardinal importance for the survival of the human race, namely the ability to adapt. Apart from the quantitative and the qualitative factors affecting the body's adaptation reactions, we must also bear in mind the specific conditions the exertion stimulus must meet. This is especially important in the light of the very different ways in which the various body tissues react.

Current methods of training embrace the following fields: endurance, aerobics and anaerobics, strength, mobility, agility and coordination. As often in nature, there are no sharp boundaries between these specific fields and they inevitably overlap to some extent. Their differentiation both practically and theoretically, however, is of great importance. It must again be stressed that the specific forms of training named are based on the different ways the various body systems react to stimulation. The adaptation reaction accords precisely with the type of stimulus applied. This means that qualitatively the different training stimuli are not interchangeable. For each element of motor function, there is a specific, well-defined form of training with which the desired increase in performance can be achieved. The attached table, which is not intended to be exhaustive, summarizes the body adaptation reactions that have so far been observed in the course of specific training programmes.

It will be clear from this list that specific training can improve not only the visible and measurable adaptation reactions, but also other functions of importance for sporting performance as well as for health in general. A body subjected to all-round training is better able to cope with stresses and can adapt more effectively to increased physical demands. Performance is thus improved and with it the results in sporting contests. At the same time, the body recovers more quickly from any given exertion and the fatigue this induces is less severe.

Prevention of illness by sport

As we have seen, regular physical exercise performed in accordance with the well-defined rules can greatly improve the functioning of various body systems. Conversely, the lack of exercise characteristic of the modern way of life has been shown to result in a whole series of symptoms. The widespread tendency towards insufficient exercise can be likened to time bomb in that disease, particularly of the cardiovascular system, is the result: though we have succeeded in reducing the incidence of infective diseases and drastically lowering infant mortality, the frequency of cardiovascular disease continues to increase. This situation is aggravated by the fact that it applies to an inactive sector of the population. Too little physical exercise causes atrophy marked by various phenomena conductive to arteriosclerosis, namely overweight, high blood triglyceride levels, high blood pressure and diabetes, to name only the

most important. Lack of exercise is moreover the cause of postural defects, that is to say weakness of the musculoskeletal system as well as psychophysiological disorders. Even though exact scientific studies on the preventive effect of exercise on pathogenic factors in the cardiovascular system are still lacking – and will probably remain so in the near future- there is already considerable evidence that such an effect exists.

Training, especially endurance training (running, cross-country, skiing, swimming, cycling) has direct beneficial effects on the heart. One of the first of these is a reduction of the heart rate due to a change in the autonomic nervous system, namely transfer of autonomic balance from sympaticotonic to vagotonic control. A fall in the level of cathecolamines after several weeks' training has been reported by many investigators. The fall in the heart rate means that the heart works more efficiently and is less highly stressed. This effect alone would seem to afford considerable protection against myocardial infarction. After more intensive training, even morphological changes in the heart muscle have been observed (figures 3a and b). These take the form on the one hand of ventricular enlargement and on the other of hypertrophy of the cardiac wall. Both these changes likewise contribute greatly to more efficient functioning of the heart, above all as a result of an increase in coronary circulation due to the lengthening of the diastoles. Finally, regular endurance training also increases the supply of blood to the heart muscle through increased cappilarization.

Endurance training not only improves cardiac functions, however, but also counters other risk factors that promote degenerative cardiovascular disease, for example high blood pressure. As numerous studies have shown, long-term endurance training of moderate intensity has a beneficial effect on various forms oh hypertension. The best response is shown by subjects with mild primary hypertension and hypertensive disorders of regulation. It must be borne in mind, however, that physical training is not treatment of choice for any of the various forms of hypertension and that careful attention must be paid to the known contraindications.

Overweight is an important risk factor that is favourably influenced by physical exercise. This effect is due to the increase in calorie utilisation, optimisation of the metabolism and reduction in appetite that follows physical exertion. Weight loss can also be due to other effects, for instance stimulation of blood sugar regulation. Body activity normalises insulin metabolism and thus affords protection against diabetes, another major risk factor. Aerobic endurance training also protects against cardiovascular disease as a result of its effect on the plasma lipoproteins, the level of which is in general lowered by this form of training. Moreover, the vasoprotective members of this group-the HLD fraction-are significantly increased by regular training.

