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Sports Medicine Today

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The growth of public participation in all forms of sport around the world is a phenomenon of modern times. In the United States, competition in sports and the number of forms of sport began to increase in the 1920's; this growth accelerated after World War II and has apparently still not reached its peak. The most recent development has been the unparalleled interest of people of all ages in running, at all levels from jogging to supermarathon races of 50 to 100 miles.

Developments in the field of sports medicine have been among the factors that have made this unusual growth possible. An increased knowledge of exercise physiology has provided a scientific basis for the establishment of better program training and conditioning, including a rational approach to nutrition for those engaged in sports; an improved understanding of the mechanisms and specific pathologies of sports injuries has led to means of preventing these injuries; and the development of superior techniques for treating these injuries has made it possible to rehabilitate, and usually return to sports activity, those who have been injured. At the same time, this powerful popular movement into organized and informal recreational sports has stimulated the growth and sophistication of sports medicine.

The field of sports medicine is generally conceived to include not only the medical and paramedical supervision of the training and competition of the individual or team athlete or participant in recreational sports, but also the identification and provision of sports for those who are physically or mentally disadvantaged, the prescription and supervision of exercise programs to achieve and maintain physical fitness in the apparently healthy, and the use of exercise as a means of therapy for those who are not. This discussion will be limited to the first of these four areas.

The supervision of team athletes or individuals engaged in recreational sport by physicians, coaches, trainers, physiologists, and many other types of specialists can be conveniently divided into four areas: (i) preparation or conditioning, (ii) prevention of illness or injury, (iii) diagnosis and treatment of illness and injury, and (iv) rehabilitation and return to sports activity. Although in any one of these areas at any particular time one or the other of the supervisory personnel may play the principal part in dealing with the athlete, the common, and ordinarily the most effective, approach is that applied by several such specialists working with the athlete as a team. A most important member of this team is the athlete, who must play an active rather than a passive role.

Conditioning

The physical qualities that normally must be improved beyond resting or basal activity levels to permit effective performance in a sport include strength, speed, endurance, cardiorespiratory function, agility, flexibility, coordination, balance, and reaction time. Power, the product of force and velocity, is a function of strength and speed of movement. The integration of these qualities in terms of movement of the whole body, or a part of it, makes possible the practice of a sports skill. The skill is learned so that it may be repeated by a process of neuromuscular integration. Through repetition its practice becomes automatic, so that the individual may devote his (or her) attention to integrating individual skills through his sense of pace, anticipa-

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tion, and reflex reactions, allowing him to rapidly judge the effects of his own actions as well as those of teammates or opponents. This process permits him to plan, and revise as necessary, his strategy in an event.

Each of these qualities can be improved by specific methods that are designed to affect individual organs singly or in groups, or the body as a whole. Two or more qualities may be improved simultaneously by the practice of any particular exercise. All training is designed to achieve a particular objective, but it may carry over to other objectives, depending on how closely they are related to the desired one. Improvements achieved by training can be maintained only by repetition, which must be at an average frequency of approximately three times weekly, preferably not consecutive days. Failure to maintain this frequency results in a decay of the improvement to the original baseline for that quality.

Repetition alone is not sufficient to improve these basic qualities beyond a certain level, which is reached quickly once the particular exercise is learned so that it may be carried out efficiently. All qualities are dependent to a greater or lesser extent on the development of strength, which is achieved by overloading muscles progressively. In the case of cardiac function, exercise of the heart muscle at rates close to the maximum causes hypertrophy and dilation of the chambers, which allow the increase in stroke volume necessary for maximum physical performance, and improves the efficiency of the heart at all rates of pumping. In the pulmonary system, the efficiency of breathing is increased by strengthening the accessory muscles of respiration. Strictly speaking, reaction time is a quality of the central and sympathetic nervous systems and it can be improved by training that associates a stimulus with a response. In the context of sports the term is taken to include movement time as well, and the ability to improve this time is partially dependent on an increase in strength. Flexibility can be improved by stretching muscles and ligaments, but maximum improvements in this quality are best obtained in those who have developed strength symmetrically in agonist, antagonist, and stabilizing muscles. Endurance in an individual muscle depends on its strength as well as its ability to contract repeatedly over time. Speed is to some extent an inborn quality, but it may be improved substantially by increasing strength. Agility, balance, and coordination may exist without great strength, but all are improved measurably by its development.

