REVIEW

FARID TALIH, MD
Department of Psychiatry and Psychology, and Sleep Disorders Center, Cleveland Clinic

OMAR FATTAL, MD
Department of Psychiatry, Lutheran Hospital, Cleveland

DONALD MALONE, JR, MD
Head, Section of Mood and Anxiety, Department of Psychiatry and Psychology, Cleveland Clinic

Anabolic steroid abuse: Psychiatric and physical costs

ABSTRACT

The psychiatric effects of anabolic-androgenic steroids (ie, testosterone and its derivatives) have been less well studied than their physical effects but are reported to include depression, mania, psychosis, and aggression. Dependence can also occur, with withdrawal involving psychiatric and physical symptoms. Adverse effects of steroid abuse should be managed by discontinuing the drugs—by tapering if necessary—and by treating the symptoms.

KEY POINTS

Steroid abusers typically take doses 10 to 100 times higher than physiologic doses, in cycles lasting 6 to 14 weeks, consisting of daily oral doses plus weekly or monthly intramuscular injections.

Anabolic-androgenic steroids can affect nearly every organ system. Gynecomastia, acne, lipid abnormalities, abnormal liver function tests, and personality changes are among the manifestations of steroid abuse.

Treatment of psychiatric effects starts with stopping the steroids. It is reasonable to substitute testosterone enanthate (Andro-Estro) and gradually taper the dose.

The short-term use of antipsychotic medications may help treat steroid-induced mania and psychosis. Benzodiazepines may help control panic or anxiety in the short term. Selective serotonin reuptake inhibitors or tricyclic antidepressants should be used if long-term treatment is needed.

Depression sometimes occurs when use is stopped. Fluoxetine (Prozac) can be used in this situation.

ANABOLIC-ANDROGENIC STEROID ABUSE is no longer confined to professional athletes; it is now on the rise in the general population, even among adolescents. Physicians should be aware of its signs and symptoms in order to address adverse effects and provide treatment.

This paper briefly discusses the physical effects of anabolic-androgenic steroids and how to recognize possible abuse in patients. We then detail the literature regarding psychiatric effects.

STEROID ABUSE IS NOT NEW

Steroid use has gained widespread public attention in recent years, owing to news of abuse by high-profile athletes in professional and Olympic sports.[1,2] Hundreds of thousands of Americans are estimated to be abusing these drugs, mostly in secret. Incidents of violent, aggressive, and even homicidal behavior have added notoriety to this topic.[3]

Athletes have used performance-enhancing substances since the time of ancient Greece. There are anecdotal reports from the 1940s of steroids being given to German soldiers to increase aggressiveness.[4] In the 1950s, the first reports emerged of steroid abuse by athletes, who used them to increase muscle mass, strength, and competitiveness.[2,5,6] Anabolic-androgenic steroids were banned by the International Olympic Committee in 1975.[4,6,7]

In 1991, the US Congress made anabolic-androgenic steroids schedule III substances. The US Drug Enforcement Agency controls and monitors their use.[1,5]

WHO IS ABUSING STEROIDS?

Professional athletes in almost every major

TABLE 1

Commonly abused anabolic-androgenic steroids

Oral preparations

- Fluoxymesterone (Halotestin)
- Mesterolone (Proviron)
- Methandienone (Dianabol)
- Methyltestosterone (Virilon)
- Mibolerone (Cheque)
- Oxandrolone (Anavar, Oxandrin)
- Oxymetholone (Anadrol)
- Stanozolol (Winstrol)

Intramuscular preparations

- Boldenone undecylenate (Equipoise)
- Methenolone enanthate (Primobolan)
- Nandrolone decanoate (Deca Durabolin)
- Nandrolone phenpropionate (Durabolin)
- Testosterone cypionate (Depotest)
- Testosterone enanthate (Andro-Estro)
- Testosterone propionate (Testex)
- Trenbolone acetate (Finajet)

DATA FROM KNOPP WD, WANG TW, BACH BR JR. ERGOGENIC DRUGS IN SPORTS. CLIN SPORTS MED 1997; 16:375–392; PERRY PJ, KUTSCHER EC, LUND BC, YATES WR, HOLMAN TL, DEMERS L. MEASURES OF AGGRESSION AND MOOD CHANGES IN MALE WEIGHTLIFTERS WITH AND WITHOUT ANDROGENIC ANABOLIC STEROID USE. J FORENSIC SCI 2003; 48:646–651; AND MALONE DA JR, DIMEFF RJ, LOMBARDO JA, SAMPLE RH. PSYCHIATRIC EFFECTS AND PSYCHOACTIVE SUBSTANCE USE IN ANABOLIC-ANDROGENIC STEROID USERS. CLIN J SPORT MED 1995; 5:25–31

Risk factors for steroid use: poor relationships with fathers, conduct disorders, substance abuse, poor body image

sport are involved in allegations of anabolic-androgenic steroid use. The current media exposure might reflect an increased prevalence and penetration of steroid use in sports culture.

Many cultural factors may enhance steroid abuse: increased competitiveness, concerns about body image, and advances in biochemical technology. Younger people are also affected by such trends because of the highly competitive nature of high school and collegiate sports. The enhanced performance that steroids provide may be the deciding factor in securing an athletic scholarship or acceptance into professional sports.

