Anti-Doping Awareness in Sports

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Lecture -9

Prohibited Substances Side Effects

Good morning friends, and welcome to the NPTEL anti-doping course. This is the Week 2, Lecture 4 session, and I am Professor Dobson Dominic. Today, we are going to look into the World Anti-Doping Agency's prohibited substances and their side effects. In the previous sessions, we looked into what banned substances and banned methods are. In this session, we will look into the side effects of various prohibited substances. Several substances are banned by the World Anti-Doping Agency due to their harmful side effects.

So, we are going to look into the gender-specific side effects, and we are also going to look into the short-term and long-term side effects of banned substances. The first substance banned by the World Anti-Doping Agency is anabolic agents. Several examples include Stanozolol, Nandrolone, DHEA (Dehydroepiandrosterone), and the testosterone group of drugs. These come under anabolic agents. Athletes use these as performance-enhancing drugs to increase muscle mass and strength. There are several side effects of anabolic agents. The gender-specific side effects in males include breast development, testicular atrophy, diminished testosterone production, diminished sperm production leading to impotence, alopecia or hair loss, and the very harmful risk of prostate cancer. These are all male-specific side effects of anabolic agents.

What are the female-specific side effects? In females, anabolic agents can cause male-pattern hair growth and baldness or extreme hair loss. It can also cause menstrual disturbances or menstrual cycle imbalances. It may lead to decreased breast size and hoarseness of voice. So, anabolic agents have widespread gender-specific side effects in both males and females.

What are the systemic side effects of anabolic agents? What do you mean by systemic side effects? Systemic means that the side effects occur in internal systems like the cardiovascular, respiratory, central nervous, gastrointestinal, and dermatological systems. Let's look into the systemic side effects. The predominant systemic side effects include greasy skin, acne, male-pattern baldness, extreme hair loss, infertility (reproductive system), hypertension (cardiovascular system), and liver and kidney dysfunction, which are very dangerous and deleterious. It can also cause central nervous system side effects such as aggressive behavior, depression, and even harmful suicidal thoughts. In the endocrine system, it can also cause tumors.

The second substance banned by WADA is peptide hormones and growth factors. Examples include HCG (Human Chorionic Gonadotropin), HGH (Human Growth Hormone), insulin, adrenocorticotrophin (ACTH), and EPO. These substances may be illegally used by athletes to counteract undesirable side effects associated with drugs like anabolic steroids. For example, when athletes abuse anabolic steroids, male athletes can develop gynecomastia. To mask this side effect, athletes often use peptide hormones.

What can this result in? It can result in many side effects due to hormone imbalance, antagonism, and modulation. The side effects include hot flashes and severe gastrointestinal disorders. It can cause fluid retention, and in extreme cases, it can even cause venous thrombosis.

Let's look into the individual side effects of peptide hormones and growth factors. Side effects of human chorionic gonadotropin include menstrual disorders in females and gynecomastia in males. Side effects of insulin include hypoglycemia, nausea or vomiting, drowsiness, extreme sleepiness, and even brain malfunction. Side effects of ACTH include extreme insomnia, hypertension, diabetes mellitus, and in extreme cases, osteoporosis or bone loss. What are the systemic side effects of peptide hormones and growth factors? Side effects of EPO include increased blood viscosity, hypertension, and in extreme conditions, myocardial infarction (heart attack), cerebral infarction, pulmonary embolism, and convulsions. Side effects of human growth hormone include overgrowth of limbs (acromegaly), soft tissue swelling, abnormal growth of organs, orthopathies or joint disorders, and it can also induce diabetes mellitus.

The next group of drugs we are going to look at is one of the most ancient and commonly abused performance-enhancing drugs—commonly abused by cyclists and endurance runners—known as S6 stimulants. What are the examples? We have already looked into them. Amphetamines, cocaine, and ephedrine are all CNS stimulants. These are predominantly used medically to treat conditions like ADHD (Attention Deficit Hyperactivity Disorder) in children and narcolepsy (a sleep disorder). Athletes predominantly misuse these drugs to increase alertness and reduce fatigue. These are very

useful in long-distance endurance events. Stimulants have also been found as adulterants in supplements.

They are commonly found in over-the-counter drugs and supplement stores. So, it is very important for any athlete—if you are going to take stimulants—to consult with a sports medicine doctor before taking these drugs. Side effects of stimulants include impaired thermoregulation. If an athlete performs for long periods in heat after consuming stimulants, the thermoregulatory mechanisms may malfunction. What happens then? It results in malfunction of vital organs like the heart, liver, and kidneys. This is one of the very dangerous side effects of stimulants and can even cause death.

Other side effects of stimulants include loss of appetite, insomnia or loss of sleep, euphoria or depression, and hyperactivity if taken in large dosages. In extreme conditions, they can cause hallucinations or psychosis. Other symptoms include trembling, tremors, restlessness, agitation, tenseness, hypertension, palpitations, and heart rhythm disorders (arrhythmias). Hyperthermia is another dangerous side effect of stimulants, which refers to an increase in body temperature.

