



# Presidential address of the American Orthopaedic Society for Sports Medicine

## Drug abuse in sports\*

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The reasons that athletes use drugs are to improve performance, to play when injured, and to achieve a "winning edge." Illegal drug use in sports is not new, as drugs in different forms have been used for many years. The abuse came into international news in 1960 when an Olympic cyclist died from an overdose of amphetamines.<sup>3</sup> Prior to that time marathon runners had used a mixture of strychnine and brandy as a stimulant to aid them in the long-distance course.<sup>2</sup> Anabolic steroids were supposedly used by the Germans during World War II and, subsequent to that war, the Soviets began using them in athletes in the late 1940s. Dr. John Ziegler, through his contacts with the Soviets, brought them to the United States in the early 1950s and began using testosterone esters in weight lifters. Subsequently, the first synthetic steroid, Dianabol (methandrostenolone; Ciba Pharmaceutical Company, Summit, NJ) was developed.<sup>5</sup>

In 1969, Bil Gilbert wrote a three-part article in *Sports Illustrated* (June 23:71; June 30:30; July 7:30) on the use of

drugs in sports. That series could be reprinted today without much change. However, the drug problem is increasing in today's sports environment. Pictures show that the body builds of athletes have changed over the past 40 years. Some of this could be attributed to nutrition and new strength training methods, but, unfortunately, illegal drugs have also made a big part in this change. Athletes have discovered that anabolic steroids, growth hormone, and other agents will, indeed, increase their lean body mass and aid in their performance.

In classifying drugs, there are three main categories: 1) therapeutic drugs used for specific medical indications; 2) "street drugs" or "pleasure drugs" used to alter mood or perception, such as narcotics, which increase pain threshold and produce euphoria; and 3) performance-enhancement or ergogenic drugs used for the purpose of gaining athletic advantage. It is this category that is our major concern in sports. These drugs are stimulants, beta blockers, diuretics, growth hormone, gonadotrophins, and erythropoietin.

The stimulants used by athletes include amphetamines, sympathomimetic amines, caffeine, and cocaine. The desired effect of stimulants is to stave off the feeling of fatigue, increase aggressiveness, and to mask pain. As mentioned

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previously, they have been used in different forms for many years.

Beta blockers are relatively new and are used by athletes to calm anxiety and relieve nervous tension. They achieve steadiness of the hands and they decrease heart rate. They are now banned in five winter Olympic sports and nine summer Olympic sports.

Diuretics are used to reduce weight quickly in sports that have weight categories, such as wrestling and weight lifting. They are also used to dilute the urine to minimize detection of illegal drug use.

Human growth hormone is a naturally occurring hormone produced by the pituitary gland to stimulate bone growth and to increase protein synthesis. This hormone is the one reputed to have been used by several of our athletes prior to the 1988 Olympic games. Human growth hormone was originally extracted from cadaver pituitary glands and was used in cases of pituitary dwarfism. However, after four cases of a virus-caused illness called Creutzfeldt-Jakob disease occurred from its use, the human growth hormone was discontinued in 1984. But in 1985 scientists were able to genetically engineer human growth hormone and there are now two exogenous supplements manufactured for human use, Somatotropin (humatrope, Eli Lilly, Indianapolis, IN) and Somatrem (protropin, Genentech, Inc, San Francisco, CA). It is these supplements that are finding their way onto the black market to be used by athletes at a very high cost. They do have a synergistic effect with anabolic steroids, so are often used in this combination. An excess of human growth hormone can produce acromegaly or thyroid disease.

Human chorionic gonadotropin is a natural hormone produced by the placenta. It is extracted from the urine of pregnant women. It is injected to stimulate normal gonadotropins and is considered to be the equivalent of testosterone injections.

In the past, athletes competing in endurance events have used "blood doping" (blood transfusion) to increase the red blood cells in their body and to enhance their oxygen-carrying capacity. Today the athletes are using the new drug erythropoietin. This is a glycoprotein hormone produced by the kidney and was originally purified in 1977. This hormone stimulates the production of red blood cell precursors; the normal stimulus for the release of this hormone is hypoxia. After it was finally synthesized in 1985, the athletes began using this by injection for competition in endurance events. The hormone improves performance by increasing red blood cell mass. In sporting events that are determined in fractions of seconds, a 5% increase in red blood cell mass may result in that winning fraction of time. There are deleterious side effects from use of this drug that include hypertension and increased blood viscosity that may lead to blood clots, strokes, seizures, and heart attacks.