The properties of muscle tissue that are important for body movement are contractility and irritability. As a muscle shortens, or contracts against a resistance that does not allow it to shorten, it develops the tension that we call strength. With the exception of reactions to direct external stimuli, muscles are dependent for their contraction on stimuli received from the central nervous system, as the result of either voluntary or reflex reactions. Muscles can contract powerfully or weakly depending on the numbers of motor units that are stimulated, the frequency of the stimuli, and their timing. A muscle can exert its greatest tension when it is fully lengthened. A normal muscle can be stretched to 1.5 times its resting length and will exert its maximum force when it is stretched to this length before contraction. When maximally contracted, a muscle is approximately 25 percent shorter than its resting length. The speed at which a muscle shortens also determines its ability to exert force, and the speed of greatest efficiency is 20 to 30 percent of the maximum speed at which the muscle can contract against a zero load.

Muscles can be trained by performing concentric contractions (isotonic), in which the muscle shortens to move or stabilize the bases to which it attaches against some resistance; eccentric contractions, in which the resistance is allowed to overcome the muscle tension so that lengthening occurs; or isometric contractions, in which the muscle may change shape as it contracts but does not lengthen or shorten as it seeks to overcome a resistance. Since the resistance against which the muscle is working in making a concentric contraction varies according to the changing mechanical advantage achieved in the movements of the body parts, the concept of isokinetic exercise has been introduced—in this type of exercise the resistance is maintained constant through the range of motion. All methods of strength training are based on one or more of these basic types of actions.

Muscle may be overloaded by (i) increasing the resistance progressively, (ii) increasing the number of repetitions, (iii) increasing the frequency of the repetitions, and (iv) increasing the time during which a muscle contraction or tension in an extended position can be maintained. The best-known systems that have been developed on the basis of these principles are those of T. L. De Lorme and A. L. Watkins and of the Oxford Group. In the system of De Lorme and Watkins the greatest amount of weight that can be lifted ten times in succession is determined. Training sessions are then held three times weekly in which half of the maximum weight is lifted ten times; three-quarters ten times; and then the full weight ten times. As strength improves a new maximum weight is determined and the program is continued with this new standard. The Oxford program simply reverses the order of lifting, starting with ten lifts of the maximum weight and going down to ten lifts of the half-maximum weight.

Although free weights such as barbells and dumbbells are still used extensively for weight training, a person may use his own body weight in push-ups or pull-ups to develop particular muscle groups, or may lift a partner to achieve similar results. Machines that provide simple controlled resistance, accommodating resistance, or isokinetic resistance, including some that provide a graphic record of each attempt, are available in a variety of styles and sizes and are used every day by thousands of exercising persons. Some are as simple as a length of elastic rope with handles, while others weigh hundreds of pounds themselves and cost hundreds of dollars. All methods of resistance training may produce injuries unless the users are properly instructed and are monitored or supervised on a regular basis to see that safety rules are observed.

The cardiovascular and respiratory systems can be trained to develop endurance by walking, running, climbing, swimming, rowing, skating, or skiing. Improvement can result from long continuous sessions at relatively slow or moderate speeds, continuous sessions in which slow pacing alternates with short bursts of rapid pacing (speedplay or fartlek), or relatively short sessions of activity interrupted at regular intervals by rest periods and repeated many times (interval training). Extensive research has been devoted to determining the suitability of each of these types of training for the preparation of athletes for particular sports, devising programs to achieve specific objectives, and finding accurate means of monitoring progress. The objective is to attain maximum improvement, while avoiding overtraining and concomitant loss of physical and emotional efficiency. Of interest at present is the use of biochemical blood analyses of athletes in training to monitor levels of such critical substances as urea nitrogen, lactic acid, and hemoglobin and rapidly changing factors such as blood pH. Computerized microanalyses make it possible to perform these tests during training sessions with almost immediate feedback.