Among the cardiovascular risk factors, a dominant role is played by stress. Epinephrine, the hormone said to enhance performance alertness, induces a series of psychosomatic reactions which ultimately lead to numerous harmful effects on health in general. These effects can be mitigated by training, which neutralizes the stress-induced sympathicotonic stimuli. It will be clear from the foregoing that participation in sport affords highly effective prophylaxis against one of the principal causes of illness in the civilised world. In view of the ensuing great improvement in the quality of life we cannot see too high a value on this prophylactic effect.

The favourable effects of the aerobic endurance training are well attested and have been confirmed by accepted scientific criteria. Although this is not true to the same extent of

other forms of fitness training, it seems that strength and mobility exercises are also beneficial to health. The dangerous nature of cardiovascular disease is well known, but it would be wrong to underestimate the importance of disorders of the musculoskeletal system. From the economic standpoint, back pain, for example, is one of the commonest causes of absenteeism, and skeletal pain is one of the commonest reasons for consulting a doctor. Here, we must bear in mind the protection afforded by the muscles as a result of their unique bracing effect. If the muscles are weak, the forces produced by physical exertion are borne by the passive components of the musculoskeletal system, namely the bones, cartilage, joint capsules and connective tissues, all parts of the body, not as a rule capable of bearing such heavy loads. This risk can be effectively countered by training of moderate intensity, which usually involves little or no additional strain on the body. Such an exercise programme, supplemented by a suitable mobility training (for instance stretching) and pursued throughout life, can prevent the premature appearance of postural defects and the resulting adverse effects on health. Rehabilitation programmes have long been based on these principles, and the training methods mentioned occupy a special place in them.

From the foregoing remarks on the preventive function of sport and physical activity in general, it is clear that regular physical exercise has a favourable effect on many biological functions of the human body. The heart, muscles, musculoskeletal system and endocrine system, together with certain immunological (anti infective) and metabolic functions, all benefit from the stimulation caused by physical activity. To this must be added the increase in mental well-being – which plays an important role in the maintenance of health as a whole – brought about by sport indulged in voluntarily, enjoyably and to the extent permitted by individual possibilities and needs. Promotion of sporting activities must be part of public society, for it is hard to imagine a more effective and more economical way of combating the cost explosion in the public health sector.

	Biological effects of the training	Type of training
Tendons	-Thickening	-Strenght training
Muscles	-increase in white, rapidly contracting fibres -increase in myofibrils (action/myosin) -physiological enlargement -increase in resting tone -increase in electrical excitability -faster transmission of impulses -activation of more fibres per unit of time -increase in glycogen and creatinine phosphate -increase in glycolytic enzimes -increase in alkali reserves -increase in red, slowly contracting fibres -increase in mitochondria -increase in myoglobin -increase in glycogen and fats -increase in oxidative enzimes -increase in oxygen uptake capacity -increase in anastomoses, opening of existing capillaries, possibly formation of new vessels, which improves vascularization.	-Strenght training -Elasticity training -Speed and resistance training -Endurance training
Blood	-increase in blood volume, increase in red cells, hemoglobin and alkali reserves -maximum pH value lowered	-Endurance training -Resistance training
Heart	-increase in weight (muscle mass), volume and residual volume -increase in maximum systolic volume, maximum minute volume and oxygen pulse -increase in lactic acid breakdown in heart muscle (lactic acid of skeletal muscle) -increase in oxygen difference in coronary region *-at rest*: reduction in frequency, minute volume and cardiac work increase in cardiac out put reserve	-Endurance training (long loading periods)
Circulation	-blood pressure amplitude lowered when resting, increased under load -improved peripheral vascularization (see under muscles)	-Endurance training
Respiration	-increase in chest volume -hypertrophy of respiratory musculature -increase in alveolar surface (formation of additional alveoli) -opening of additional capillaries -increase in vital capacity, maximum breathing capacity, maximum minute volume, maximum O^2 uptake capacity and diffusion capacity -respiratory minute volume and frequency lowered when resting; under load, and -increase especially in minute volume	-Endurance training
Endocrine glands	-increase in volume of adrenals, possibly also of anterior pituitray lobe	-Severe physical loading
Liver	-increase in glycogen content -increased metabolization of lactate (oxidation) -possibly enlargement of liver	-Endurance training
Nervous System	-more rapid psychophysiological adaptation to loading -optimization in functioning of various internal organs (see under heart, respiration) -vagotonia -development of dynamic stereotypes (learning process) -increase in loading tolerance (e;g; pain tolerance)	-General training -Endurance training -Technical and tactical training -Specific training depending on nature of load
Bones	-increase in thickness -morphological changes in bone and joint structure and in muscular insertions in bones	-Traction and compression loading
Joints	-thickening of cartilage -enlargement of joint capsules and ligaments -increased mobility and flexibility of joint capsules and ligaments	-Compression training -Strength training -Mobility training