The most abused category of drugs today is the group known as anabolic-androgenic steroids. There is a question of this substance being the "Breakfast of Champions" versus the "Dangerous Juice of Strength." It is reported that 6.6% of male high school seniors in an extensive survey have used

anabolic-androgenic steroids.<sup>1</sup> A great many of them are using them just to improve their physical appearance and not for athletic achievement. They take them just to "look better." An excellent reference on these steroids can be found in *Clinical Sports Medicine* by Yesalis et al.<sup>7</sup> This article is a very comprehensive look at anabolic-androgenic steroids and gives an indication of the overall problem and offers some possible solutions.

Anabolic steroids are derivations of the male hormone testosterone and they are used for recuperation and for body building. The anabolic effect implies the ability to promote tissue growth and/or repair. The androgenic effect implies the ability to produce the male secondary sex characteristics, just as does testosterone. The anabolic effect of these steroids does increase lean body mass and reduces the percentage of body fat if they are used in conjunction with conventional methods of strength training and body building. Adequate caloric and dietary intake is necessary, but what is adequate? Still to be determined is how many calories are necessary and what is the proper ratio of protein to carbohydrates. Much research needs to be done in this area. This anabolic effect increases protein synthesis through interaction with specific receptor proteins in target tissues such as skeletal muscle, skin, and testes, and the prostate. All skeletal muscles respond to these steroids, but considerable variation and sensitivity of individual muscles exists. In man, the muscles of the pectoral and shoulder girdle appear to be the most sensitive.

The anticatabolic effect is one of great interest because the athlete can recover quickly from a hard workout and train longer and harder. These steroids can convert a negative nitrogen balance to a positive balance by improving the use and retention of ingested protein. Are we missing some of the beneficial medical effects? I have had people who are familiar with anabolic steroids tell me that if they underwent an anterior cruciate ligament reconstruction, they would like to be placed on these steroids for their anticatabolic effect for a few weeks. After a period of 4 to 6 weeks, the body will no longer react because it seeks a level of equilibrium. But in those early stages of recovery, there may, indeed, be a beneficial medical effect.

We always hear about the many dangers of steroids. However, testosterone has been used for the last 12 to 15 years in certain centers as a controlled method of birth control. Approximately 200 mg of testosterone esters are injected into the male each week and no serious side effects from these relatively low doses have been noted. This dosage does give a good, effective method of birth control. We do not hear much about these studies, but the endocrinologists are well aware of them.

What are the various forms of anabolic-androgenic steroids? There are oral preparations and injectable preparations, and the injectable preparations are of the oil-based and water-based varieties.

First, in regard to the oral preparations, there is a modification of molecules at the 17 $\alpha$  position of testosterone, and these preparations are not destroyed by gastric acid. They

are absorbed in the intestine and there is slow inactivation by the liver. They have short half-lives so they must be taken more often. Athletes do not usually like injections, so the oral varieties are the ones most commonly used. Unfortunately, it is these steroids that have the most consistent association with medical complications. They have been associated with hepatomas and carcinoma of the liver.

Of the injectable steroids, the oil-based injectables are absorbed slowly, so there is a lower concentration in the liver. The modification in these steroids is in the molecules at the  $17\beta$  position, and they have much longer half-lives. There are more varieties and more manufacturing companies for these oil-based injectable steroids. Dianabol was the first synthetic steroid, but more recently, the popular varieties have included Deca-Durabolin (Organon, Inc., West Orange, NJ) and Stanozolol (Winstrol, Winthrop Pharmaceuticals, New York, NY). The latter is the one that was detected frequently at the 1988 Olympic games in Seoul and made world headlines when athletes were stripped of their medals. One of the current favorites is a steroid called Furazabol (miotolon, Daicchi Laboratories, Tokyo, Japan). It is speculated that athletes were taking some mislabeled steroids when they were detected in Seoul. Also, a much more sophisticated form of drug testing was used at the Olympic games and athletes that had gone undetected in previous games were found to be positive in Seoul.

The water-based injectable steroids have very similar molecular structure to the oil-based, but have much shorter half-lives and require more frequent injections. They are less available and more expensive, but also less dangerous.

"Steroid stacking" is the common practice of using multiple types and doses of steroids over a certain period of time. The rationale is to minimize the side effects by decreasing the dosage of any particular drug. The dosages used by these athletes are often very high when compared to medical or physiological dosages. The athletes, also, may use human growth hormone or chorionic gonadotropin for synergistic effect when they are steroid stacking.

The adverse effects of these steroids in the male include acne, overaggressiveness, gynecomastia, testicular atrophy, liver dysfunction, tumors, and cholesterol level changes. Most of these effects are, indeed, reversible in the male.