Limited data are available on the prevalence of anabolic steroid use in adults, but estimates are in the hundreds of thousands.[8] Most users are men involved in weightlifting, bodybuilding, and professional sports, but use among women and adolescents is also on the rise.[9] The 2005 Monitoring the Future study estimated the lifetime use of anabolic-androgenic steroids at 1.7% in eighth graders, 2% in tenth graders, and 2.6% in twelfth graders,[10] which is significantly more than in 1990.

Risk factors for using anabolic-androgenic steroids are poorly understood but include poor relationships with fathers, a history of conduct disorders, a history of substance abuse, and poor body image.[11] Race, education level, and income do not appear to be significant factors. Among adolescents, boys are more prone to abuse steroids than are girls, and participation in organized sports and knowing someone who uses anabolic steroids are predictors of future use.[12]

In 1990, the illicit steroid market was estimated to be $400 million. Steroid cycles, typically lasting 6 to 14 weeks, can cost hundreds of dollars. A cycle consists of daily oral doses plus weekly or monthly intramuscular depot injections. Some users take multiple cycles per year.[2,5]

WHAT ARE ANABOLIC-ANDROGENIC STEROIDS?

People have known for centuries that castrating animals leads to tameness, loss of male characteristics, and infertility. In 1849, it was discovered that the human testes provide hormones that affect the body. Human testosterone was first isolated in 1935.[13]

Testosterone, a four-ring cyclic compound composed of 19 carbon atoms, is produced in the body from cholesterol.[1,14] In males, the testes are the major site of testosterone production, and the adrenal glands are a minor site. In females, testosterone is produced in the adrenal glands and the ovaries.[14]

Normal total plasma testosterone levels in males are in the range of 300 to 1,000 ng/dL.[14] Most is bound by sex hormone-binding protein and is inactive; free testosterone, the active form, makes up only 2% to 3% of circulating testosterone. Testosterone is metabolized into dihydrotestosterone, which is 10 times more potent than testosterone, and estradiol, which has feminizing effects.[15]

After its discovery, testosterone was found to be inactive when taken orally and rapidly inactivated by the liver when injected. Synthetic derivatives, made by modifying the testosterone molecule, have enhanced bioavailability and activity. Currently available

anabolic-androgenic steroids (TABLE 1) are active when taken either orally or as an intramuscular depot injection, depending on the position and type of the biochemical alteration.[14] Some of these agents are designed to have minimal side effects, and others (not listed in TABLE 1) are designed to avoid detection in antidoping tests.[16]

Medical uses for testosterone include treatment of some anemias, muscle dystrophies, wasting related to human immunodeficiency virus infection, and male hypogonadism.[1,14,15]

Nearly every cell in the human body has receptors for steroids, so that every organ system is susceptible to the effects of these molecules.[2] Giving physiologic amounts of testosterone has no net effect on plasma levels because feedback inhibition shuts down endogenous production. Users of anabolic steroids take 10 to 100 times the physiologic dose to override feedback inhibition.[15]

ADVERSE PHYSICAL EFFECTS

Testosterone and its derivatives can have adverse effects on the cardiovascular, metabolic, reproductive, endocrine, dermatologic, and hepatic systems.[2,9,14,17–19] Coronary artery disease is of the most concern.

O'Sullivan et al[20] conducted a community-based study of 27 past users of anabolic-androgenic steroids, 14 current users, and 17 potential users (who served as controls) attending a medical clinic established specifically to examine steroid use. The most common adverse effects were changes in libido, changes in mood, reduced testicular volume, and acne. Twenty-nine percent of the present users had hypertension, as did 37% of past users—but only 8% percent of potential users. After learning of the results of the study, only 11 participants (19%) reported that they would not use anabolic steroids in the future.

Increased risk of cancer, death. Some reports have found that anabolic steroid use can have more serious effects, including an increased risk of cancer and of death.[18]

Parssinen et al[21] studied 62 professional weightlifters in Finland who were strongly suspected of using anabolic-androgenic steroids and compared them with 1,094 population controls. Over a 12-year period, 8 (12.9%) of the weightlifters died vs 34 (3.1%) of the controls ($P = .0002$). The causes of death in the weightlifters were suicide (3 subjects), acute myocardial infarction (3), hepatic coma (1), and non-Hodgkin lymphoma (1).

Vascular effects. Reported severe adverse effects of anabolic-androgenic steroid use include cerebral venous sinus thrombosis, ischemic cerebral stroke,[22,23] and cardiovascular events in the absence of risk factors.[24,25] Two cases of limb-threatening arterial thrombosis were reported with the use of danazol (Danocrine), an antigonadotropin steroid-like compound with weak anabolic properties.[26]

Cardiovascular toxicity may occur via atherogenic, thrombotic, or vasospastic mechanisms or through direct myocardial injury.[27–29]

Hepatic effects. Toxic hepatitis and life-threatening hepatocellular adenomas have been reported.[30,31]

Infections from injecting steroids are a serious problem, although no cross-sectional or prospective studies exist that document the risk. Rich et al[32] reviewed the literature from 1966 to 1998 and found three cases of human immunodeficiency virus infection, one case of hepatitis B infection, one case of hepatitis C infection, eight abscesses, and one case of fungal endophthalmitis.

