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Substance Use in Athletics: A Sports Psychiatry Perspective

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Professional and other elite athletes use some substances at higher rates than nonathletes in the general population [1–7]. This is especially true for substances that have actual or perceived positive impacts on athletic performance. Substances such as anabolic androgenic steroids, amphetamines, human growth hormone, or erythropoietin that combat fatigue, relieve pain, enhance injury recovery, alter intensity and aggression, sharpen focus, increase strength and endurance, or reduce or add weight are the most attractive (Fig. 1). Although these "performance-enhancing" substances may objectively or subjectively aid performance, they may also produce negative effects at higher dosages [8–15]. Other substances such as alcohol, marijuana, cocaine, or club drugs are used or abused for the same reasons by athletes as nonathletes. The reasons for starting these "drugs of abuse" (ie, fit in, boost self-confidence, produce pleasure, escape problems, have fun) are not always the same as for continued use (ie, stress relief, psychological dependence, negative emotions reduction, tolerance/withdrawal). Tobacco, especially if it contains high dosages of nicotine, can be viewed as either a drug of abuse or a performance enhancer (see Fig. 1).

This article focuses on the most common substances seen in professional, Olympic, and collegiate athletes; namely alcohol, tobacco, stimulants, and steroids. The prevalence and patterns of use, performance and health effects, and preventive and treatment interventions for each are discussed. For alcohol, its basic pharmacology and adverse effects on athletic performance through dehydration, hangover, insomnia, fights, and weight gain are emphasized [16–19]. The value of urine alcohol testing to reduce heavy drinking is discussed. For stimulants, the chemical structures of ephedrine, synephrine, phenylpropanolamine, and amphetamines are presented. The risks of "stimulant stacking" (ie, caffeine, nicotine, synephrine, amphetamine) and "upper-downer" pairings such as amphetamine and alcohol/marijuana are highlighted. Preventive efforts to

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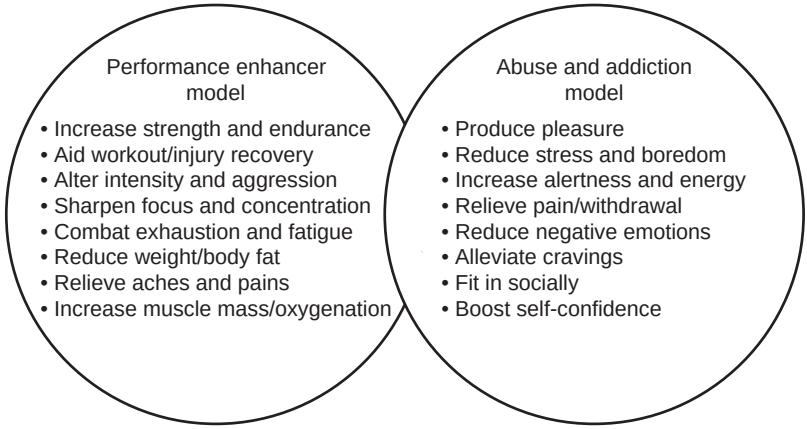

Fig. 1. Substances and athletics: reasons for use.

reduce stimulant use with several teams are described, and the problem of stimulant-induced insomnia and anxiety is discussed [20,21]. For tobacco, the patterns of use in baseball, football, and other sports are described. An organized prevention and early intervention program involving the team dentist is detailed. Successful substitutes for spit tobacco (moist snuff and chewing tobacco) are described [22–26]. For steroids, the complex issues of supplement contamination, adverse effects, designer drug detection, and prevention policy are reviewed [27–31]. The proper balance between sanctions and clinical interventions is discussed. For each of these substances, the different perspectives between addictive and performance-enhancing substances are used to highlight effective interventions.

