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**Performance-Enhancing Substances: Is Your Adolescent Patient Using?** 651  
Cynthia Holland-Hall

Small, but significant, numbers of adolescents use anabolic-androgenic steroids to improve their appearance or sports performance. Many more use creatine and other performance-enhancing substances with the hope of achieving these goals. This article assists primary care physicians in the office assessment of adolescents who may be using these substances, focusing on identifying adolescents at risk, asking the right questions, and helping adolescents feel comfortable discussing this sensitive topic. Providers must present themselves as credible sources of information on the topic to communicate effectively with adolescent athletes.

**Prevalence of Use of Performance-Enhancing Substances Among United States Adolescents** 663  
Edward M. Castillo and R. Dawn Comstock

Adolescents may regard the use of performance-enhancing substances as an easy means to gain self-esteem through improved body appearance and athletic performance. The use of performance-enhancing substances by adolescents is particularly troubling because safety data are largely lacking. This poses a dilemma for the pediatrician who needs correct information, including the potential efficacy and negative health effects of such substances, to identify the patients in need of counseling and to find the best way to help adolescent patients make informed decisions to promote

healthy behaviors. This article is intended to assist pediatricians by providing a summary of the current state of knowledge regarding the prevalence of use of performance-enhancing substances by United States adolescents.

### **Consequences of Use of Anabolic Androgenic Steroids**

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Marcel J. Casavant, Kathleen Blake, Jill Griffith,  
Andrew Yates, and LaRae M. Copley

Whether providing anticipatory guidance to the young adolescent patient, conducting a preparticipation examination on a young athlete, or treating a sick user of anabolic androgenic steroids (AASs), the primary care physician must be familiar with the adverse consequences of the use of these compounds. This article reviews the endocrine, cardiovascular, neuropsychiatric, musculoskeletal, hematologic, hepatic, and miscellaneous effects of AASs, highlighting effects reported in children and adolescents, and relying on consequences in adults when pediatric data is unavailable.

### **Erythropoietin and Other Blood-Boosting Methods**

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Thomas L. Pommering

Dating back to the earliest Olympics, athletes have been searching for a performance edge. Recombinant human erythropoietin was made commercially available in 1987 to treat various diseases associated with anemia. Within a few years, elite endurance athletes capitalized on its potential as an undetectable performance-enhancing agent. Although antidoping agencies have developed a test to detect its use, there are pitfalls. More importantly, athletes continue to add more sophisticated doping practices to their armamentarium, challenging regulatory agencies, putting their health at great risk, and tainting the spirit of fair competition.

### **The World Anti-Doping Program and the Primary Care Physician**

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Richard L. Hilderbrand

The presence of a prohibited substance in an athlete's urine (or blood, when applicable) or the use of a prohibited method constitutes a doping offense, even if the substance is a pharmaceutical and is properly prescribed. To avoid a doping offense for the therapeutic use of a prohibited substance or method the International Standard for Therapeutic Use Exemptions (TUE) must be followed. When the TUE is required, the appropriate process must be completed before testing under conditions where the substance or method is prohibited. This article describes the World Anti-Doping Code and the International Standards, which

are part of the Code. In addition, the procedures for the proper preparation and submission of TUE requests are presented along with the manner in which the requests are considered by the Therapeutic Use Exemption Committees.

**Beyond Sports-Doping Headlines: The Science of Laboratory Tests for Performance-Enhancing Drugs** 713  
Caroline K. Hatton

This primer on urine analysis in sports-doping control is an overview with an emphasis on the main analytical chemistry technologies in use: gas chromatography-mass spectrometry (GC-MS), liquid chromatography-tandem mass spectrometry (LC-MS-MS), isotope ratio mass spectrometry detection of exogenous testosterone use, and isoelectric focusing detection of recombinant erythropoietin (EPO) use. Included are graphic examples of GC-MS selected ion monitoring and full scan, LC-MS-MS, and EPO test electropherogram data; a list of common acronyms; and answers to questions frequently asked about tampering and test accuracy.