Reaction training is carried out by repetitions of a specific activity, such as racing starts at the signal of a starter's pistol; it may take place in a laboratory setting, when a subject is asked to identify and respond to a simulated sports situation, which is illuminated by flashes of light that are shortened progressively (recognition training). Flexibility is improved by regular stretching exercises. This is best accomplished by slow rhythmic movements, which activate the muscle stretch receptors minimally. There is less chance of injuring a muscle if it is thoroughly warmed up before stretching and is not called on for a maximum contraction shortly after it has been fully stretched. Speed is developed by perfecting technique and performing repetitions of the desired action at near maximal or maximal speed. As mentioned above, the rate of acceleration, and therefore power, also depends on appropriate development of strength. Agility, balance, and coordination are all developed through specific exercises. Biomechanical studies, particularly by computerized photographic analyses of sports skills, now make it possible to develop the most efficient techniques.

Until very recently there was practically no application of the available knowledge of human nutrition to the fields of exercise and sports. Moreover, the amount of potentially useful information provided by basic nutritional studies was limited until interest was aroused in the relation of blood fats to the development of atherosclerosis. In the past 30 years, sports scientists, especially in Scandinavia, have clarified the roles played by carbohydrates and fats in metabolism during exercise.

By distinguishing between aerobic and anaerobic phases of exercise and studying the fuels and products of metabolism during exercise in the blood and in the cells, it has been shown that the substrates in the anaerobic phase are primarily adenosine triphosphate (ATP) and creatine phosphate, with small amounts of glycogen. In the aerobic phase both glycogen and fatty acids are used as fuel. Which is used more depends on the length and intensity of exercise. In general, fatty acids are used more when body glycogen and glucose stores are exhausted and when exercise continues at relatively low intensity. Although fat has a greater caloric density than glucose, partly because of the dilution of glycogen by the water required to store it, glycogen can be utilized more efficiently during exercise since it requires less oxygen per gram for metabolism.

Since about 400 B.C. athletes in training have been nourished with diets rich in protein, especially meat. The origins of this practice are obscure, since athletes of an earlier day subsisted on bread, cheese, fruits, fish, and wine, but it seems likely that in the case of beef there was some association with the idea that consuming the flesh of a powerful animal would give a human greater strength. The story told about Milo of Crotona probably illustrates this concept. (Milo was an ancient Greek athlete who was said to have killed a 4-year-old heifer with a blow of his fist and eaten it all in 1 day.) Except in isolated instances where athletes have chosen a high-carbohydrate diet and in countries where religious beliefs require vegetarianism, most coaches and athletes still place great reliance on high protein intakes.

The traditional precompetition meal of athletes continues to be a protein-rich one, and the favorite main dish is a large steak. The fact that protein is not used as an energy source by the body except in starvation or when the diet is grossly deficient in fat and carbohydrate seems to have little impact on the practice. If enough fat is consumed with the beef it may become an energy source, but at a greater cost than carbohydrate, and not until many hours later. Since such a meal is digested and passed through the gastrointestinal tract much more slowly than a carbohydrate meal, especially in the presence of the usual precompetition tension, the athlete would probably be better off eating nothing. At least he would minimize the tendency to nausea and vomiting that is so common before competition or even a difficult practice.

We know now that the ability of an athlete to sustain a high level of performance over time can be directly related to the stores of glycogen in the liver and muscles at the beginning of the competition. Although there appear to be limits to the amounts that can be stored, these limits seem to be approached only under special conditions. Swedish scientists have demonstrated that a diet high in protein and fat and low in carbohydrate reduces muscle glycogen levels below those found in individuals taking a mixed or so-called balanced diet, and far below those found in individuals taking a high-carbohydrate diet. If the high-protein, high-fat diet is taken for three or more days and then followed for at least 3 days by a high-carbohydrate diet that is low in fat and protein, however, levels of muscle glycogen are higher than those found with the high-carbohydrate diet alone. This pattern of feeding, now known as carbohydrate loading, has been used successfully in preparing for long-distance races.

