REPORT

Doping control in sports—a perspective from the 1996 Olympic Games

PETER J. AMBROSE

Abstract: Doping-control (DC) procedures, particularly as used at the 1996 Olympic Games, are described, and the role of pharmacists in DC is discussed.

DC procedures must be strict and precisely followed to avoid contamination of samples, the appearance of bias, and breaches in security and confidentiality. The process of selecting athletes for testing can be random, nonrandom, or a combination of the two. Escorts are used to notify athletes of their selection, verify their identity, and accompany them to the DC station. When urine specimens are obtained for DC, the voiding process must be directly observed. The specimen is checked for pH and specific gravity and then processed for shipping to a laboratory to be analyzed for banned substances. Medication histories are also obtained, giving athletes the opportunity to declare any substance that has been taken for legitimate medical purposes. Laboratory analysis involves screening and confirmation phases. During the Atlanta Games, roughly 50 pharmacists participated in the DC program as escorts or technical officers. It is logical to involve pharmacists in DC programs because they can develop and conduct drug-testing protocols; educate athletes, coaches, and trainers about drug use and abuse; and help ensure the safe and effective use of medications.

Sophisticated doping-control procedures have been developed for athletic competitions, and pharmacists have much to offer DC programs.

Index terms: Athletes; Drug abuse; Education; International Olympic Committee; Patient information; Pharmacists; Regulations; Sports; Tests, laboratory; Toxicity

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Although the use of drugs to improve athletic performance dates to ancient times,[1,2] today's emphasis on winning at any cost is believed to have exacerbated the problem. Performance-enhancing substances are not only contrary to the ideal of fair competition, they can threaten the health and safety of athletes. These agents are a particular concern at that ultimate of sporting events—the Olympic Games. Performance-enhancing substances include stimulants, opiate agonists, anabolic steroids, growth hormone, diuretics, epoetin alfa, and in some sports, alcohol and β-blockers.

The term "doping" is believed to have been derived from the Dutch word "doop" (viscous opium juice),[3] and "doping control" is the common international term for drug testing in sports. The International Olympic Committee (IOC) publishes a list of prohibited or restricted substances that are considered to be either performance-enhancing agents or masking agents (substances intended to prevent drug detection).[a] The appendix lists some of the banned or restricted drugs.[4,a] Wide-scale drug testing at the Olympics was first conducted during the 1972 games; by 1984, technology had advanced to the extent that it was possible to rapidly and accurately screen urine samples for many banned substances.[3]

During the 1996 Olympic Games in Atlanta, I served as a doping-control (DC) technical officer. I was responsible for collecting and processing urine specimens and obtaining medication histories from athletes. Pharma-

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cists, as experts in the therapeutic use of drugs, including medication use in sports medicine (sports pharmacy), should also be knowledgeable about DC. This report describes general DC procedures, with a focus on the experience at the 1996 Olympic Games. Additional information on drug-testing techniques and analytical procedures is available elsewhere.[5-7]

DC at the Atlanta Games

DC officers recruited for the 1996 games were individuals who had previous experience in drug testing. A majority of the DC officers had been involved in drug testing for either the United States Olympic Committee (USOC) or the National Collegiate Athletic Association (NCAA). Officers recruited from other nations served in similar capacities in their countries. I had been a crew chief for the NCAA's drug-testing program since 1987.

The DC team included medical and technical officers. Medical officers were physicians, while technical officers were nonphysicians from many other medical fields, although their responsibilities were essentially the same. Some half-dozen pharmacists served as technical officers.

The medical and technical officers were thoroughly trained in DC protocols and procedures. The primary role of these persons was to collect urine samples and process them at DC stations in accordance with IOC policy. This included observing the collection of urine specimens, taking medication histories, and ensuring that no contamination of specimens occurred.

Venues for DC officers were assigned before the games opened. My schedule included boxing, men's and women's basketball, men's and women's gymnastics, and white-water kayaking and canoeing. Each morning during the games, a briefing was held for DC officers. The officers were required to arrive at the DC station in their assigned venue two hours before the start of the first competition. The station was inspected to ensure that it was stocked and operational. DC procedures were performed at each venue at the conclusion of each selected athlete's competition.