Orthopedic complications, mostly tendon ruptures, have been reported.[26,33–36]

Sexual changes. Gynecomastia can occur in men but may be reversible. Many masculinizing changes in women tend to be irreversible.[1,14,15]

Cardiac toxicity may be atherosclerotic, thrombotic, or vasospastic, or a direct effect

RECOGNIZING STEROID ABUSE

Physicians should be alert to the signs and symptoms of steroid abuse and should consider the problem in patients at high risk. Early recognition and intervention may prevent adverse and potentially irreversible consequences.

Clues to possible anabolic-androgenic steroid abuse are listed in TABLE 2.[37] New-onset acne on the back and chest, temporal hair loss, and alopecia are common signs. Subtle personality or mood changes are sometimes the only manifestation.

TABLE 2

Clues to anabolic-androgenic steroid use

SYSTEM AFFECTED	SIGN OR SYMPTOM
Cardiovascular	Cardiac disease in absence of risk factors Thrombotic events in absence of risk factors
Dermatologic	Alopecia Male pattern baldness in women Needle marks on buttocks and thighs New-onset acne affecting the chest and back
Endocrine	Glucose intolerance Lipid abnormalities
Hepatic	Abnormal liver function tests Hepatic masses Jaundice
Infectious	Deep abscesses in the thighs or buttocks Human immunodeficiency virus infection or hepatitis
Musculoskeletal	Rapid and pronounced muscle hypertrophy Tendon injury
Neurologic	Strokes in absence of risk factors Unexplained syncope
Psychiatric	Irritability, hostility Mood changes (mania or depression) Personality changes Psychosis
Reproductive	Breast atrophy in women Clitoromegaly Gynecomastia in men Testicular volume decrease Virilization in women with voice changes

PSYCHIATRIC SIDE EFFECTS ARE LESS WELL UNDERSTOOD

Psychiatric effects of anabolic-androgenic steroid use are not as well understood as the physiologic effects.[19]

Steroids act on the central nervous system in several ways: they can affect the brain by releasing endogenous opiate peptides or by converting into estrogen derivatives and activating secondary messenger systems. Electroencephalographic changes are similar to those seen with amphetamines and tricyclic antidepressants.[14,38]

Psychiatric effects of steroids are hard to study

The psychiatric effects of anabolic-androgenic steroids are hard to study, for several reasons. Many of the available studies were, by necessity, observational. But because the substances are illicit, users have no way to verify their exact nature or amounts taken.[1,2,39] Moreover, many steroid users concomitantly take a multitude of other performance-enhancing drugs and dietary supplements that also may have psychiatric effects (**TABLE 3**).[40,41]

Prospective studies are hard to carry out because of the ethical issues inherent in testing a potentially dangerous substance. Because many users belong to a subculture of bodybuilders, weightlifters, or elite athletes, study results are hard to extrapolate to the general public.[42] Most studies to date have evaluated dosages lower than most users report taking.[15,42,43] Further, users of anabolic-androgenic steroids tend to use them for prolonged and repeated cycles over many years, which is hard to recreate in clinical trials.

More studies are needed on a larger scale with dosing that is compatible with the supraphysiologic dosages used in the community.

Are steroid users psychologically dysfunctional to begin with?

In addition, pre-existing personality traits that might predispose people to use steroids may significantly confound assessing any psychiatric effects of drug use.[44–47] Suspected risk factors for men include antisocial personality traits, low self-esteem, and poor body image (body dysmorphia).[11,48]

Porcerelli and Sandler[49] found that weightlifters and bodybuilders who used anabolic steroids had significantly higher scores on dimensions of pathologic narcissism and lower scores on ratings of empathy. Another study found that up to 50% of steroid users had worked as bouncers and described themselves as aggressive regardless of their drug use.[47]

MOOD EFFECTS

Uncontrolled, observational trials in the 1930s and 1940s found that men with refractory depression responded favorably to testosterone treatment.[15] However, randomized,

TABLE 3

Other drugs that steroid abusers often use

SUBSTANCE	EFFECT
Amino acids (various)	Anabolic
Clenbuterol (Ventipulmin, equine)	Weight control
Danazol (Danocrine)	Antigonadotropin
Dehydroepiandrosterone (Prasterone)	Anabolic
Diuretics (various)	Weight control
Ephedrine/pseudoephedrine (Sudafed)	Weight control
Growth hormone (Humatrope)	Anabolic
Human chorionic gonadotropin (Ovidrel)	Anabolic
Insulin (various)	Anabolic
Levothyroxine (Synthroid)	Weight control
Nalbuphine hydrochloride (Nubain)	Pain control
Tamoxifen (Nolvadex)	Antifeminizing

DATA FROM PERRY PJ, KUTSCHER EC, LUND BC, YATES WR, HOLMAN TL, DEMERS L. MEASURES OF AGGRESSION AND MOOD CHANGES IN MALE WEIGHTLIFTERS WITH AND WITHOUT ANDROGENIC ANABOLIC STEROID USE. J FORENSIC SCI 2003; 48:646–651; AND POPE HG JR, KATZ DL. PSYCHIATRIC AND MEDICAL EFFECTS OF ANABOLIC-ANDROGENIC STEROID USE. A CONTROLLED STUDY OF 160 ATHLETES. ARCH GEN PSYCHIATRY 1994; 51:375–382.

placebo-controlled studies conducted in the 1980s were equivocal.[50,51]

Observational studies show hypomania, mania, and depression

Malone et al[45] retrospectively studied 164 weightlifters and bodybuilders who used anabolic-androgenic steroids and found that about 10% had hypomania. Depression occurred when steroids were stopped in about 10%.