It is not yet certain how this principle can be applied to an athlete in training during a season of competition in which it is necessary to reach peak performance levels every week, or even four or five times a week. Meals on the day of competition, and preferably for 2 days before, should be high in carbohydrate, moderate in fat, and low in protein. On the day of competition they should be in a form that is easily assimilated. A theoretical drawback to carbohydrate loading is that the body retains more water as it stores glycogen, so that weight is slightly increased. This disadvantage may be more than offset by the increased extracellular water available to prevent dehydration during performance.

Because athletes and others who engage regularly in physical recreation wish to do anything they can to enhance performance, they tend to be strongly influenced by fads and superstitions, especially in the area of nutrition. The misuse and abuse of biological substances and drugs for this purpose is unfortunately common. Vitamins are seen by many athletes and their coaches as having almost magical powers. When the athlete is taking a well-balanced diet appropriate to his needs for energy production and maintenance of strength, he is receiving enough of the vitamins related to both of these needs, unless for some unusual reason he is suffering from a deficiency of one or more vitamins. When he is recovering from an injury his requirements for vitamin C may exceed his dietary intake temporarily. Athletes nevertheless continue to take large quantities of vitamins B, C, and E, despite the fact that the amounts in excess of daily requirements for the water-soluble vitamins are simply washed out daily in the urine, and no role for vitamin E in energy production has yet been identified. Most mysterious of all are the heroic intramuscular injections of vitamin B_{12}, whose only known role is in the treatment of pernicious anemia.

Many different drugs, some relatively harmless and others very toxic, such as strychnine, have been used by athletes as aids to performance. We know that none of them are effective in producing superior performance. Amphetamines are used by some athletes, especially in professional sports, because of the sense of euphoria and even recklessness that they may produce. Alcohol is used in small amounts to steady the hand in pistol shooting. Anabolic steroids have been used by athletes in the vain hope that they will help them to increase muscle bulk and strength substantially. The use of drugs for the purpose of improving performance is considered unethical in amateur sport. At present, the practice of testing competitors for drugs is limited, however, because of the expense, to certain international competitions such as the Olympic Games and world championships in various sports. There are now sophisticated methods of testing the urine that can detect the presence of very small amounts of the drugs that are on the banned list.

In competitive weight lifting and in the combat sports, where competitors are assigned to classes according to their body weights, and in horse racing, where small size and light weight are advantages for the jockeys, there is a constant struggle on the part of many athletes to "make weight." In wrestling in particular it is thought to be a great advantage to wrestle at a weight that is 20 pounds or more below one's "normal" weight. The practices of crash dieting and dehydration to reach desired weight levels may reduce performance capabilities in some instances, and serious heat illness has occurred in others when plastic suits and exercise in the heat were used to promote dehydration. Where there are several hours between weigh-in and competition, too rapid repletion with food has been the cause of acute pancreatitis. Body fat can be reduced safely by restriction of calorie intake accompanied by regular exercise on a gradual basis, and the reduction can be maintained during the course of a season with restraint and without starvation. There is good reason to suspect that adolescents who begin crash dieting and semistarvation in their early teens retard their natural growth and never reach their potential size. There is no ethical way to test this experimentally in humans.

In the past, sports have traditionally been practiced in certain seasons and training has usually been confined to 1 month or so before opening of the season. Increased competition at national and international levels, the availability of indoor facilities for sports formerly practiced only outdoors, greater ease of travel, and a greater general level of prosperity have produced a specialization that has led to year-round competition in some sports and made a constant level of training almost a necessity in all sports. This means that the training process must be monitored so that athletes can reach peaks of performance at certain times and have rest and recuperation periods at other times without their physical capacities falling below levels that allow a quick return to the fully conditioned state. The sports physician must be alert to detect the state of overtraining, which is characterized by deterioration of performance, falling blood pressure, a rapid resting pulse rate, and failure of the pulse rate to return quickly after exercise to a baseline level. The only effective treatment for this condition is a prolonged period of complete rest.