DC procedures in athletic competitions

DC procedures must be strict and precisely followed to avoid contamination of samples, the appearance of bias, and breaches in security and confidentiality. Moreover, procedures must protect athletes from the possibility of false-positive and false-negative results.

Athlete selection. The selection of athletes to be tested must be fair and free of bias or discrimination. The selection process can be random, nonrandom, or a combination. Random selection must be able to undergo legal scrutiny to ensure that each individual had an equal chance of being selected. Nonrandom selection is typically based on the event or the placement of the athletes; for instance, the top three finishers in a race may be selected for testing. All selection processes must be defined in advance of the competition.

For the Atlanta Games, a combination of random and nonrandom selection was used. Random testing was conducted for preliminary events, and all medal winners were tested. The random selection of athletes was performed by representatives from the IOC medical commission and the International Federation (IF) using a lottery-type device before the start of an event.

Escorts. Escorts are used to notify an athlete of his or her selection for testing, verify the athlete's identity, and accompany the person to the DC station. Escorts maintain visual contact with the athlete at all times and are generally of the same sex as the athlete so that they can enter locker rooms. Escorts also monitor any food or drinks consumed by the athlete and watch for unusual activities that might affect the testing.

In Atlanta, the athletes selected were notified by an escort immediately after their competition. If a competitor did not speak English, a translator assisted. The competitors were allowed one hour to report to the DC station, which enabled them to attend award ceremonies and press conferences. When athletes entered the DC station, they were required to sign in along with the escort, the translator, and one representative of their choice. Credentials and identification badges were verified. The athletes were then allowed, if they wished, to choose drinks from individually sealed containers. They had to pick their own drinks and keep them in their possession at all times. No one else was allowed to pick a drink for an athlete or handle it for the athlete.

Specimen collection. When urine specimens are obtained for DC, the voiding process must be directly observed to prevent the possibility of tampering or substitution. Beakers or other collection containers are randomly selected by the athlete from an array of sealed containers. Only the athlete is allowed to handle the collection vessel until the specimen is sealed in its final container. The volume of urine needed depends on the requirements of the laboratory being used and the number of drug tests to be conducted. Typically, 75–100 mL of urine is required for thorough drug testing in athletics. Collection containers should be graduated or premarked so that the athletes and DC officers can easily determine if a sufficient sample volume has been obtained. If an athlete is not able to produce the full amount of the required specimen, a partial-sample protocol is followed.

At the Atlanta Games, when an athlete was ready to provide a urine specimen, he or she randomly selected a sealed collection vessel (a graduated beaker with a lid) and was accompanied to the toilet by a DC officer of the same sex. Athletes were required to undress and expose themselves from the middle of the back to just below the knees to allow the DC officer an unobstructed view of the voiding process. A minimum of 75 mL of urine was required at the Atlanta Games. If the urine sample was less than 75 mL, the partial-specimen procedure

was followed. The athlete randomly selected a partial-sampling kit with a unique identification number. The partial sample was transferred by the athlete into a bottle, which was sealed in a tamper-proof canister. The identification number was recorded on the athlete's DC form. The athlete was required to hold or monitor the canister at all times. When the athlete was able to provide additional urine, the collection process was repeated, the partial-specimen bottle was removed from the sealed canister by the athlete, and the contents of the bottle and the new collection vessel were combined. If the total volume was still insufficient, the partial-sample protocol was repeated again.

Processing the specimens. When sufficient urine has been collected, the specimen is processed. Containers suitable for shipping to a laboratory are again randomly selected by the athlete. Containers are usually packed in a kit that contains two bottles (an "A" bottle and a "B" bottle), tamper-proof seals, and identification codes. The athletes pour approximately two thirds of the required sample volume into the A bottle and most of the remaining third into the B bottle; a small amount of urine is left in the collection container. At the laboratory, screening and confirmation assays are performed on the A sample. If a positive result is obtained and contested, then the B sample is used. (A smaller volume is required for the B specimen because the toxicologist already knows what substance to test for.) The athlete may be allowed to witness testing of the B specimen or have a representative witness it, depending on the rules of the relevant sports-governing organization.