Pope and Katz[52] interviewed 41 bodybuilders and football players taking anabolic-androgenic steroids and found that 9 displayed full affective syndromes and 5 showed psychotic symptoms.

In a later study, Pope and Katz[39] compared 88 athletes who were using anabolic-androgenic steroids with 68 nonusers and found that 23% of the steroid users reported major mood symptoms (including mania, hypomania, and depression) vs only 6% of the nonusers, and several users reported aggressive thoughts. The higher the steroid dosage, the more severe the psychiatric symptoms.

Perry et al[44] conducted a similar study of weightlifters and found more symptoms of depression and mania among users of anabolic-androgenic steroids, although formal diagnoses were not made.

In controlled studies, high dosages led to mood changes in some users

Studies with supraphysiologic doses of anabolic-androgenic steroids found minimal or no changes in mood in most users, but a minority of users had significant mood changes.

Pope et al,[53] in a randomized, placebo-controlled crossover trial, gave injections of testosterone cypionate (Depotest) to 56 men, gradually increasing the dosage to 600 mg/week. Most of the men showed no significant manic symptoms, but 6 (12%) had mild hypomania and 2 (4%) had marked hypomania.

Su et al,[54] in a placebo-controlled, crossover prospective trial, gave oral methyltestosterone (Virilon) 40 or 240 mg/day to 20 normal men. Those on the high dose had increased positive mood changes (euphoria, increased energy, and sexual arousal) as well as negative mood changes (irritability, violent feelings, hostility, and distractibility). One man developed mania at the high dosage, and another developed hypomania.

Kouri et al,[55] in a randomized, placebo-controlled crossover study, gave gradually increasing doses of testosterone cypionate (150 mg/week for 2 weeks, 300 mg/week for 2 weeks, 600 mg/week for 2 weeks) or placebo to 8 normal male volunteers. Higher dosages of testosterone were associated with manic symptoms.

Physiologic doses have minimal mood effects

Studies of the effects of low or near-physiologic doses of anabolic-androgenic steroids found minimal effects on mood.

Pope et al[56] randomized 23 men with refractory depression to treatment with testosterone transdermal gel or placebo. Treated patients had improved depressive symptoms compared with controls. No negative side effects were found.

Seidman et al,[57] in a randomized, double-blind trial, gave testosterone enanthate (Andro-Estro) 200 mg per week or placebo to 30 hypogonadal men with major depression. Treated patients had marginal but statistically significantly improved sexual function compared with controls but no other mood effects.

O'Connor et al[58] gave either testosterone enanthate 200 mg per week intramuscularly or placebo to 8 hypogonadal and 30 eugo-

nadal men and found no significant mood change in the eugonadal men but significant mood improvement from baseline in the hypogonadal men.

Mania has been reported with use of the testosterone patch (Testoderm).[59]

AGGRESSION

Studies in mice have found aggressive behavior correlating with increasing dosages and duration of anabolic-androgenic steroid treatment, culminating in females killing their offspring.[60]

Observational studies were equivocal

Observational studies of aggressive behavior changes in people taking steroids have been equivocal.

Midgley et al[47] compared measures of aggression in 50 users of anabolic-androgenic steroids and 40 nonusers and found that the only significant difference was that steroid users tended to be less in control of aggressive feelings. Although 60% of users had higher levels of irritability and bad temper, no significant difference in physical violence was found.

Malone et al[45] performed psychological tests on 164 anabolic-androgenic steroid users and nonusers and did not find a significant difference in measures of hostility and aggression.

Perry et al[44] compared 10 weightlifters who used anabolic steroids and 18 who did not and found significantly elevated measures of aggression in those with supraphysiologic levels of testosterone.

Pope et al[61] interviewed 133 consecutive male convicts and found two cases of apparent steroid-induced crimes.

Other small studies showed increased verbal aggression in users of anabolic-androgenic steroids and no increased attention to aggressive environmental cues (ie, no increased paranoia; the subjects did not misinterpret the behaviors of others as hostile or aggressive).[62,63]

Controlled studies: Also equivocal for aggression

Placebo-controlled studies using supraphysiologic doses of anabolic-androgenic steroids have also been equivocal.

Kouri et al,[55] in the study in 8 volunteers summarized above, found significantly higher aggressive response scores with testosterone cypionate use, but the authors did not report whether a dose-response effect was seen.

Tricker et al[64] randomized 43 eugonadal men to receive either supraphysiologic doses of testosterone enanthate (600 mg/week) or placebo and found no increase in angry behavior.

Physiologic doses do not enhance aggression

Studies of men taking physiologic doses of anabolic-androgenic steroids found no changes in aggressive behavior.