ALCOHOL

Beverage alcohol is a simple organic compound that easily crosses the blood-brain barrier quickly, affecting brain centers for balance and coordination, fluid retention, judgment and reasoning, emotional control, level of alertness, sexual interest, and socialization. Studies of the general population show that approximately 75% to 80% of young adults use alcohol, and that approximately 15% to 20% are heavy drinkers or binge drinkers [32]. Rates of alcohol use among college athletes are higher than the general public, with use rates for men of 75% to 93% and for women of 71% to 93% [32]. Use rates do differ by sport—swimming/diving, soccer, and baseball/softball rates are higher than basketball, volleyball, and track and field rates. Binge drinking is also more common among athletes compared with nonathletes, with recent episodic heavy drinking rates of 25% to 50% for athletes, compared with 16% to 43% for nonathletes [33].

Motivation to drink alcohol is usually divided into social, coping, hedonistic, or performance categories. Athletes cite all these reasons, and there is some evidence that these may differ by sport [33,34]. The National Collegiate Athletic

Association (NCAA) 2001 study [33] shows that college athletes drink mostly for social reasons (83.9%) compared with feeling good (12.9%), coping (3%), or performance (0.2%). Martens [34], however, demonstrates higher performance enhancement motives, especially among swimmers and divers. In addition, swimmers and divers and basketball players have higher levels of social motivation than track/cross-country athletes.

Alcohol use among athletes is associated with negative general health and athletic performance consequences. College athletes, for example, cite alcohol as the most negative substance on performance and health. Surprisingly, its harmful effects are cited two to three times more often than those of cigarettes, spit tobacco, or marijuana [33]. Injury rates among regular drinking athletes are also higher than among nondrinking athletes. One study [16] showed that athletes who drank at least weekly had injury rates that were twice those of nondrinkers (54.8% versus. 23.5%). A recent study by Martens and colleagues [35] demonstrates that athletes who drink for coping reasons have more negative consequences than those who drink for other reasons.

Alcohol adversely impacts athletic performance in a number of different ways. Previous research has shown that alcohol consumption in the 24 hours before athletic activity significantly reduces aerobic performance, by about 11.4% [36]. This might not be significant, except that drinking the day before training and competition is extremely common, with rates by sport ranging from 18% to 84%. The lowest rates are seen for cycling, horse racing, and tennis, whereas the highest rates are seen in football, rugby, basketball, soccer, and golf [16]. Alcohol's negative effects on aerobic performance and psychomotor skills are thought to be due to its slow/fixed rate of metabolism (zero order kinetics) and its toxic interference with energy and carbohydrate metabolism. Additional negative effects come through dehydration, mood instability, and sensory motor system dysfunction. Interestingly, this "hangover effect" is seen even in low doses of just a few standard drinks, and may last from 24 to 36 hours, depending on its severity [16]. Alcohol is also poor nutritionally. Although it provides seven calories of energy per gram, it does not replace expended carbohydrates, and is often associated with significant weight gain caused by its "empty calories."

Alcohol can also adversely effect performance by interfering with sleep, disinhibiting aggression, and increasing high-risk behaviors such as drinking and driving, gambling, illicit drug use, or sexual promiscuity. Alcohol is notorious for its toxic effect on sleep. It is common for an intoxicated person to awaken 3 to 5 hours after falling asleep. This prevents adequate restoration, and can impair motor performance, concentration, and attentional shifting the following day. Some persons become aggressive or exercise poor judgment when intoxicated. Fights and injuries to the hands, wrists, and jaw are common. Negative behaviors such as those cited above can lead to arrest or suspension.

The authors discover heavy drinking in athletes in several ways. Any alcohol-related arrest or negative behavioral incident leads to automatic evaluation by a team assistance program professional. Referrals also come from concerned teammates, coaching staff, or the team's physicians and trainers. Heavy spit

tobacco users often use alcohol heavily. Individuals who test positive for an illicit or performance enhancing drug are also more likely to be misusing alcohol. The University of Maryland's team assistance programs have found it especially useful to include alcohol in our urine testing program. When an athlete tests positive on a late morning or early afternoon test, it means that heavy drinking occurred the night before. Because alcohol's elimination is fixed at about one drink per hour, the quantitative results and the history can be used to determine the approximate peak blood alcohol concentration and number of standard drinks consumed.