A great deal of attention is devoted in sports medicine today to the psychology of sport and of the athlete, in particular to motivating the athlete and maintaining him in a state of mental and emotional preparedness before and during competition. Very little study has been devoted to the psychology of the athlete in the postcompetitive state, however. The development of concentration by the athlete immediately before and during competition is stressed. At the same time, a relaxed attitude should be emphasized in order to avoid an excessive buildup of anxiety and tension, which can be harmful to performance. A number of test instruments have been devised, or simply borrowed from other areas of psychology, but counseling of athletes remains largely an intuitive process. Coaches must be constantly cautioned against attitudes and practices that result in negative motivation of their athletes.

The great majority of recreational and many competitive athletes today train themselves without coaches. There is a great demand for specific information that will help them in this, not only in the development of specific skills but in all the areas that have been discussed here. This demand is being met in part by periodicals on all of the popular sports, in part by mutual assistance between individual athletes, and in part by consulting physicians who are knowledgeable in sports medicine.

Prevention of Illness and Injury

Prevention begins with the qualification of persons wishing to participate in recreational or competitive sports. Levels of skill and previous experience vary widely. Self-selection plays an important role, especially in recreational sports, but choices are not always made rationally. If a coach or instructor is involved, he or she ordinarily makes some evaluation of the candidate's suitability, including a very superficial psychological appraisal. In many organized team sports there is a mandatory physical examination by a physician before entry. Depending on the level of the sport and a number of other factors, including the availability of medical personnel, this examination may be simple or elaborate. A person entering a recreational sport for the first time in adult life may seek a medical evaluation independently, but this is the exception rather than the rule.

The preparticipation examination is directed at uncovering any factors that might make effective performance in the selected sport impossible or dangerous. The examining physician should be familiar with all pertinent aspects of the sport in question in order to be able to make a correct judgment in this matter, and the examination can be as limited or as extensive as the physician's knowledge indicates. It may include laboratory or functional capacity testing. The physician's recommendation regarding participation should be made on the basis of all the available evidence and should be accepted by the athlete and other concerned persons. If some condition that requires correction before participation is found, the physician should repeat the examination after the correction to be sure the problem has been overcome.

Persons who are handicapped by physical, mental, or emotional problems that do not lend themselves to complete correction may be able to participate in modified programs of sports and physical recreation safely and effectively and with great benefit. The physician, physical educator, coach and other specialists should combine their observations and knowledge to prescribe exercise for such persons.

Among the many factors that may be considered in prevention, environmental conditions and measures to counteract their sometimes unfavorable effects are among the most important. Variations in air temperature, relative humidity, air movement, degree of pollution, and barometric pressure are important. The nature and conditions of the facilities for sports and provisions for the control of spectators should also be matters of concern.

Increases in air temperature, particularly when accompanied by increases in relative humidity, can be a particular problem for athletes since their temperatures can increase 4° to 5°F during exercise and they must have a way to rid themselves rapidly of this excess internal heat. It has been known for years that unacclimated persons develop salt deficiency when exposed to high air temperatures while working, and suffer from heat cramps and exhaustion. Prophylactic administration of salt tablets or salted water can prevent this. The most common heat stress hazard in sports occurs in American football early in the season. The players, whose uniforms cover practically the entire body, are 97 percent dependent on sweating to eliminate excess body heat.

For many years coaches have discouraged or actually prevented players from taking water during practice or games. Under some pressure they did provide them with salt tablets during preseason practices, but often in too great quantity and not at the appropriate time. It has taken some additional time for sports scientists to persuade coaches that players should be allowed free access to water to reduce the toll of heat exhaustion and heat stroke. Taking added salt is now considered less important than attempting to replace water losses immediately and as completely as possible. Replacement of potassium losses after practice helps to prevent the progressive depletion of potassium stores, which may lead to reduced performance.

Relative humidity is critical when athletes are exercising at high temperatures because of their almost total dependence on sweating to eliminate their excess body heat. Readings as low as 68°F have been associated with fatal heat stroke when the relative humidity was about 85 percent. Guidelines for the conduct of practices and games based on certain combinations of air temperature and relative humidity have been promulgated for sports but are not always observed.

Studies of accidents in sports parachuting and ballooning have led to the setting of allowable limits for speed of air movement for these activities. Lightning injures hundreds of persons every year, but it is only in sports that rules have been established to prevent outdoor activities when it is present or threatened. It is also only in sports that outdoor events have been postponed or canceled because of high levels of air pollution.