O'Connor[42] randomized 28 eugonadal men to receive testosterone undecanoate (Andriol; mostly used in fertility research, but uncommon in illicit use) or placebo and found no increase in aggressive behavior.

In another study, O'Connor et al[58] randomized a group of eugonadal and hypogonadal men to receive either testosterone enanthate or placebo and found no increase in aggression or impulsivity. The hypogonadal men improved in self-reported symptoms of tension and anger.

Ellingrod et al[65] gave testosterone cypionate 100 mg per week (a physiologic dosage) and 250 and 500 mg per week (supraphysiologic dosages) to six normal volunteers and detected no increased aggressiveness during simulated driving.

Serum testosterone level correlates with aggressiveness

Salvadora et al[66] analyzed videotapes of 28 judo competitors during fights and found that aggressiveness correlated with higher serum testosterone levels.

Orengo et al[67] measured hormone levels in 50 elderly men with dementia and found that plasma free testosterone levels were positively associated with aggressiveness.

ADDICTION AND ABUSE OF OTHER SUBSTANCES

Up to half of steroid abusers develop physical or psychological dependence

An estimated 14% to 57% of anabolic-androgenic steroid users develop dependence. How

addiction develops is unknown, but psychological dependence is believed to play a large role.[14]

Different substance abuse patterns exist in different populations that use anabolic-androgenic steroids.

Kanayama et al[11] found that steroid-using weightlifters almost always previously tried other illicit substances. On the other hand, others found that elite athletes, weightlifters, and bodybuilders rarely abuse illicit drugs, reflecting their interest in optimizing their physique and performance.[14,45]

Adolescents who abuse steroids are more likely to smoke and use other illicit substances than are older users.[12] Steroid abuse in adolescents is especially worrisome because of the danger of further illicit drug experimentation. Results of the Monitoring the Future study reinforce these concerns.[10]

Unfortunately, even substance abuse treatment centers frequently overlook the use of anabolic-androgenic steroids and other substances that athletes tend to use.

A study of 200 men admitted to substance abuse treatment centers found that 13% had a history of anabolic-androgenic steroid use. Despite being common, steroid use was often unrecognized by the physician. In this study, 25% of opiate users admitted to earlier steroid use.[6]

Steroid abusers rarely seek help, and many regard the psychiatric effects as beneficial

Wines et al[68] reported on anabolic-androgenic steroid users who were dependent on the opiate analgesic nalbuphine hydrochloride. Anecdotal reports from users describe the analgesic's widespread abuse in gymnasiums for treating pain from excessive training.

EFFECTS IN WOMEN

Few studies have evaluated the effects of anabolic-androgenic steroids in women.

Gruber et al[69] evaluated 75 female bodybuilders and weightlifters and found that 33% reported current or past anabolic-androgenic steroid use. Among steroid users, 56% reported hypomanic symptoms during use, and 40% reported depression when the steroids were discontinued. Some users developed a body image distortion similar to "reverse anorexia," in which they felt they were too small.

Ten of the 75 weightlifters had been raped as teenagers or adults, and most started or increased their weightlifting activities as a defense strategy. Seven of the 10 rape victims used anabolic steroids.[70]

EFFECTS IN CHILDREN

A few studies have examined the behavioral effects of anabolic-androgenic steroids in children.

Finkelstein et al,[71] in a double-blind, placebo-controlled, crossover trial, gave injections of testosterone in increasing doses to 35 boys and oral doses of conjugated estrogens to 14 girls with delayed puberty. Both treatment groups had more physical aggressive behavior and aggressive impulses than those receiving placebo.

A study by van Goozen et al[72] compared plasma levels of hormones in 15 boys with conduct disorders and in 25 normal controls. The boys with conduct disorders had significantly higher levels of dehydroepiandrosterone sulfate, marginally significantly higher levels of androstenedione, and no differences in testosterone levels.

TREATING PSYCHIATRIC EFFECTS OF STEROID USE

Little information is available about treating the psychiatric effects of anabolic-androgenic steroids. Steroid abusers rarely seek help, and many regard the psychiatric effects as beneficial, especially for athletes in certain sports. Illicit use is compounded by mistrust of doctors, a perception that medical people lack knowledge about these drugs, and fear of stigma or negative consequences that may result from drug use being exposed.

Malone and Dimeff[73] reported that four men who had used anabolic-androgenic steroids in high doses over a long time and who developed severe depression when they stopped the drugs responded to treatment with fluoxetine (Prozac).

Rashid[74] described a patient who had been diagnosed with bipolar disorder and antisocial personality disorder who was secretly abusing anabolic-androgenic steroids. He significantly improved when the steroids were stopped. Providing the patient with literature

about the negative physiologic and psychiatric effects of testosterone was helpful.