Sport as Medicine

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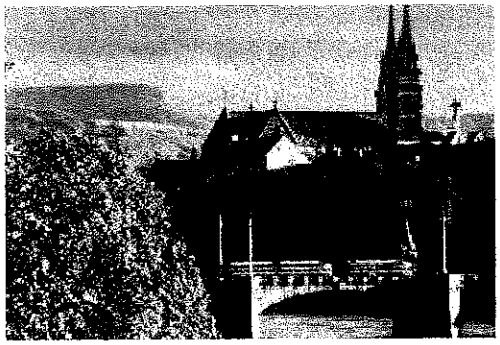

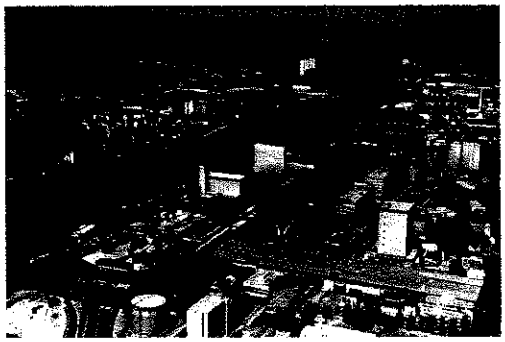

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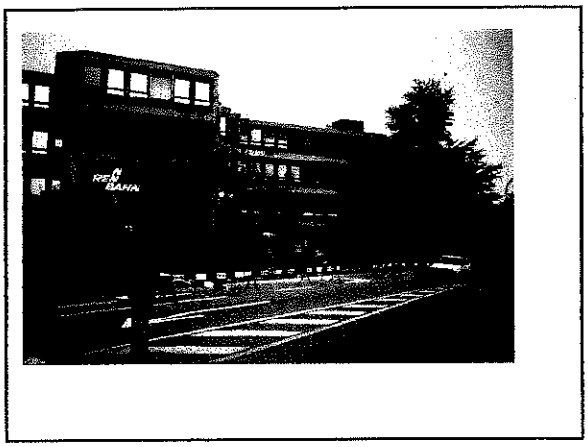