The effects of reduced barometric pressure on human life and performance were originally observed by mountain climbers. Our knowledge of these effects was greatly enlarged by studies that were stimulated by the scheduling of the Olympic Games in Mexico City in 1968. It was determined that although performance in jumping and weight events might be improved as a result of the reduced gravitational force and lower density of the air, performance in events lasting more than 2 minutes would not reach marks established at sea level. Training at high altitude for 3 to 4 weeks would be necessary for athletes to achieve their best possible performance there, and performance at sea level would be improved for an equal period after returning from this training. Training above 8500 feet (approximately 2500 meters) becomes inefficient, except for adaptation to climbing higher.

Studies of human performance under increased barometric pressure were initiated by scientists who studied men working in compressed air while building tunnels and foundations below water level. The advent of self-contained underwater breathing apparatus (scuba) as sports equipment greatly expanded our knowledge of human limits and the prevention of compressed air sickness (caisson disease).

The tremendous expansion of participation in sports has created a need for multi-use facilities and led to the development of new surfaces which would provide suitable foundations for particular sports and be able to stand up under hard and repeated use. The manufacture of artificial turfs answered these needs but also created problems of heat, abrasion, and friction for athletes performing on them. Sports scientists have developed strategies and equipment for dealing with these problems. Indoor and outdoor sports facilities today are constructed with provisions for safety of the athletes and the spectators. The interaction between athletes and spectators is becoming a matter of increasing concern, however, as violence in sports appears to be increasing.

Individual protective equipment for sports such as baseball, football, ice hockey, lacrosse, and auto racing has been developed and constantly improved as the result of cooperation between sports scientists and manufacturers. Independent standards for football helmets and hockey masks have been prepared and accepted. The development of standards for other types of equipment is under way.

Rules for safety in sports are being modified almost constantly to improve protection of athletes. In one of the most recent changes use of the football helmet to assist in blocking and tackling has been outlawed. Well-trained officials are necessary to enforce these rules, but they are unfortunately not available at all levels of play.

Occurrence and Treatment of Injuries

It is extraordinarily difficult to study the incidence and distribution of sports injuries because of the enormous number of variables involved. As a result, we have only general ideas about the occurrence of such injuries. American football has been studied more than any other sport in this respect. In some sports the data are fragmentary and we have little idea of the numbers of serious, disabling, or fatal injuries. There is no overall system for recording and collecting data on sports injuries that is broad and detailed enough to provide accurate information.

A more productive approach has been to combine an analysis of the hazards of each sport with the personal experiences of those who participate in and supervise it. In-depth studies have been made of particular injuries in certain sports where disabling and even fatal injuries are common. Serious and fatal neck injuries in football and arm and shoulder injuries in baseball are examples.

The modern management of acute trauma in general owes a good deal to techniques developed for the management of sports injuries. Local application of cold and compression to the injured part is an outstanding example. The current indications and accepted procedures for surgery on the acutely injured knee are outgrowths of those established a little more than 30 years ago for the treatment of injured athletes. One of the most important reasons for this is that disabilities following injuries that might be acceptable for those not engaged in sports can seriously affect an athlete's ability to compete. The injured part must be restored as close as possible to normal function, as rapidly as is consistent with recovery and prevention of reinjury.

Direct supervision of competing athletes by knowledgeable sports physicians and trainers has made possible earlier identification and more prompt and accurate diagnosis of significant sports injuries. Unfortunately, the major proportion of these services goes to the athletes who represent the smallest group numerically, the professionals, and the least to the groups who are most numerous, the high school and recreational athletes. Special clinics for the diagnosis and treatment of sports injuries have appeared in increasing numbers in the past 10 years.

Rehabilitation After Sports Injuries

The basis for the rehabilitation of the injured athlete is the team approach. The physician, sports trainer, physical therapist, coach, and the athlete himself are the principal members of this team. In some cases one person is both trainer and therapist. Few high school athletes and even fewer recreational or independently training athletes have access to a qualified trainer. They may go themselves or be referred by a physician to an independent or hospital-based physical therapist. The rehabilitation team could also include a sports psychologist or a specialist in biomechanics or kinesiology. In the case of adolescent athletes, the parents are frequently involved as well.