STIMULANTS

The use of amphetamines by athletes in the United States dates back to the 1940s for football and to the late 1950s for other sports [20]. Despite the lack of strong scientific evidence of a positive effect on athletic performance, amphetamines quickly became the most popular ergogenic aids, because of their demonstrated and perceived positive effects on self-confidence, mood, attention, aggression, and energy. Over-the-counter (OTC) stimulants such as phenylpropanolamine, ephedrine, and pseudoephedrine became regular substitutes for amphetamines after the passage of the Controlled Substances act of 1970. Although these sympathomimetic amines are not as potent as amphetamines, when used in combination with caffeine they became quite popular. The use of these OTC amphetamine "look-alikes" further expanded after the passage of the Dietary Supplement Health and Education Act of 1994 [9,20]. This act did not require manufacturers to prove the safety or effectiveness of their products. Consequently, the use of these OTC supplements for weight loss and athletic performance enhancement exploded, despite existing safety concerns. In 2000 and 2004 these safety concerns were fully recognized, when the Food and Drug Administration banned the sale of phenylpropanolamine and ephedra-containing supplements because of adverse events including sudden death, heat stroke, cerebrovascular accident, serious arrthymias, myocardial infarction, seizure, and serious psychiatric illness [11,21]. As soon as ephedra was removed from retail and internet suppliers, however, it was quickly replaced by bitter orange (*Citrus aurantium*), another sympathomimetic amine that contains synephrine. Because the chemical structures of amphetamine and these look-alikes are quite similar, it is no wonder that they are associated with similar risks and benefits (Fig. 2). In the last few years, the use of a new class of stimulants, the so-called "eugeroics" or "good arousal" drugs, has increased. The two drugs from this class, modafinal and adrafinil, were developed in France to treat narcolepsy and hypersomnia. Only modafinil is legally available in the United States, but both are easily obtained via internet pharmacies. Compared with amphetamine-like stimulants, they are marketed as having low abuse liability and fewer side effects such as insomnia, anxiety, and agitation. This is reportedly due to selective stimulation of noradrenergic neurons in the hypothalamus and brain stem [37,38]. Because these drugs are not chemically similar to amphetamine, they will not typically be picked up on stimulant urine drug testing.

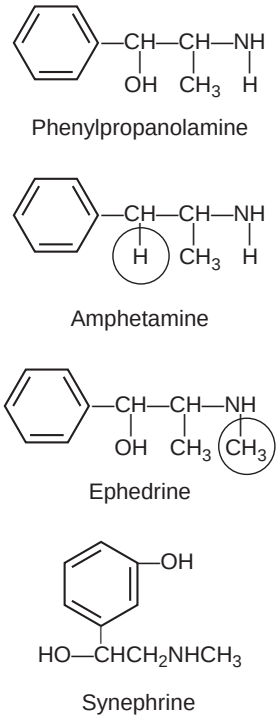

Fig. 2. Chemical structures of amphetamine substitutes.

Much lower rates of about 5% or less have been seen over 10 years from the University of Maryland's team assistance urine drug testing program. Media and former player claims that 60% to 80% of baseball players use amphetamines are clearly exaggerations [39]. Much lower rates of about 5% or less have been seen from urine drug testing. This seems too low, however, because about 3.3% of college athletes in 2001 and 10% of 12th graders, 7% of college students, and 6% of young adults in 2003 self-reported amphetamine use [32,33,40]. Additionally, 3.9% of college athletes reported using ephedrine. For college athletes, social and personal reasons were the most common primary reason for use (27.4%), followed by performance improvement (23.8%), energy boost (21.5%), and weight loss (11.7%). Interestingly, for college athletes, use of amphetamines and ephedrine were more common in men for power sports (football, lacrosse, wrestling) and for those requiring enhanced concentration (rifle, fencing). For women, stimulant use was more common in ice hockey, gymnastics, and field sports (soccer, field hockey). Rates for women's sports were higher than for men for ephedrine but lower for amphetamines.