In the female, the adverse effects are increases in facial and body hair, deepening of the voice, enlargement of the clitoris, shrinkage of breast size, and irregular menstrual cycles. Several of these effects are irreversible. Women use these steroids in body building and in strength events. The normal percentage of body fat in the female is approximately 23%, but the ratio of body fat to lean muscle mass can be altered with these steroids.

In the adolescent, the adverse effects of steroids are acne and premature closure of the growth plates.

We, as adults, are guilty of perpetuating the use of these substances. Some of the glib lies that we tell our kids are:

1. You will play big-time college football.
2. You will enjoy playing big-time college football.
3. You will be drafted by the NFL.

4. After being drafted, you will have a long and successful career in the NFL. (The average life-span in the NFL is only 3.1 years.)

5. You will enjoy life in the NFL.

6. During your career in the NFL you will be surrounded by people who are truly interested in you.

7. After retirement your NFL coach will continue to show interest in your life.

8. After retirement many opportunities will be offered to you as a result of your participation in the NFL.

9. You will live long enough to collect your NFL pension. (The average life-span for the professional football player is around 60 years of age.)

We are doing a poor job of educating our young people about these substances. They can buy books such as *The Anabolic Reference Guide* and the *Underground Steroid Handbook*. (See the article by Paul J. Perry, PhD, Kathleen H. Andersen, and William R. Yates, MD, in the July/August 1990 issue of the journal, pages 422-428, regarding the latter book and the anabolic steroid situation.) These books probably have more good knowledge in them for the kids than we are giving them medically. These books not only tell young people where they can obtain these illegal substances, but they tell them how to take steroids safely so that, theoretically, if the individuals follow these recommended doses, they can achieve the desired effect and avoid complications. In medical lectures we stress the dangerous side effects of steroids, but these kids certainly do not see their friends "dropping like flies," so our credibility is in doubt. In fact, there are only a few proven deaths from steroids recorded in the literature.

After the anabolic effect is achieved from use of steroids, the athletes can maintain some of their increased size with regular workouts. There obviously would be some drop in strength without repetitive use, but the body never goes completely back to its original form after using anabolic steroids. Some of the effect is maintained and strength training builds on that effect. That is why young people may not be using steroids in college, but after achieving their increased size through their use in high school are able to maintain size in college.

Can drug testing eliminate the use of these performance-enhancing drugs? No, they cannot completely solve the problem, but they help. The substances detected in drug tests are narcotics, stimulants, beta blockers, and anabolic steroids, particularly the oil-based and oral steroids.

However, we cannot test for human growth hormone, erythropoietin, low doses of testosterone esters, and unknown designer drugs. An example of one of the designer drugs is a stimulant called Syndocarb. This is an amphetamine-like substance that was used by athletes in the 1988 Seoul Olympics, but was unknown to the medical personnel and the drug testing personnel until 18 months after the conclusions of the games. In many instances, the athletes are ahead of the testing devices in their use of some of these drugs.

A big problem with drug testing is announced testing.

Less than 2% of athletes test positive for drugs when tests are announced. At an event in 1985, our Olympic people offered random testing for athletes with the stipulation that the results would not be punished. Fifty percent of the athletes in that study tested positive for illegal substances. Therefore, if tests are announced, the athletes can avoid detection in most instances. The detection time for many anabolic steroids is short, so the athletes will avoid the steroids with longer half-lives if they know when they will be tested. Oral steroids may be detected for up to 30 days and the oil-based steroids for longer periods of time.

There is also a problem with testing for low doses of testosterone esters. This is usually done by comparing the testosterone/epitestosterone ratio. The normal ratio is usually 1:1. In drug testing, they have arbitrarily established that any ratio 6:1 or greater is a positive test for use of steroids. This level is set to avoid a large number of false-positives, but a ratio of 2:1, 3:1, or 4:1 may really indicate some use of steroids.

In a study by Freidl et al. in 1989,<sup>4</sup> two volunteers were given 100 mg of injectable testosterone each week for 6 weeks and two other volunteers were given 300 mg of testosterone esters per week for 6 weeks. At the end of the 6 weeks the subjects were tested and the highest level found was a 4:1 testosterone/epitestosterone ratio. These doses are the approximate doses that many of our track athletes are using. These athletes are using steroids for their anticatabolic effect and not for their strength gain effects. These track athletes can train hard each day without feeling the fatigue and soreness they would normally encounter. They want to train harder and longer and, by using low doses of the testosterone esters, achieve the desired effect without detection.

Drug tests are also expensive. They can be performed for approximately \$125 per test if no more than 2% of subjects test positive. If that ratio would rise to 4% or 5%, the cost would rise dramatically. This is because when an initial test is positive it must be repeated under very exacting and elaborate circumstances.

