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Perspective

Hair Analysis for the Detection of Misuse of Drugs in Sports: A Perspective

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Abstract

Doping is forbidden by athletic organizations as well as by the World Anti-Doping Agency (WADA) established in 1999. WADA defines doping as the "presence of prohibited substances in an athlete's body". In last decades, urine & blood are the routine samples of choice for the analysis of drugs. However, in recent years, hair has become an alternative biological specimen for drug testing within the field of doping in sports, forensic toxicology & workplace testing. Hair testing can complement technique for conventional blood and urine analysis because it prolongs the detection window and by segmental analysis, permits discrimination between long-term therapeutic use and acute exposure.

Keywords: Hair testing; Doping control in sports; WADA; Long term history

Introduction

Doping is forbidden by athletic organizations as well as by the World Anti-Doping Agency (WADA) established in 1999. WADA defines doping as the "presence of prohibited substances in an athlete's body". In order to make this abstract definition more practical, WADA has involved an inventory of substances illegal to be used in sports. WADA provides world anti-doping codes and guidelines for screening substances under international standard prohibited list [1-3].

The work of anti-doping laboratories is regulated by WADA that ensures to guarantee world harmonization of the anti-doping guidelines. The list of prohibited substances and strategies includes many with chemically and pharmacologically numerous compounds from completely different category was innervated and updated annually by WADA [2-7]. The anti-doping laboratories mainly work on the following tasks:

1. To widen the range of doping substance and doping methods that can be detected.

2. To prolong the interval of time between use of a doping substance/method and the time of attainable detection.

3. To extend reproducibility and robustness of the analytical results.

Problems with existing methods

Blood and urine are usually the routine samples of choice for drug analysis. However, there is some limitations viz., (1) Smaller detection window (hours to 2-4 days for many drugs). (2) restricted stability of matrices in case of blood/urine. (3) More prone to bacterial growth. (4) The risk of disease transmission while handling of samples. (5) Sample collection is invasive, in case of blood. (6) High potential for manipulation of results & samples. In order to overcome these limitations, hair is being recognized as an alternative and fundamental biological specimen for drug testing [8-14].

Advantages of drug testing in hair

Hair testing extends the variety of major sensible advantages/ merits of hair testing over different matrices i.e., urine & blood. Hair testing provides larger detection window (from three days to years) betting on the length of the hair shaft in comparison with urine/ blood (hours to two–four days for many drugs). It also facilitates the task to increase detection window for anti-doping laboratories. The sample collection is simple, non-invasive & easy to transport. In addition, it has indefinite stability & less liable to microbial growth. Moreover, the repetitive use of drug pattern can be extrapolated by using segmentation analysis [14-16].

Passive exposure of drug in hair analysis

Unique quality of hair as a biological matrix: Hair is a distinctive matrix that does not have an active mechanism for drug metabolism. It is an imperative quality of hair to prevent the drug to be excreted out from the body. Furthermore, since hair grows at an average rate of 1.0-1.3 cm/month, it is theoretically attainable to extrapolate a record of eventual drug usage by Segmental Hair Analysis [12,17,18].

Transport of drug substances in hair by means of pH gradient: Many drugs are either weak bases or weak acids that may be ionized by protonation or deprotonation. The pH of plasma is 7.3, whereas the pH of the keratinocytes and melanocytes in comparison with plasma is lower, varying between 3 and 6. Therefore, the assumption that basic drugs, in contrast to acidic drugs, may accumulate in keratinocytes and melanocytes more likely, because the diffusion into the cell is favored by the pH gradient, and once within the cell cytosol, the molecules are protonated and not be able to diffuse back to the plasma [14,19-22].

Structure-activity relationship for the incorporation rate (IR) of the drug in hair

There are several functional groups responsible for the increase or decrease the incorporation rate of the drugs into the hair. The strategy is predicted on the careful examination of the chemical structure of the substances. The outcomes of the previous study reveal that the presence of nitrogen atom (N atom) increases the IR of drug, the

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longer N-alkyl chain & N-benzene rings increases the IR of the drugs, Absence of acidic cluster increases the IR, Basic drugs reduce the IR and Triple bonds on the alkyl chain cut-back the IR [14,19,21,22].

Regulatory guidelines for hair testing

Harmonizing efforts are initiated on sample collection, interpretation of results, cut off values etc to make sure uniformity of results across countries. There are some international societies like Society of Hair Testing (SoHT), United nation office on drugs & crime (UNODC), European Workplace Drug Testing Society (EWDTS) devoted for the detection of drugs in hair [13,14,19,23].

Applications of Hair Testing

Sports/athletics testing

While conventional drug testing is performed on competitive athletes, the first focus is on doping, the use of drugs and/or supplements supposed to push muscle growth and/or to boost strength and endurance.

Medical screening

Medical testing for drugs of abuse is primarily targeted on identifying what medication or combinations of drugs an individual might have taken so the person can receive correct treatment.

Legal or forensic information

Drug testing for legal functions primarily aims to detect banned or prohibited drug use in miscellaneous situations.

Workplace drug testing

It may be carried out before employment, on a random basis, or if the employer/worker has a reasonable doubt for using prohibited medication.

In addition, hair testing also facilitates in reducing

a) Drug-related deaths: Due to poisoning caused by chronic use of drugs

b) Drug-facilitated crime: Drug cause sedation and amnesia, e.g. benzodiazepines.

c) Child protection: Mothers who continue to misuse drugs and alcohol during pregnancy expose the unborn fetus.

Moreover, hair testing can be also employ in monitoring drug misuse such as drug rehabilitation programs & workplace drug testing.

Conclusions

Dope testing of prohibited substances is usually carried out with urine or blood samples taken from athletes and horses. Investigation of alternative specimens, e.g. hair samples, is restricted to special cases, however may also be worthy, additionally to urine/blood analysis. Moreover, hair testing is most well linked in cases of limited availability or complicated collection of urine samples, e.g. from horses. Hair testing can complement conventional blood and urine analysis because it enlarges the detection window and by segment analysis, allows differentiation between long-term/short term therapeutic uses. In future, hair testing studies would be introduced in doping detection in respect to various advantages over urine/blood.

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