The adverse effects of regular amphetamine and other sympathomimetic stimulant use are quite relevant to athletic performance. The most common are anxiety, insomnia, tremulousness, irritability, and weight loss. Even though these effects

are common and dose-related, when asked, athletes note more positive than negative effects. For college athletes, almost twice as many noted amphetamines to have a helpful rather than harmful effect on performance, whereas more than twice as many noted them to be harmful rather than helpful on health [33]. In the authors' practices with elite athletes, the most common problems that we have seen are insomnia and substance-induced panic attacks or generalized anxiety. In these cases, athletes were usually using high dosages of caffeine (>500 mg/day), nicotine, and either ephedrine or amphetamine [41]. In addition, many were also drinking alcohol regularly to counteract the side effects of the stimulant stacking. Some were also using short-acting soporifics such as zolpiderm or zaleplon. For insomnia, we are able to get athletes to reduce their stimulant use through informed discussion and improved sleep hygiene. For several cases of stimulant panic, we also used low-dose benzodiazepines short-term and then selective serotonin reuptake inhibitors later. To prevent these problems, we give regular preseason and in-season talks. After each, players will routinely bring us their stimulant-containing supplements and ask for advice about continued use.

SPIT TOBACCO

Spit tobacco, primarily as moist snuff, is used extensively by male professional and collegiate athletes. In professional baseball, prevalence rates of 35% to 40% are seen, and even higher rates of 40% to 50% are reported for college baseball players [22,23,33,42,43]. Current rates of use in professional football players are estimated to be 20% to 30%, and rates in college were 35.6% in 1993 and 28.9% in 2001 [33]. Other male collegiate sports that had high rates of use in 2001 were wrestling (38.6%), ice hockey (35%), and lacrosse (32.2%) [33]. For professional athletes, the most common reasons cited for spit tobacco use are: (1) pregame and postgame relaxation, (2) improve concentration and focus, (3) relieve boredom, (4) boost energy/combat fatigue, (5) habit–need to have something in my mouth, (6) handling–dip and tin, (7) relieve withdrawal symptoms, and (8) improve performance. These are in contrast to those reported by college baseball players in a structured survey [33]. They cited recreational or social reasons (47.9%), pleasure (28%), stress relief (22.8%), and performance enhancement (1.4%). In sharp contrast with the positive reports on athletic performance that the authors receive from professional athletes, college athletes reported that spit tobacco use was nearly 20 times more likely to have no effect, and nearly twice as likely to have a harmful effect as a positive effect on performance.

Most athletes who use spit tobacco prefer brands that are more alkaline and therefore have more nicotine available for absorption. Remarkably, snuff's nicotine bioavailability can vary from 3% to 90%, depending on whether the additives make it more acid or alkaline [42,44]. This makes pH a much more potent variable for nicotine absorption than even the size of the dip or the fineness of the cut. Use can vary from a 30-gram tin every few days for those that use only when practicing or competing, to more than a tin a day for hard-core users. The best indication of nicotine dependence is use throughout the day, especially within 30 minutes of awakening and just before bedtime.