**Creatine and Other Supplements** 735  
Anthony Lattavo, Andrew Kopperud, and Peter D. Rogers

Ergogenic dietary supplement use is highly prevalent among adolescent and collegiate athletes, and use is increasing. To make appropriate recommendations for or against use by individual athletes, physicians who work with adolescent athletes should be knowledgeable about the most commonly used supplements and be able to access high-quality information about others. This article first discusses the legal and regulatory environment of dietary supplements. Several of the most commonly used supplements are then discussed in detail, including creatine, beta-hydroxy-beta-methylbutyrate, protein, amino acids, stimulants, alkalotic agents, glycerol, vitamins, and minerals. Finally, the "Gateway Theory" as it may relate to adolescent supplement and other drug use is discussed.

**The History of the Development of Anabolic-Androgenic Steroids** 761  
Jennifer L. Dotson and Robert T. Brown

The history of anabolic-androgenic steroids (AASs) is an interesting tale that has its roots in ancient "endocrinology." More than 6000 years ago, farmers noted enhanced domestication of animals after castration. The development of AASs, and, later, their artificial synthesis, have remained a hot topic in scientific research and pharmaceuticals. Over the years, AASs have been used as a proposed treatment for a wide variety of ailments, despite deleterious side effects. Unfortunately, they have been, and still are, abused by body builders, athletes, and teens.

**Anabolic-Androgenic Steroids: Use and Abuse in Pediatric Patients**

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Julie M. Kerr and Joseph A. Congeni

The “win at all costs” mentality fuels athletes to seek performance-enhancing substances, such as anabolic-androgenic steroids, to gain an advantage over their opponents. Nonathletes espouse this same attitude to “win” the battle of attractiveness. An enhanced understanding of anabolic-androgenic steroids and the motivations behind their abuse will arm pediatricians with the ability to engage their patients in a balanced discussion of the benefits and costly risks of anabolic-androgenic steroids and successfully deter further use.

**Testosterone Precursors: Use and Abuse in Pediatric Athletes**

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Troy M. Smurawa and Joseph A. Congeni

The dietary supplements androstenedione, dehydroepiandrosterone, and androstenediol are precursors in the endogenous production of testosterone. The efficacy and safety of these prohormones are not well established but are promoted to have the same androgenic effects on building muscle mass and strength as anabolic-androgenic steroids. Studies have demonstrated repeatedly that acute and long-term administration of these oral testosterone precursors does not effectively increase serum testosterone levels and fails to produce any significant changes in lean body mass, muscle strength, or performance improvement compared with placebo. The Anabolic Steroid Control Act of 2004 lists androstenedione as a schedule III controlled substance, and it is regulated by the U.S. Food and Drug Administration. Testosterone precursors are banned by most major sports organizations.

**Sports Medicine: Performance-Enhancing Drugs**

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Andrew J.M. Gregory and Robert W. Fitch

Performance-enhancing drugs, ergogenic aids, or sports supplements have been a part of sports since sporting competition began and likely always will be. Considered cheating by purists and necessary by some athletes, we must accept the fact that they are used, understand why they are used, and study how to prevent their use to institute change. This article summarizes current information regarding the use of performance-enhancing drugs in young athletes and provides proven prevention strategies for instituting a program in your local schools.

**Gene Doping: A Review of Performance-Enhancing Genetics**

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Gary R. Gaffney and Robin Parisotto

Unethical athletes and their mentors have long arrogated scientific and medical advances to enhance athletic performance, thus

gaining a dishonest competitive advantage. Building on advances in genetics, a new threat arises from athletes using gene therapy techniques in the same manner that some abused performance-enhancing drugs were used. Gene doping, as this is known, may produce spectacular physiologic alterations to dramatically enhance athletic abilities or physical appearance. Furthermore, gene doping may present pernicious problems for the regulatory agencies and investigatory laboratories that are entrusted to keep sporting events fair and ethical. Performance-enhanced genetics will likewise present unique challenges to physicians in many spheres of their practice.

### **Abuse of Growth Hormone Among Young Athletes**

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Sergio R.R. Buzzini

The underground abuse of growth hormone (GH) among young athletes presents a challenge to medical professionals. Health care professionals providing knowledgeable guidance regarding healthy ways to improve performance and appearance, as well as accurate information regarding substances' perceived benefits, risks, and unknown qualities, is invaluable to the young athlete. Further research focused on the profile and motivation of young people who use GH is essential to understanding and intervening better with those who use these substances.

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