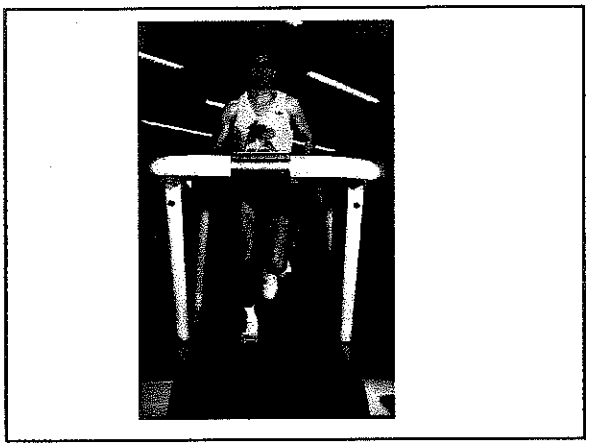

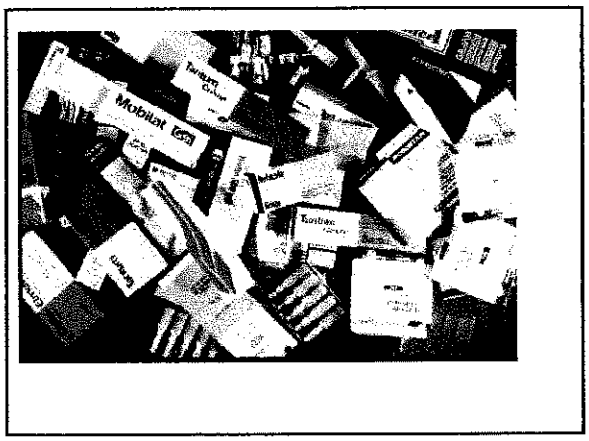
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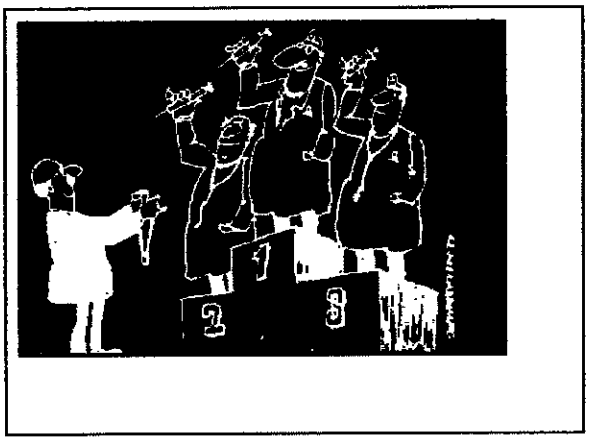
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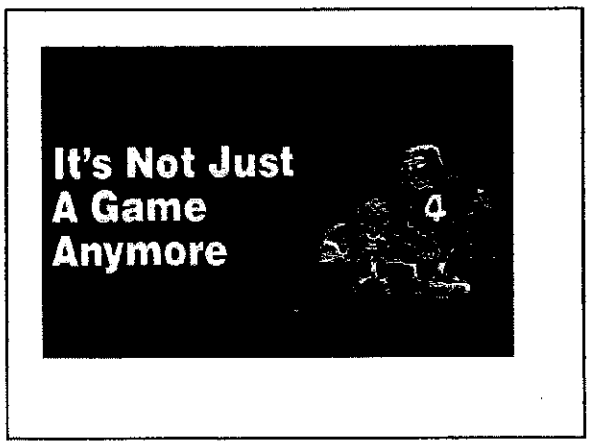
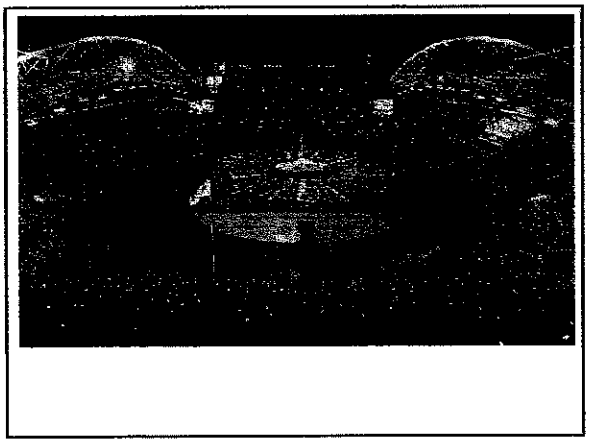
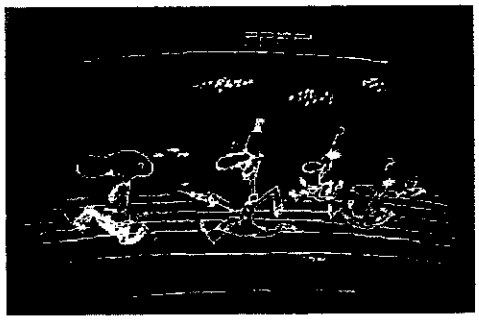
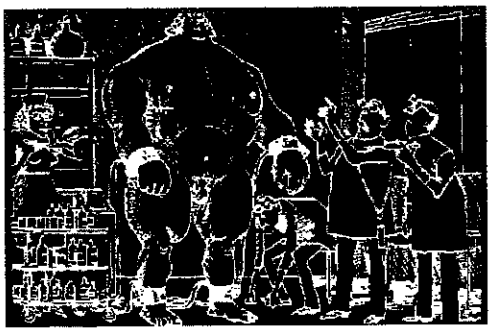
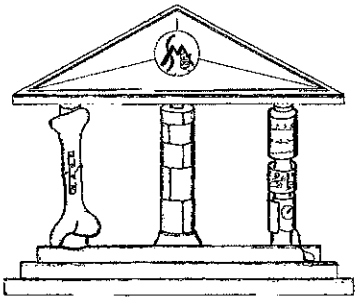
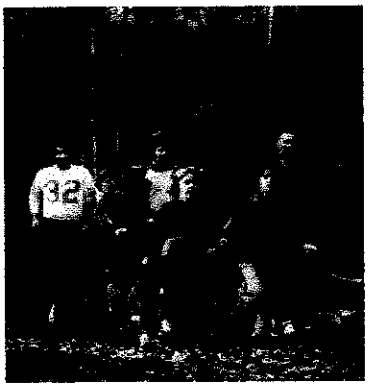