The next banned substance we are going to look at is narcotics. Some common examples are morphine, codeine, and oxycodone. These are commonly present in over-the-counter cough syrups. Narcotics are prohibited in sports because they are derived from morphine and its chemical and pharmacological analogues.

How do they act? These substances act on the central nervous system and reduce the sensation of pain. Use of narcotics can give a false sense of recovery in an injured athlete. During the rehabilitation phase, when an athlete is injured and away from sport for a long time, they may become anxious and want to return quickly. Due to ignorance of the potential harmful effects of narcotics, they may misuse them, leading to further serious injury and risk of long-term damage.

What are the main side effects of narcotics? They can lead to addiction and overdose, which is very common. Athletes who use narcotics may also suffer from loss of balance and coordination. Common side effects include nausea, dizziness, insomnia, depression, decreased heart rate (bradycardia), and respiratory depression. These are all systemic side effects of narcotics.

The next substance banned by the World Anti-Doping Agency is cannabinoids. Cannabinoids are psychoactive chemicals like marijuana, hashish, and hashish oils, which are predominantly derived from the cannabis plant. Examples of cannabinoids include THC (tetrahydrocannabinol), which is predominantly misused by athletes for pain relief and to reduce anxiety. One of the main side effects is that prolonged use may result in a loss of motivation, decreased concentration, impaired memory, learning

disabilities, and in extreme cases, respiratory disorders such as lung cancer, throat cancer, and chronic bronchitis.

Other side effects include impaired balance and coordination, loss of concentration, increased heart rate (tachycardia), increased appetite, drowsiness, hallucinations, cognitive impairment, dependency, anxiety, and paranoia (fear of even common things).

The next group of banned substances is glucocorticoids. Examples include prednisone and dexamethasone, which are commonly used medically as anti-inflammatories and are frequently used by sports doctors to treat musculoskeletal injuries.

All glucocorticoids are prohibited when administered via injectable routes. They are also banned when used orally or through oral mucosal routes such as buccal, gingival, sublingual, or even rectal routes. All these forms of administration of glucocorticoids are banned by WADA. However, other routes of administration such as inhaled, topical, dental, dermal, intranasal, and ophthalmological are not prohibited when used with proper certification—that is, a Therapeutic Use Exemption (TUE). The athlete and support staff must apply for this certificate before using glucocorticoids through these routes.

Now, coming to the side effects of glucocorticoids—the predominant side effects are fluid retention, so athletes might develop edema in the feet. Hyperglycemia and systemic infections are also common. Musculoskeletal disorders such as osteoporosis or bone loss, high blood pressure (hypertension), compromised immunity, increased blood sugar levels (hyperglycemia), and CNS symptoms like mood swings, depression, and anxiety are also observed.

The next group of banned drugs is diuretics and masking agents. Common examples include Furosemide and Hydrochlorothiazide. This is one of the masking agents involved in the famous case of cricketer Shane Warne, the legendary leg spinner from Australia, who was caught using diuretics. He was given these by his support staff to overcome obesity.

The main effect of diuretics is that they cause increased urine output. Athletes use these drugs as performance-enhancing agents to mask the usage of other drugs. Common side effects of diuretics and masking agents include extreme dehydration, very common among those undergoing rapid weight-loss programs. Other side effects include electrolyte imbalance, kidney damage (if used long-term), muscle cramps (short to medium term), and low blood pressure (hypotension).

Now coming to beta-2 agonists. Examples include clenbuterol and salbutamol. These are predominantly misused by athletes to enhance muscle growth and stimulate weight loss.

Side effects of beta-2 agonists include tremors, heart palpitations, arrhythmias, and muscle cramps.

The next group of drugs we are going to look at is beta-blockers. They are particularly banned in precision sports like archery and shooting. These drugs are used by archers and shooters because these sports require accuracy and steady, still limbs. Examples of beta-blockers include Alprenolol, Atenolol, Acebutolol, and Betaxolol. Common side effects of beta-blockers in athletes include hypotension, decreased heart rate (bradycardia), and fainting episodes.

So, these are the common side effects of the WADA-banned substances and drugs.

In conclusion, the take-home message is: most of the drugs and substances banned by WADA have both short-term and long-term side effects, and these side effects are gender-specific for both males and females. Depending on the usage, there may be short-term effects, and prolonged misuse may lead to long-term consequences and addiction. Long-term side effects in severe cases can even lead to organ damage like kidney and liver damage, hormonal imbalances, mental health disorders like depression and anxiety, and in some extreme cases, even certain types of cancer.

These references are predominantly taken from World Anti-Doping Agency sites. Thank you, and Jai Hind.