A DC officer measures the pH and specific gravity of the small amount of urine remaining in the collection container. This is necessary to ensure that a sample is valid for analysis and has not been manipulated to avoid identification of banned substances. For example, alkalinizing the urine can minimize the excretion of basic drugs (e.g., amphetamines)[8]; diluting specimens can reduce drug concentrations to the point where they are too low to measure reliably and accurately. The exact specimen requirements depend on the testing protocol and the laboratory's specifications for the drugs included in the testing. Samples that do not meet the requirements may be sent to the laboratory for analysis anyway, depending on the testing protocol. If the pH or specific gravity is not acceptable, the athlete must submit further specimens until an acceptable sample is produced.

In Atlanta, once the athlete provided a minimum of 75 mL of urine, the DC officer accompanied him or her to the processing area. The athlete randomly selected a sample kit that contained the A and B bottles and two matching, tamper-proof canisters. The bottles and canisters were color-coded and contained a unique code number, which was recorded on the DC form with bar-code labels. The laboratory used this code to identify samples; the athlete's name was not provided on the laboratory's copy of the forms, blinding the laboratory personnel to the athlete's identity.

After the DC officer verified and recorded the volume of the urine specimen, the athlete poured approximately 50 mL into the A bottle and 25 mL into the B bottle. Each bottle was then sealed in the corresponding canister. The DC officer used pH test strips to measure the pH of the small amount of urine left in the collection vessel and a refractometer to measure specific gravity. If the pH was not between 5.0 and 7.5 or if the specific gravity of the specimen was less than 1.005, further urine samples were obtained until both pH and specific gravity requirements were met.

Signatures were required from the athlete, the DC officer, and all those who witnessed the processing of the specimen, including the athlete's representative, the IOC medical commissioner, and the IF commissioner. The samples were then prepared to be transported to the IOC-accredited laboratory under a chain-of-custody procedure.

Medication histories. Obtaining medication histories from athletes is an important DC procedure. It allows the athlete the opportunity to declare any substance that has been taken for legitimate medical purposes and is particularly important during out-of-competition testing, when athletes may be taking medications that will be banned during competition. Food and dietary supplements can also be declared if there is concern that they will influence the testing.

The Olympic athletes were asked if they wished to declare that they were using any medications or food supplements and, if so, to give the dosages or amounts and the date each was last consumed. The medication histories were recorded on the DC forms.

Analysis and interpretation

Drug testing is routinely conducted on urine specimens rather than blood or other body tissues or fluids because urine collection is noninvasive, drugs and their metabolites are concentrated in the urine, urine is easier to analyze (proteins and other test-interfering substances are usually absent), and drugs and their metabolites are stable in urine, particularly when the urine is frozen and stored.[5] However, there are also disadvantages, including pH and specific gravity requirements, the need to directly observe voiding, the difficulty of obtaining sufficient samples from athletes who are inhibited by the direct-observation process or who are dehydrated as a result of their exertions, and the risk of contamination if processing does not strictly follow protocol, particularly when partial samples are obtained.

Drug testing has some inherent limitations. Except for ethanol, there is no known correlation between the concentration of a drug in the urine and the pharmacologic effect. For example, cocaine and its metabolites may be detected in the urine for several days[5,9] (the elimination half-life in the blood is approximately one hour[10]).

Table 1.
Assay Techniques Commonly Used in Drug Testing[5,6]

For Screening
Enzyme immunoassay
Fluorescence polarization immunoassay
Gas chromatography
High-performance liquid chromatography
Radioimmunoassay
Thin-layer chromatography
For Confirmation
Gas chromatography
Gas chromatography–mass spectrometry
High-performance liquid chromatography

Thus, a positive urine test result does not necessarily indicate that an athlete was "under the influence" at the time of the competition. Alternatively, an athlete may benefit from an anabolic steroid by building strength and muscle mass but discontinue the drug for a sufficient period before competition so that the drug has been totally eliminated from the body. In addition, all assays have sensitivity limits, so results can be false-negative. All this supports the need for out-of-competition testing, with little advance notification of the athlete.