It's Not Just
A Game
Anymore



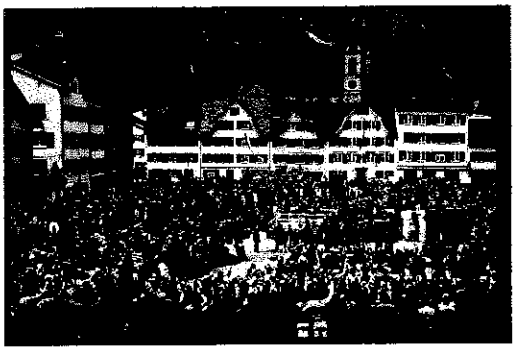




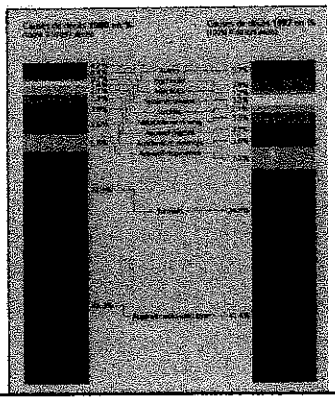




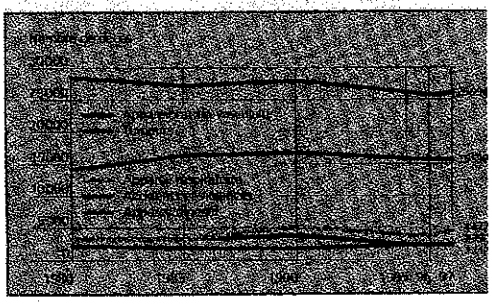
- *Sports medicine is a speciality using the conventional medical knowledge and related ones such as biomechanics, training sciences, psychology, etc. to give the right direction and support to all those practizing sport, whatever their age and level are, with the smallest risks for their health, better even, with benefit for it.*
- *Sports medicine will also help those, ill or disabled who could take profit of an adequate physical activity.*



Principales causes de décès



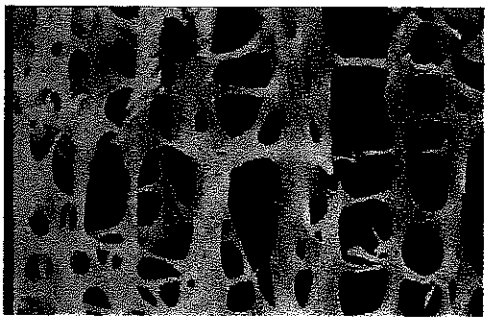
Evolution des principales causes de décès

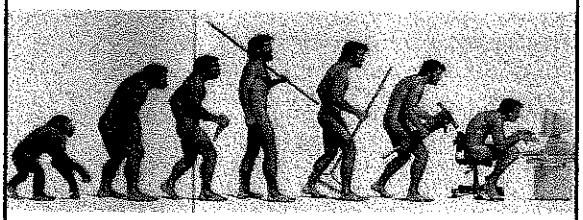


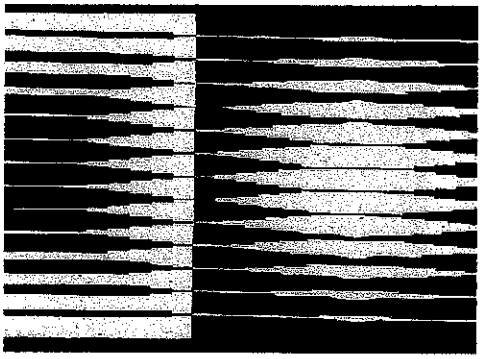
Différenciation des décès dus aux maladies cardiaques

Maladies cardiaques	1980	1997
Total des décès	19087	19071
Infarctus du myocarde et autres maladies cardiaques ischémiques	46.5%	58.3%
Insuffisance cardiaque et troubles du rythme cardiaque	11.7%	19.0%
Hypertension	0.6%	6.2%
Autres	35.2%	16.5%

- ***Increased blood fat***
- ***Diabetes***
- ***High blood pressure***
- ***Smoking***
- ***Obesity***







Effets indésirables

Il apparaît un blanchiment transitoire des muqueuses en regard de la zone d'injection.