The first step in treating psychiatric effects of anabolic-androgenic steroids is to get the patient to stop using steroids and to address any psychiatric or physical symptoms.[75] A short course of an antipsychotic medication can help treat mania and psychosis. In severe cases, hospitalization is needed. For panic or anxiety symptoms, the short-term use of benzodiazepines is usually enough to control symptoms. If long-term treatment is needed, selective serotonin reuptake inhibitors or tricyclic antidepressants should be used.[76] Psychotherapeutic interventions to encourage and maintain abstinence are essential.[74,75]

To withdraw steroids, it is reasonable to taper off high doses by substituting testosterone enanthate in gradually decreasing doses. Clonidine (Catapres) may help in treating withdrawal, as some researchers postulate an opiate-like withdrawal mechanism.[76]

Information about the physical and psychiatric dangers of anabolic-androgenic steroids should be made more readily available for the general population and especially for adolescents. ■

REFERENCES

1. **Knopp WD, Wang TW, Bach BR Jr. Ergogenic drugs in sports.** Clin Sports Med 1997; 16:375–392.
2. **Yesalis CE, Bahrke MS.** Anabolic-androgenic steroids. Current issues. Sports Med 1995; 19:326–340.
3. **Pope HG Jr, Katz, DL.** Homicide and near-homicide by anabolic steroid users. J Clin Psychiatry 1990; 51:28–31.
4. **Yesalis CE, Anderson WA, Buckley WE, Wright JE.** Incidence of the nonmedical use of anabolic-androgenic steroids. NIDA Res Monogr 1990; 102:97–112.
5. **Lombardo JA.** Anabolic-androgenic steroids. NIDA Res Monogr 1990; 102:60–73.
6. **Kanayama G, Cohane GH, Weiss RD, Pope HG.** Past anabolic-androgenic steroid use among men admitted for substance abuse treatment: an underrecognized problem? J Clin Psychiatry 2003; 64:156–160.
7. **Catlin DH, Murray TH.** Performance-enhancing drugs, fair competition, and Olympic sport. JAMA 1996; 276:231–237.
8. **Yesalis CE, Kennedy NJ, Kopstein AN, Bahrke MS.** Anabolic-androgenic steroid use in the United States. JAMA 1993; 270:1217–1221.
9. **Kutscher EC, Lund BC, Perry PJ.** Anabolic steroids: a review for the clinician. Sports Med 2002; 32:285–296.
10. **Johnston LD, O'Malley PM, Bachman JG, Schulenberg JE.** Monitoring the Future National Survey Results on Drug Use, 1975–2005. Volume I: Secondary school students. Bethesda, MD: National Institute on Drug Abuse; 2006. NIH Publication No. 06-5883.
11. **Kanayama G, Pope HG, Cohane G, Hudson JI.** Risk factors for anabolic-androgenic steroid use among weightlifters: a case-control study. Drug Alcohol Depend 2003; 71:77–86.
12. **Bahrke MS, Yesalis CE, Kopstein AN, Stephens JA.** Risk factors associated with anabolic-androgenic steroid use among adolescents. Sports Med 2000; 29:397–405.
13. **Kochakian CD.** History of anabolic-androgenic steroids. NIDA Res Monogr 1990; 102:29–59.
14. **Mottram DR, George AJ.** Anabolic steroids. Baillieres Best Pract Res Clin Endocrinol Metab 2000; 14:55–69.
15. **Pope HG, Brower KJ.** Anabolic androgenic steroid abuse. In: Sadock BJ, Sadock VA, editors. Kaplan & Sadock's Comprehensive Textbook of Psychiatry. 7th ed. New York: Lippincott Williams & Wilkins; 2000:1085–1095.
16. **Brower KJ.** Anabolic steroids: addictive, psychiatric, and medical consequences. Am J Addict 1992; 1:100–114.
17. **Enevoldson TP.** Recreational drugs and their neurological consequences. J Neurol Neurosurg Psychiatry 2004; 75(suppl 3):9–15.
18. **Parssinen M, Seppala T.** Steroid use and long-term health risks in former athletes. Sports Med 2002; 32:83–94.
19. **Porcerelli JH, Sandler BA.** Anabolic-androgenic steroid abuse and psychopathology. Psychiatr Clin North Am 1998; 21:829–833.
20. **O'Sullivan AJ, Kennedy MC, Casey JH, Day RO, Corrigan B, Wodak AB.** Anabolic-androgenic steroids: medical assessment of present, past and potential users. Med J Aust 2000; 173:323–327.
21. **Parssinen M, Kujala U, Vartiainen E, Sarna S, Seppala T.** Increased premature mortality of competitive powerlifters suspected to have used anabolic agents. Int J Sports Med 2000; 21:225–227.
22. **Sahraian MA, Mottamedi M, Azimi AR, Moghimi B.** Androgen-induced cerebral venous sinus thrombosis in a young body builder: case report. BMC Neurol 2004; 4:22.
23. **Lisiewicz J, Fijalkowski P, Sankowski J.** Ischemic cerebral stroke and anabolic steroids (case report) [in Polish]. Neurol Neurochir Pol 1999; 32(suppl 6):137–139.
24. **Halvorsen S, Thorsby PM, Haug E.** Acute myocardial infarction in a young man who had been using androgenic anabolic steroids [in Norwegian]. Tidsskr Nor Laegeforen 2004; 124:170–172.
25. **Mewis C, Spyridopoulos I, Kuhlkamp V, Seipel L.** Manifestation of severe coronary heart disease after anabolic drug abuse. Clin Cardiol 1996; 19:153–155.
26. **Alvarado RG, Liu JY, Zwolak RM.** Danazol and limb-threatening arterial thrombosis: two case reports. J Vasc Surg 2001; 34:1123–1126.
27. **Faergemann C, Laursen JO.** Simultaneous bilateral rupture of the quadriceps tendon [in Danish]. Ugeskr Laeger 1998; 160:1329–1330.
28. **Dhar R, Stout CW, Link MS, Homoud MK, Weinstock J, Estes NA 3rd.** Cardiovascular toxicities of performance-enhancing substances in sports. Mayo Clin Proc 2005; 80:1307–1315. Erratum in: Mayo Clin Proc 2006; 81:133.
29. **Winkler UH.** Effects of androgens on haemostasis. Maturitas 1996; 24:147–155.
30. **Stimac D, Milic S, Dintinjana RD, Kovac D, Ristic S.** Androgenic/anabolic steroid-induced toxic hepatitis. J Clin Gastroenterol 2002; 35:350–352.
31. **Socas L, Zumbado M, Perez-Luzardo O, et al.** Hepatocellular adenomas associated with anabolic androgenic steroid abuse in bodybuilders: a report of two cases and a review of the literature. Br J Sports Med 2005; 39:e27.
32. **Rich JD, Dickinson BP, Feller A, Pugatch D, Mylonakis E.** The infectious complications of anabolic-androgenic steroid injection. Int J Sports Med 1999; 20:563–566.
33. **Sollender JL, Rayan GM, Barden GA.** Triceps tendon rupture in weight lifters. J Shoulder Elbow Surg 1998; 7:151–153.
34. **Stannard JP, Bucknell AL.** Rupture of the triceps tendon associ-