Analysis of urine specimens for banned substances consists of screening and confirmation phases (Table 1).[5,6] During screening, specimens are subjected to nonspecific assays for the presence or absence of drugs, metabolites, and related compounds. For instance, the screening assay may detect a sympathomimetic amine but may not be able to differentiate one from another. If the screening process does not detect any banned substances, then the drug test is considered negative. If the screening assay detects a compound that is consistent with a banned substance, a confirmation assay is conducted. A positive screening result is confirmed or refuted by using a different assay technique. Ideally, the confirmation assay should be capable of identifying the compound in question, thus minimizing (and theoretically eliminating) the possibility of a false-positive result. Although liquid and gas chromatography can be used for confirmation, gas chromatography–mass spectrometry is generally used for confirmation testing and is considered the standard.

Role of pharmacists

There is ample opportunity for pharmacists to participate in, and lend their expertise and professional skills to, sports medicine.[11] During the 1996 Olympic Games, about 50 pharmacists participated in the DC program, primarily as escorts.[12] Several were technical officers. In addition, the drug information service at Mercer University Southern School of Pharmacy served as a resource for the DC program.

It is only logical to involve pharmacists in the collection and processing of urine specimens for drug testing. Pharmacists have experience with basic laboratory procedures, such as pipetting, reading test strips, and using refractometers. In addition, they know how to maintain the aseptic integrity of urine specimens. For example, a pharmacist would know to dip a pH test strip in a small volume of liquid removed from the original sample, not in the entire sample. Pharmacists are trained to pay strict attention to minute details, to follow rules and regulations carefully, to keep accurate records, and to obtain medication histories. Specimen collection places the pharmacist directly with the athlete, the trainer, and the coach, who frequently have questions about drugs, banned and otherwise.

Pharmacists can help develop and conduct drug-testing protocols for schools, institutions, and sporting organizations. This is particularly true for schools wishing to institute their own drug policies and drug-testing procedures. For out-of-competition testing, athletes can report to pharmacists practicing in the community to have samples collected, processed, and shipped to a laboratory. Such testing could be used by a variety of sports organizations, including the NCAA and the USOC. Pharmacists can also help teams, schools, and sporting organizations determine which drugs should be banned or restricted.

Pharmacists are desperately needed to ensure the safe and effective use of medications in training rooms, where drugs may be stored and dispensed under unsafe, and often illegal, conditions.[11,13] For example, medications dispensed to university athletes were often found to be improperly packaged and labeled. In addition, athletic trainers and team physicians often take medications to sporting events, where they may be subjected to extreme temperatures and high humidity.

Athletes need accurate information about the effects of drugs and the harm that abusing ergogenic drugs can produce. Many athletic programs include some education about drug use and abuse; pharmacists can participate in these programs to the benefit of athletes, coaches, and trainers.[11]

Conclusion

Sophisticated doping-control procedures have been developed for athletic competitions, and pharmacists have much to offer DC programs.

[a]International Olympic Committee, Prohibited Substances List, 1996.

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Appendix—Abbreviated list of substances prohibited by the International Olympic Committee[a]

Peptide hormones
Corticotropin
Epoetin alfa
Growth hormone
Human chorionic gonadotropin

Narcotics
Ethylmorphine
Hydrocodone
Meperidine
Morphine
Pentazocine
Propoxyphene

Diuretics
Acetazolamide
Bendroflumethiazide
Bumetanide
Canrenone
Chlorthalidone
Furosemide
Hydrochlorothiazide
Indapamide
Spironolactone
Triamterene

Androgenic–anabolic steroids
Boldenone
Danazol
Dihydrotestosterone
Dromostanolone
Fluoxymesterone
Methyltestosterone
Nandrolone
Norethandrolone
Oxandrolone
Oxymesterone
Stanozolol
Testosterone

Beta-blockers
Acebutolol
Alprenolol
Atenolol
Betaxolol
Bisoprolol
Bunolol
Metoprolol
Oxprenolol
Propranolol
Sotalol

Stimulants
Amphetamines
Caffeine
Cocaine
Ephedrine
Fenfluramine
Mephentermine
Methamphetamine
Methylphenidate
Norphenfluramine
Phentermine
Phenylephedrine
Phenylpropanolamine
Pseudoephedrine
Strychnine

[a]Many drug compounds are automatically considered prohibited under the phrase "and related substances." The list is adapted from *Athletic Drug Reference '96* and *International Olympic Committee, Prohibited Substances List, 1996*.