Les réactions toxiques (témoignant d'une concentration anormalement élevée d'anesthésique local dans le sang) peuvent apparaître soit immédiatement, par injection intravasculaire accidentelle, soit plus tardivement, par surdosage vrai après injection d'une quantité excessive de solution anesthésique.

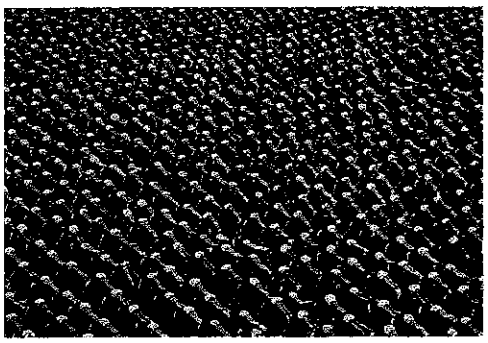
On peut observer:

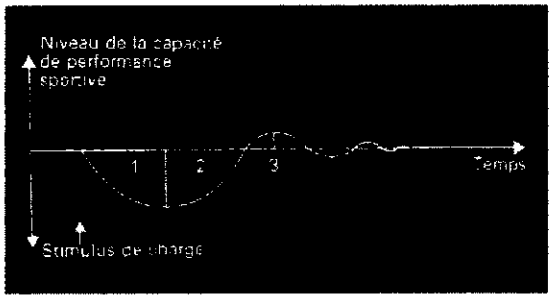
des symptômes relevant des effets sur le système nerveux central:

nervosité, agitation, bâillements, tremblements, appréhension, nystagmus, logorrhée, céphalée, nausées, bourdonnements d'oreille. Ces signes d'appel nécessitent une surveillance attentive à l'affût d'une éventuelle aggravation: convulsions puis dépression du S.N.C.

Sur le plan respiratoire: tachypnée puis apnée.

Des signes cardiovasculaires: dépression de l'inotropisme, hypotension artérielle; aux doses élevées: vasodilatation, collapsus, troubles de la conduction, bradycardie, bloc auriculo-ventriculaire, extrasystoles ventriculaires, tachycardie et fibrillation ventriculaire, arrêt cardiaque.




Niveau de la capacité
de performance
sportive
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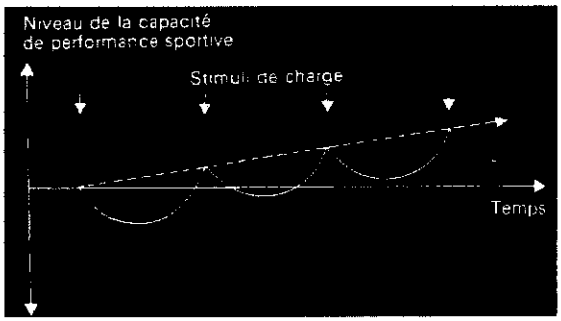
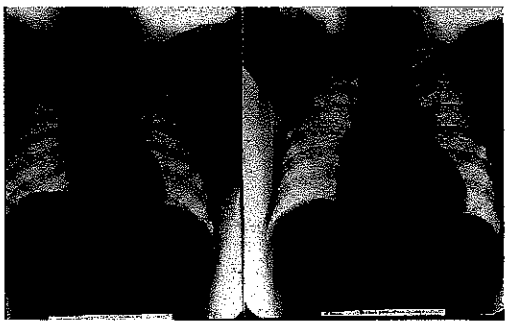
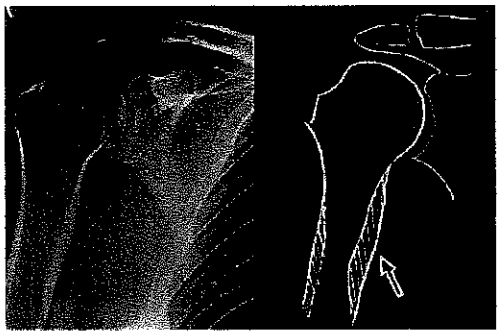
Temps
Stimulus de charge