ated with steroid injections. Am J Sports Med 1993; 21:482–485.
35. **Visuri T, Lindholm H.** Bilateral distal biceps tendon avulsion with use of anabolic steroids. Med Sci Sports Exerc 1994; 26:941–944.
36. **Freeman BJ, Rooker GD.** Spontaneous rupture of the anterior cruciate ligament after anabolic steroids. Br J Sports Med 1995; 29:274–275.
37. **Maravelias C, Dona A, Stefanidou M, Spiliopoulou C.** Adverse effects of anabolic steroids in athletes. A constant threat. Toxicol Lett 2005; 158:167–175.
38. **Yesalis CE, Vicary JR, Buckley WE, Streit AL, Katz DL, Wright JE.** Indications of psychological dependence among anabolic-androgenic steroid abusers. NIDA Res Monogr 1990; 102:196–214.
39. **Pope HG Jr, Katz DL.** Psychiatric and medical effects of anabolic-androgenic steroid use. A controlled study of 160 athletes. Arch Gen Psychiatry 1994; 51:375–382.
40. **Evans NA.** Gym and tonic: a profile of 100 male steroid users. Br J Sports Med 1997; 31:54–58.
41. **Kennedy MC.** Newer drugs used to enhance sporting performance. Med J Aust 2000; 173:314–317.
42. **O'Connor DB, Archer J, Wu FC.** Effects of testosterone on mood, aggression, and sexual behavior in young men: a double-blind, placebo-controlled, cross-over study. J Clin Endocrinol Metab 2004; 89:2837–2845.
43. **Katz DL, Pope HG Jr.** Anabolic-androgenic steroid-induced mental status changes. NIDA Res Monogr 1990; 102:215–223.
44. **Perry PJ, Kutscher EC, Lund BC, Yates WR, Holman TL, Demers L.** Measures of aggression and mood changes in male weightlifters with and without androgenic anabolic steroid use. J Forensic Sci 2003; 48:646–651.
45. **Malone DA Jr, Dimeff RJ, Lombardo JA, Sample RH.** Psychiatric effects and psychoactive substance use in anabolic-androgenic steroid users. Clin J Sport Med 1995; 5:25–31.
46. **Verroken M.** Drug use and abuse in sports. Baillieres Best Pract Res Clin Endocrinol Metab 2000; 14:1–23.
47. **Midgley SJ, Heather N, Davies JB.** Levels of aggression among a group of anabolic-androgenic steroid users. Med Sci Law 2001; 41:309–314.
48. **Wroblewska AM.** Androgenic-anabolic steroids and body dysmorphia in young men. J Psychosom Res 1997; 42:225–234.
49. **Porcerelli JH, Sandler BA.** Narcissism and empathy in steroid users. Am J Psychiatry 1995; 152:1672–1674.
50. **Itil TM, Michael ST, Shapiro DM, Itil KZ.** The effects of mesterolone, a male sex hormone in depressed patients (a double blind controlled study). Methods Find Exp Clin Pharmacol 1984; 6:331–337.
51. **Vogel W, Klaiber EL, Broverman DM.** A comparison of the antidepressant effect of a synthetic androgen (mesterolone) and amitriptyline in depressed men. J Clin Psychiatry 1985; 46:6–8.
52. **Pope HG Jr, Katz DL.** Affective and psychotic symptoms associated with anabolic steroid use. Am J Psychiatry 1988; 145:487–490.
53. **Pope HG Jr, Kouri EM, Hudson JI.** Effects of supraphysiologic doses of testosterone on mood and aggression in normal men: a randomized controlled trial. Arch Gen Psychiatry 2000; 57:133–140.
54. **Su TP, Pagliaro M, Schmidt PJ, Pickar D, Wolkowitz O, Rubinow DR.** Neuropsychiatric effects of anabolic steroids in male normal volunteers. JAMA 1993; 269:2760–2764.
55. **Kouri EM, Lukas SE, Pope HG Jr, Oliva PS.** Increased aggressive responding in male volunteers following the administration of gradually increasing doses of testosterone cypionate. Drug Alcohol Depend 1995; 40:73–79. Erratum in: Drug Alcohol Depend 1998; 50:255.
56. **Pope HG Jr, Cohane GH, Kanayama G, Siegel AJ, Hudson JI.** Testosterone gel supplementation for men with refractory depression: a randomized, placebo-controlled trial. Am J Psychiatry 2003; 160:105–111.