There is a new steroid being used by athletes that will escape the normal testing methods. Therefore, the Olympic Training Center is now paying \$400 per test because the testing apparatus must be run at two different speed levels to detect this particular steroid. There are, possibly, other steroids that may even require more sophisticated forms of testing for detection, and this will further increase the cost of drug testing.

The main value of drug testing is probably in unannounced testing currently in use by the NCAA. This type of unannounced, random testing might normally result in a much higher incidence of positive tests, but, if the penalties are sufficient, it will discourage the use of steroids and, most importantly, perhaps eliminate the more dangerous oral steroids. These tests would, at least, cut down the use of such steroids.

Athletes have always found methods of cheating; some of the more common methods to escape detection have been

the use of diuretics to dilute the urine or the use of masking agents to hide the illegal substances. Other methods have been to use someone else's normal urine through catheterization or in a vaginal bladder.

Are we really faced with a problem that we cannot control? There are some solutions to the problem that will certainly help to control, if not eliminate, the problem. First, we must accept the reality that these drugs are available and we must eliminate the myth that the athletes do not use these drugs. We must use education and research, and try to effect a societal psychological change with a deemphasis on winning.

In education, we should start with young adolescents and emphasize the harmful effect on growth. We should try to delay their decision to use these drugs. We should educate the parents in the deleterious effects of these drugs in children. We should educate parents to encourage their children to participate in sports for the joy of playing and discourage the mind set on winning. We have to encourage the sports federations, athletic administrators, and coaches at all levels to evaluate their level of resolve in dealing with the abuse of these performance-enhancing drugs. They must accept sacrifices, such as fewer victories and lower revenues. This is a very difficult decision in our society. We must educate our sports physicians in the awareness of drug problems. Physicians must have a good knowledge of drugs and their effects. They must counsel athletes on potential harmful effects. They must also encourage research in all fields of drug effects, use, and testing. An excellent reference for all sports physicians and trainers is a book entitled *Drugs and the Athlete*, edited by Gary Wadler and Brian Hainline.<sup>6</sup> This book should be in each sports physician's office and, perhaps, in each of our training rooms. It is easy to read and easy to understand and is an excellent reference text for all of these substances.

In regard to research, we have several avenues to follow. We have to evaluate the long-term health effects of the various drugs in otherwise healthy men and women. We must determine if the incidence, prevalence, and type of sports injuries are affected by drug use. We have to determine the effects on specific groups such as women and children. We should determine the incidence and prevalence of the use by males and females in all age groups. We must identify their frequency of use and the dose patterns as well as establish the credibility of our medical and scientific community with these users in regard to the information that they are getting about these drugs. We have to test the attitudes, knowledge, and behavior of physicians related to the drug use. We should refine our drug testing technology and develop new analytical techniques. We must try to develop lower cost techniques and develop better methods to detect the natural substances such as testosterone, growth hormone, and erythropoietin.

In conclusion, we must accept that there is a very large and increasing number of athletes using ergogenic drugs and there are new performance-enhancing drugs being consistently developed. We must accept that drug testing is inade-

quate and cannot eliminate the problem. We must educate athletes of all ages who must be fully informed about all aspects of drug use. Parents and teachers must be knowledgeable and supportive. Coaches and trainers must be totally aware of the problem and must be cooperative in dealing with it. Sports physicians must be more knowledgeable and deal with the athletes fairly. Research is needed in areas of incidence of use, the ergogenic effects of use, the health effects of use, and new drug testing procedures.

Lastly, major results will be achieved only after athletes, teams, schools, and federations are willing to renew a commitment to fair play, deemphasize winning, and no longer tolerate, either actively or passively, the abuse of drugs in sports.

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#### REFERENCES

1. Buckley WE, Yesalis CE, Friedl KE, et al: Estimated prevalence of anabolic steroid use among male high school seniors. *JAMA* 260: 3441-3445, 1988
2. Burks TF: Drug use in athletes. *Fed Proc* 40: 2680, 1981
3. Dymont PG: Drugs and the adolescent athlete. *Ped Ann* 13: 602, 1984
4. Friedl K, Jones R, Hannan C, et al: The administration of pharmacological doses of testosterone or 19-nortestosterone to normal men is not associated with increased insulin secretion or impaired glucose tolerance. *J Clin Endocrinol Metab* 68: 971-975, 1989
5. Todd T: Anabolic steroids: The gremlins of sports. *J Sport Hist* 14: 87-107, 1987
6. Wadler G, Hainline B (Eds): *Drugs and The Athlete*. Philadelphia, FA Davis Co, 1989
7. Yesalis CE, Wright JE, Lombardo JA: Anabolic-androgenic steroids: A synthesis of existing data and recommendations for future research. *Clin Sports Med* 1: 109-134