Spit tobacco users can develop many adverse health effects, including oral cancer, oral leukoplakia, caries, periodontal disease, hypertension, cardiovascular disease, sexual impotence, gastric ulcers, anxiety, insomnia, and nicotine addiction [42]. College athletes report that spit tobacco use is 20 times more likely to have a negative effect on general health than a positive one. These effects ,especially oral lesions, anxiety, and insomnia, are very helpful in getting athletes interested in cutting down or quitting [33,42]. One of the most effective approaches to tobacco cessation in high school, college, and professional athletes involves a dental examination and a brief motivational intervention by a dental hygienist [42,43,45]. One-year quit rates of 10% to 35% are seen after this type of intervention. The University of Maryland has supplemented this approach with a referral to our team assistance program (TAP). The TAP staff includes several addiction psychiatrists who are present during the preseason and throughout the season, and are able to prescribe nicotine replacement, buproprion, or antidepressant/anti-anxiety agents if needed. In addition, we provide ongoing relapse counseling targeting stress and craving control. We have discovered that many long-term users can stop during the season, but only if they find an effective oral substitute. Examples have included herbal snuff, nicotine gum, chewing gum, hard candy, plastic cigar tips, sunflower seeds, aromatic hardwood branches, and a low nitrosamine, spitless tobacco pellet.

STEROIDS

The history of anabolic steroid abuse in American began in weight lifting [4,46]. Bob Hoffman, a World War I veteran, invented the barbell in 1923 and later established the famous York Barbell Company and Gym in York, Pennsylvania. His success as a trainer in York eventually led to him being named the head coach of the US Olympic weight lifting team. Mr. Hoffman became friends with John Ziegler, a physician from Maryland who trained at Hoffman's gym. As a result of this contact, Hoffman appointed Ziegler as the Olympic weight lifting team physician. At the 1954 World Championships in Vienna, Hoffman met a Soviet colleague who told him of a synthetic form of testosterone that produced dramatic improvements in strength and power. Ciba Pharmaceuticals provided Zeigler with this steroid and Nazi research records that had been confiscated by the United States after the War.

Ziegler decided to study its effect in weightlifting athletes. This resulted in the first mass-produced anabolic steroid, methandrostenalone, in 1958. Ziegler gave the steroid to the entire US Olympic weight lifting team in the 1960 Rome games, but still lost to the Soviets. They had already developed the next generation of anabolic performance enhancers. Although this was not in violation of existing Olympic rules, it was clearly inconsistent with the spirit of the Games or the Olympic Code. After the 1960 Games, York became the Mecca of US weightlifting. Former York lifters went on to become strength and conditioning coaches across the United States, taking what they had learned from Dr. Ziegler about anabolic steroids with them. By 1968, the use of anabolic steroids had become so common in Olympic competition that routine urine

testing was instituted [4]. Dr. Ziegler died in 1984. Just before his death he was quoted as saying, "All those young kids, what a terrible price they'll pay. If only I'd known it would come to this. I wish to God I'd never done it" [46].

The use of anabolic steroids became widespread in Olympic and professional sports through the 1970s and 80s. Their use in football eventually led the National Football League to begin urine testing in 1987, and to impose sanctions in 1989. Nonusing players who wanted to "level the playing field" initiated this policy change. Finally, in 1990 the Anabolic Steroid Control Act was passed, placing anabolic steroids on Schedule III and requiring prescription by a physician. This act and the passage of the Dietary Supplement Health and Education Act in 1994 promoted a shift away from illegal anabolic steroids to legal nutritional supplements. Those supplements contained testosterone precursors or prohormones such as androstendione or dihydroepiandrosterone (DHEA). Studies of androstenedione have yielded conflicting results as to whether its use actually increases serum testosterone [4,47,48]. Other studies have shown that the dosages and contents of these supplements as reported on their labels may not be accurate, leading to the possibility of positive urines from contamination [5]. In the past few years with the Bay Area Laboratory Co-Operative (BALCO) steroid scandal in track and field and baseball, the important issue of designer steroids and other strategies to test negative has surfaced. Tetrahydogestrinone (THG), the active ingredient of the BALCO clear oral liquid was identified by the University of California at Los Angeles (UCLA) Olympic laboratory from syringe residue discovered at a US track and field meet. Although it took several months to identify this new anabolic steroid, it was eventually determined to be chemically similar to gestrinone and trembolone [49]. The BALCO body cream, on the other hand, was determined to contain both testosterone and epitestosterone. This combination presumably was designed to mask steroid use by keeping the ratio of testosterone to epitestosterone in the normal range (ie, under 6:1). The discovery of these compounds and their use in baseball led to the January 2005 changes in major league baseball's steroid testing and sanctions policy.