The process of rehabilitation should properly begin at the time of injury. This involves emergency care designed to minimize the impact of the original injury and prevent further damage; prompt referral to definitive care, which is selected to prevent, or at least minimize, future disability and to return the athlete as rapidly as possible to practice and competition within the limits of safety; and preservation during the entire process, as far as possible, of the athlete's overall state of physical and emotional conditioning. As healing occurs, measures to restore strength, endurance, range of motion, flexibility, speed of movement, balance, and coordination are brought into play.

At various stages in the rehabilitation process one or the other of the team may assume a dominant role in working with the athlete. The typical sequence might be trainer, physician, therapist, trainer, and coach. Simulated actions of the athlete's sport are introduced as soon as possible, to be succeeded by the actions themselves as the individual returns to restricted and then unrestricted practice and finally competition. There is an ongoing evaluation of the reconditioning and retraining measures by the team. In the case of an injured extremity, one general indication of the athlete's readiness to return to competition is that the injured part is equal in strength to the uninjured opposite extremity. Consultation within the team determines the time for return to competition, with the physician making the final decision. This is less his prerogative than his responsibility. Finally there is a follow-up evaluation on return to competition to be sure that the objectives of rehabilitation have been fully realized.

Future of Sports Medicine

The body of knowledge in sports medicine and the rapid expansion of its practice have raised the question of whether it will become a recognized medical specialty in the United States. It has enjoyed this status in many European countries for some time. Since it cuts across almost all existing specialties of medical practice and since many of its practitioners are nonphysicians in different fields, it seems unlikely that in the immediate future there will be much pressure from physicians to establish a specialty board. At present there is no formal training program for such a board to acknowlege or certify. Medical schools have shown little or no interest in incorporating teaching in sports medicine into their curricula. There are no residency training programs in sports medicine. A few short fellowships are offered for physicians who are already qualified in orthopedic surgery.

There is no National Institute of Sports Medicine corresponding to those included in the National Institutes of Health. There are a few privately founded institutes, and a number of universities now have programs or centers which embody in their educational, research, and service activities some of the various aspects of sports medicine. The U.S. Olympic Committee has established two training centers, but these are in the initial stages of development. They may establish more, depending on the availability of funds and the experiences of the first two.

The American College of Sports Medicine is a multidisciplinary organization that was established in 1954. It now numbers almost 5000 members and fellows. Its objectives are primarily educational, but it does not have a formal academic program or grant degrees. It holds an annual scientific meeting and publishes a quarterly newsletter and a journal, *Medicine and Science in Sports*.

The American Orthopaedic Society for Sports Medicine was established in 1972. Up to 10 percent of its membership may be physicians who are not orthopedic surgeons. It holds semiannual scientific meetings and publishes a bimonthly journal, the *American Journal of Sports Medicine*.

In 1954 the American Medical Association (AMA) appointed a standing Committee on Injuries and Sports, which became the Committee on Medical Aspects of Sports but which was discontinued in 1977. The committee now enjoys ad hoc status and continues to have annual meetings on medical aspects of sports, as it has done for the past 20 years. An AMA standing Committee on Exercise and Physical Fitness was also dropped in 1975, but has not been continued on an ad hoc basis. Both committees had a number of publications.

There are also Osteopathic and Podiatric Academies of Sports Medicine. The American Physical Therapy Association has a Sports Medicine Section. The National Athletic Trainers Association has an active educational program, publishes a quarterly journal, *Athletic Training*, and has a certification program for its members. It has stimulated the development of undergraduate and graduate training programs for trainers and provided standards for their approval.

Periodicals published in English which are available to physicians in the United States also include *The Journal of Sports Medicine and Physical Fitness*, a quarterly; *The Physician and Sportsmedicine*, a monthly; *The Canadian Journal of Applied Sport Sciences*, a quarterly; and the *British Journal of Sports Medicine*, a bimonthly.

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