57. **Seidman SN, Spatz E, Rizzo C, Roose SP.** Testosterone replacement therapy for hypogonadal men with major depressive disorder: a randomized, placebo-controlled clinical trial. J Clin Psychiatry 2001; 62:406–412.
58. **O'Connor DB, Archer J, Hair WM, Wu FC.** Exogenous testosterone, aggression, and mood in eugonadal and hypogonadal men. Physiol Behav 2002; 75:557–566.
59. **Weiss EL, Bowers MB Jr, Mazure CM.** Testosterone-patch-induced psychotic mania [Letter]. Am J Psychiatry 1999; 156:969.
60. **Samuels O, Jason G, Mann M, Svare B.** Pup-killing behavior in mice: suppression by early androgen exposure. Physiol Behav 1981; 26:473–477.
61. **Pope HG Jr, Kouri EM, Powell KF, Campbell C, Katz DL.** Anabolic androgenic steroid use among 133 prisoners. Compr Psychiatry 1996; 37:322–327.
62. **Cooper CJ, Noakes TD, Dunne T, Lambert MI, Rochford K.** A high prevalence of abnormal personality traits in chronic users of anabolic-androgenic steroids. Br J Sports Med 1996; 30:246–250.
63. **Bond AJ, Choi PY, Pope HG Jr.** Assessment of attentional bias and mood in users and non-users of anabolic-androgenic steroids. Drug Alcohol Depend 1995; 37: 241–245.
64. **Tricker R, Casaburi R, Storer TW, et al.** The effects of supraphysiological doses of testosterone on angry behavior in healthy eugonadal men—a clinical research center study. J Clin Endocrinol Metab 1996; 81:3754–3758.
65. **Ellingrod VL, Perry PJ, Yates WR, et al.** The effects of anabolic steroids on driving performance as assessed by the Iowa Driver Simulator. Am J Drug Alcohol Abuse 1997; 23:623–636.
66. **Salvadora A, Suay F, Martinez-Sanchis S, Simon VM, Brain PF.** Correlating testosterone and fighting in male participants in judo contests. Physiol Behav 1999; 68:205–209.
67. **Orengo C, Kunik ME, Molinari V, Wristers K, Yudofsky SC.** Do testosterone levels relate to aggression in elderly men with dementia? J Neuropsychiatry Clin Neurosci 2002; 14:161–166.
68. **Wines JD Jr, Gruber AJ, Pope HG Jr, Lukas SE.** Nalbuphine hydrochloride dependence in anabolic steroid users. Am J Addict 1999; 8:161–164.
69. **Gruber AJ, Pope HG Jr.** Psychiatric and medical effects of anabolic-androgenic steroid use in women. Psychother Psychosom 2000; 69:19–26.
70. **Gruber AJ, Pope HG Jr.** Compulsive weight lifting and anabolic drug abuse among women rape victims. Compr Psychiatry 1999; 40:273–277.
71. **Finkelstein JW, Susman EJ, Chinchilli VM, et al.** Estrogen or testosterone increases self-reported aggressive behaviors in hypogonadal adolescents. J Clin Endocrinol Metab 1997; 82:2433–2438.
73. **van Goozen SH, Matthys W, Cohen-Kettenis PT, Thijssen JH, van Engeland H.** Adrenal androgens and aggression in conduct disorder prepubertal boys and normal controls. Biol Psychiatry 1998; 43:156–158.
73. **Malone DA Jr, Dimeff RJ.** The use of fluoxetine in depression associated with anabolic steroid withdrawal: a case series. J Clin Psychiatry 1992; 53:130–132.
74. **Rashid W.** Testosterone abuse and affective disorders. J Subst Abuse Treat 2000; 18:179–184.
75. **Sturmi JE, Diorio DJ.** Anabolic agents. Clin Sports Med 1998; 17:261–282.
76. **Malone DA Jr.** Pharmacological therapies of anabolic androgenic steroid addiction. In: Miller NS, Gold MS, editors. Pharmacological Therapies for Drug and Alcohol Addictions. New York: Marcel Dekker Inc; 1995:227–237.

ADDRESS: *Farid Talih, MD, Department of Sleep Medicine, FA20, Cleveland Clinic, 9500 Euclid Avenue, Cleveland, OH 44195; e-mail talihf@ccf.org.*