Anabolic androgenic steroids (AAS) are synthetic derivatives of testosterone. They induce protein synthesis in muscle cells and stimulate the release of growth hormone, which has robust anabolic effects. In addition to potent anticatabolic effects, these compounds allow athletes to overtrain and to achieve dramatic increases in muscle size and strength. Once training is stopped, size and strength gains rapidly disappear [50]. Steroid-abusing athletes report a dramatic increase in training and a faster recovery time. Ariel and Seville [51] demonstrated a significant placebo effect in competitive weight lifters who got stronger than matched controls when given placebos thought to be AAS. In addition to their strength effects, AAS have psychiatric side effects [14,15]. Interpreting the extant literature on psychiatric side effects is problematic. Doses used in clinical trials rarely reflect the supratherapeutic psychiatric doses by abusing athletes. Despite methodologic variations, the most consistent clinical psychiatric findings are increased hostility, aggression, irritability, and mood lability [52,53]. Pope and Katz [13], two of the leading steroid abuse researchers, evaluated 88 athletes

using AAS. This nonblinded, retrospective, self-report survey study revealed that 23% of respondents reported major mood syndromes–12% with psychotic symptoms and 8% with drug dependence. No control group was used. Other self-reported effects are increased sex drive, acne vulagris, gynecomastia, and increased body hair [15]. Despite over half a century of steroid abuse by athletes, however, much remains to be learned about the long-term effects when taken in very high doses and combined with intensive physical training.

The current prevalence of AAS use in professional athletics has been greatly exaggerated in the media. In the 2003 major league baseball survey the urine positive rate was 5% to 7%, rather than the 40% to 50% suggested by former players. Admittedly the rate could be an underestimate, because survey testing was done only once during the playing season for each player on the 40-man roster; however, because testing was not tied to individuals as it was in 2004, it might not have had as strong a deterrent effect. The experience in minor league baseball, where steroid testing began in 2001, shows that urine drug testing and sanctions have a deterrent effect. Positive rates, 9% in the first year of testing [54], have dropped significantly.

Results from male college athletes in the 2001 NCAA report show that self-reported rates of use vary greatly by sport [33]. The lowest rates are seen in swimming (0.2%), soccer (0.9%), and gymnastics (1.1%), whereas the highest rates are in water polo (5.0%), football (3.0%), baseball (2.3%), and lacrosse (2.2%). Rates in football dropped dramatically from 9.7% in 1989, to 5.0% in 1993, to 2.2% in 1997, before rising to 3.0% in 2001. Women's use rates were much lower, ranging from 0.0% in several sports (field hockey, gymnastics, track and field, tennis) to 1.3% in swimming and 1.6% in lacrosse. Surprisingly, the average use rate for all sports of 1.4% is lower than self-reported community use rate of 2.4% in 12th graders for the same year [32]. The most common reasons for AAS use in this report were performance improvement (42.7%), appearance improvement (19.8%), and injury rehabilitation (16.7%).

The professional athletes that the authors see are referred for evaluation after a positive urine test. This provides an opportunity to discuss AAS initiation, recent patterns of use, and the impact on health and performance. A balanced discussion of the risks and benefits, with an emphasis on graduated sanctions, seems the best preventive approach. So far we have seen no cases of steroid dependence in baseball or football, and only one in another sport (competitive bodybuilding).