Niveau de la capacité
de performance sportive
Stimuli de charge
Temps





- *Increase in white, rapidly contracting fibres*
- *Increase in myofibrils (action / myosin)*
- *physiological enlargement*
- *increase in resting tone*
- *increase in electrical exitability*
- *faster transmission of impulses*
- *activation of more fibres per time unit*
- *increase in glycogen and creatinine phosphate*
- *increase in glycolytic enzymes*
- *increase in alkali reserves*
- *increase in red, slowly contracting fibres*
- *increase in mitochondria*

- *Increase in myoglobin*
- *increase in glycogen and fats*
- *increase in oxidative enzymes*
- *increase in oxygen uptake capacity*
- *increae in anastomoses, opening of existing capillaries, possible formation of new vessels leading to improved vascularization*

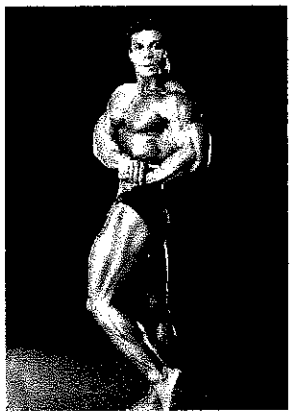
- *Tendons*
  - *increased diameter*
- *Joints*
  - *thickening of cartilage*
  - *enlargement of joint capsule and ligaments*
  - *increased mobility and flexibility of joint capsules and ligaments*
- *Bones*
  - *increase in thickness*
  - *morphological changes in bone and joint structure and in muscular insertions in bones*

- *Blood*
  - *increase in blood volume, in red cells, hemoglobin and alkali reserves*
- *Heart*
  - *increase in weight (muscle mass), volume and residual volume*
  - *increase in maximum systolic volume, maximum minute volume and oxygene pulse*
  - *increase in lactic acid breakdown in heart muscle (lactic acid of skeletal muscle)*
  - *increase in oxygen difference in coronary region*
  - *at rest: reduction in frequence, minute volume and cardiac work, increase in cardiac output reserve*

- *Blood pressure amplitude lowered when resting, increased under load*
- *improved peripheral vascularization (see under muscles)*

- *Endocrine glands*
  - *increase in volume of adrenals, possible also of anterior pituitary lobe*
- *Liver*
  - *increase in glycogen content*
  - *increased metabolization of lactate (oxidation)*
  - *possible enlargement of liver*

- *More rapid psychophysiological adaptation to exercise*
- *optimization in functioning of various internal organs (see under heart, respiration)*
- *vagotonia*
- *development of dynamic stereotypes (learning process)*
- *increase in loading tolerance (e.g. pain tolerance)*



- ***Physical Activity for the Chronically Ill and Disabled***
  J. Larry Durstine, Paricia Painter, Barry A. Franklin, don Morgan, Kenneth H. Pitetti and Scott O. Roberts
- ***The Role of Exercise Training in the Treatment of Hypertension (an update)***
  James M. Hagberg, Jung -Jun Park and Michael D. Brown
- ***Exercise Following Heart Transplantation***
  Randy W. Braith and David G. Edwards

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- *acute death*
- *acute injuries*
- *overuse injuries*

- *Cardio-vasc. Mortality* ↓
- *Life hope* ↑
- *Platelet aggregation* ↓
- *Blood rheology*
- *Fluidity* ↑
- *Oxygene need by myoc.* ↓
- *Sore of ventr. Arythmia* ↓
- *Lipid profile*
- *HDL* ↑ */ LDL* ↓
- *Triglycerid* ↓
- *Hypertensin* ↓
- *Tolerance to glucose* ↑

- *Bone density* ↑
- *Osteoporosis* ↓
- *Functional capacity (age)* ↑
- *Colic carcinoma* ↓
- *Depression* ↓
- *No overweight*
- *No smoking*
- *No absentism*
- *visit to doctors inc. for men*
- *visit to doctors dec. for women*
- *Injuries and Overload of the locomotion system* ↑
- *Arthrosis (knee, hip)* ↑
- *Sudden heart death*
- *Anorexia*
- *Sec. amenorrhea* ↑
- *Enteral hemorragies*