DISCUSSION

Athletes use substances to produce pleasure, relieve pain and stress, improve socialization, recover from injury, and enhance performance. Given that the rates of use for many substances are substantially higher than in nonathletes, it is not clear whether this can be explained using abuse/addiction or performance enhancement models. Athletes may certainly develop substance-use disorders just as nonathletes do; however, the most common performance-enhancing substances (stimulants and steroids) have low addictive potential, despite moderate levels of neurobehavioral toxicity [55]. Because the most addictive substances

(alcohol and tobacco) are often used episodically and the patterns of use can change dramatically from the playing season to the off-season, the rates of substance dependence may be kept low. An important clinical question is whether the treatment of athletes who have a substance-use disorder should in any way differ from the treatment of nonathletes? Also, should performance-enhancing drug abuse be viewed in the same way as alcohol, tobacco, marijuana, or cocaine abuse? In this article the authors have reviewed the existing literature on substance use in athletes, and we recommend future research into this highly emotionally charged topic.

Over the past 25 years, psychiatry has made great strides in understanding the complex interaction of biological and psychosocial factors that ultimately lead to drug abuse. Although there is much work to be done, clinical and basic research funded largely by the two National Institutes of Health (NIH) agencies responsible for studying this problem (National Institute on Drug Abuse [NIDA] and National Institute on Alcohol Abuse and Alcoholism [NIAAA]) have helped create the current interest in the science of addiction and abuse. This, in turn, has helped clinicians deal with the ever-present problem of stigma on drug abusers. Slowly but surely, the medical community and general population are realizing that drug abuse is not merely the result of a flaw in the moral fiber of the abuser, but a true medical/psychiatric disorder. This issue becomes even more problematic when an athlete is involved. World class and professional athletes are held to a higher standard by their adoring fans. When a prominent athlete is caught using drugs, it is a newsworthy event and almost always made very public. This is not the case for other professionals, such as doctors and lawyers, who strive to maintain confidentiality when one of their own has a drug problem. Why are athletes held to a higher standard? Conventional wisdom declares that athletes are role models who are looked up to by our youth, and who by setting this bad example may be encouraging drug use by others. Well-conducted survey research confirming this point is currently nonexistent. This is a very important point that needs to be addressed in future research.

Another prevalent conception is that drug use is cheating and sports are, or should be, all about fair competition. There is no doubt that some drugs do provide a competitive advantage to the user, but at what cost to the athlete? The psychiatric aspects of drug abuse include understanding the motivation to use, as well as determining effective treatment strategies. What role do pre-existing or emergent psychiatric symptoms and syndromes play in drug abuse in athletes [18]? This is a critical question that requires further study. None of the existing studies reporting on psychiatric effects of performance-enhancing drugs used by athletes match the dosing seen in the gym. No institutional review board in the country would approve giving high doses of black market compounds to study subjects. The extant literature on effective drug abuse treatment does not control for the unique aspects of athletes. The impact of intense training, along with other lifestyle differences between athletes and nonathletes, has not been addressed in the substance-use literature. Generalizing what has been learned from studies conducted in drug-abusing nonathletes to drug-abusing athletes

may be problematic. Methodologically sound, large-scale clinical trials conducted on athletes are the only reliable way to study the issues surrounding athlete substance use. The unique role a coach plays in the life of an athlete is well known, yet little has been written about the coaches' contribution in identifying and intervening with substance use or abuse. A subtle but potentially important early warning sign of abuse may be a change in training habits or a drop-off in competition success. A coach is likely to observe this early on in the course of a developing problem, and may help initiate early treatment interventions. Training coaches on the early warning signs of sport-specific substance-abuse behaviors and providing confidential professional referrals may be an effective early warning system. This hypothesis needs to be studied.

Leshner published an excellent paper on science-based views of drug addiction and its treatment [56]. This work needs to be expanded to athletes. Validated and reliable screening instruments and effective treatment interventions for drug abusing athletes need to be studied using methodically sound research paradigms. For substance abuse researchers, this is an exciting area for future research.

Sports steroid-abuse scandals involving high-profile athletes continue to be front-page news across the country. The short- and long-term effects of headline articles, such as "The Bonds Bombshell" and "Tainted by Drugs" or Canseco's allegations [57] on drug use by athletes are yet to be determined, and are an important topic for sport psychiatrists to study.

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