Forensic Science International 285 (2018) 105–110

Contents lists available at ScienceDirect

Forensic Science International

journal homepage: www.elsevier.com/locate/forsciint

Hair analysis when external contamination is in question: A review of practical approach for the interpretation of results

Lolita Tsanaclis[a,b,*], Maristela Andraus[b], John Wicks[a,b]

[a] Cansford Laboratories Limited, Cardiff, Wales, CF23 7HB, United Kingdom
[b] Laboratorios Chromatox Limitada, Sao Paulo, Brazil

ARTICLE INFO

Article history:
Received 31 August 2017
Received in revised form 14 January 2018
Accepted 19 January 2018
Available online 7 February 2018

Keywords:
Hair testing
Drugs
External contamination

ABSTRACT

Despite having been extensively discussed over the last decade, the differentiation between systemic exposure and external contamination still continues to be one of the limitations of hair testing for drugs. For this reason, we consider it worthwhile to re-state some basic principles in this short review. Various studies investigating a diversity of wash protocols, most using artificially contaminated hair with cocaine, have been valuable in evaluating wash efficacy and in understanding the incorporation of drugs in hair. However, assessments of wash efficacy made with real hair samples, as opposed to artificially contaminated samples, provide a different perspective, and demonstrate how rarely external contamination affects the interpretation of results. Data from a large number of hair samples from crack cocaine users, confirmed the usefulness of our protocol to remove most of the externally deposited cocaine. The data showed that hair levels of cocaine and benzoylecgonine in crack cocaine users were overall high with ratio of benzoylecgonine to cocaine in all samples above 0.1. The wash residue concentrations of cocaine ranged from not detected to 21 ng/mg with a median of 0.5 ng/mg. Cocaine was detected in the wash residue in 105 out of 138 samples. The wash to hair cocaine ratio ranged from not detected to 0.36 with a median of 0.02. The wash to hair cocaine ratios were below 0.07 in 133 cases. The five cases that produced wash to hair ratios above 0.1, one sample was at 0.11, three at 0.13 and one at 0.36, possibly because these cases were at the lower end of cocaine levels, however, we could not rule out that the hair was contaminated. Whilst it is not possible to differentiate between the drug extracted from the hair and the drug attached to the outside of the hair, we can compare levels of drug in the wash residue with levels detected in the hair sample. In addition, further diagnostic criteria must be applied to minimise potential misdiagnosis of external contamination. When drugs are detected in hair, individuals have clearly been in an environment where drugs are present, but it is only on rare occasions that it is unclear whether this is the result of drug use or of external contamination, and, in those cases, the results of testing need to be interpreted in the light of corroborating evidence from clinical data or social context.

1. Introduction

Despite having been extensively discussed over the last decade, the differentiation between systemic exposure and external contamination still continues to be referred to as one of the limitations of hair testing for drugs [1]. This short article reviews the current practice and our own experience in this respect.

External contamination of hair for drug groups that are usually smoked or snorted, like cocaine or cannabis, is a possibility when an individual in the company of users can be subject to drug exposure to smoke which might be deposited on their hair. Thus, when testing for drugs using hair samples, the removal of any possible externally deposited drug is an integral part of the analysis.

A variety of wash protocols or decontamination procedures have been published over many years and their efficacy and limitations have been recently reviewed [2–4]. There are two common agreements in these reviews: the first is that results vary between the several decontamination procedures investigated, and the second is that it is difficult to achieve (and to prove) that the externally deposited drug has been totally eliminated. There is a common call for the development of more effective strategies for hair decontamination and for improved knowledge about the

* Corresponding author at: Cansford Laboratories Limited, Cardiff, Wales, CF23 7HB, United Kingdom.
E-mail address: loli@cansfordlabs.co.uk (L. Tsanaclis).

https://doi.org/10.1016/j.forsciint.2018.01.028
0379-0738/

mechanisms of drug incorporation, in order to be able to interpret hair testing results in a more reliable way.

In this paper, we reassess the current understanding regarding strategies used in hair drug testing and the approaches used to reduce the potential impact of external contamination on hair samples, focusing on cocaine.

2. An overview analytical challenges in hair testing for demonstrating that drugs have been used

Before considering the impact of external contamination (especially of cocaine) laboratories testing hair samples need to demonstrate that drugs have been used. If drug use is confirmed, external contamination, whether present or not, is not a critical factor. The confirmation of drug use in hair drug testing is achieved by a combination of the following elements: confidence in the analytical result; use of relevant cut-offs; proven non-in-vitro generation of the metabolites during analysis at metabolite to parent drug ratios; validated wash protocols (Fig. 1). These are outlined in the following sections.

2.1. Confidence in the analytical result

Apart from using state of the art instrumentation and qualified personnel, laboratories performing the analysis need to have proven capability that no false positive results are possible by using robust procedures. These procedures are not exclusively based on the sophistication of the instrumentation used to detect and identify substances, but they clearly need to make sure that as a minimum: (a) mix-ups are impossible when handling hair samples and extracts during testing procedures; (b) there is confidence in up-loading the sequence on instruments of analysis and on results transcriptions; (c) there is zero cross-contamination of a negative sample by a positive sample during sample transfers; (d) reports of false positive results do not occur due to misuse of cut-offs when interpreting results; (e) the analytical process does not generate other interfering compounds such as metabolites.

2.2. Use of relevant cut-offs

Cut-offs are used in drug testing as an interpretation criterion, where values above the cut-off are reported as “Detected” and below, as “Not detected”.

Cut-offs are used for several reasons, principally to reduce the chance of reporting drug use when drugs were taken involuntarily (for example where drugs have been smoked in the vicinity of a non-user) or because of telogen hair, when drugs were used at an earlier time, before the time window covered by the tested hair sample. Telogen hair carries drugs that entered the hair in an earlier period. After use of a drug stops, the levels found in the hair drop rapidly to a level some 10–15% of what they were during active drug use and then the levels decline to zero after 3–4 months if no drug is used, depending on the extent of use and previous concentrations [5].

Cut-offs may vary with the purpose of the test but may be specific to a particular laboratory. The Society of Hair Testing (SoHT) [6] and the European Workplace Drug Testing Society (EWDTS) [7] have recommended cut-offs for substances and metabolites in hair. Different cut-offs may be applicable in different contexts. For example, in workplace testing the onus in many cases is to set the cut-off at a point where a positive result can be regarded as irrevocable proof that drugs have been taken. This is important because the proof provided is then assessed against workplace policy and can result in summary dismissal. However, to test for single use in cases of drug facilitated crime, cut-offs employed are usually at the analytical limit of quantitation.

Cut-offs are drug specific due to differences in metabolism and the incorporation of drugs and metabolites in hair. For example, the cut-off for cocaine is 0.5 ng/mg and for 11-nor-9-carboxy-Δ9-tetrahydrocannnabinol (THC-COOH) is 0.2 pg/mg. Although cut-offs employed in hair analysis are usually analytical cut-offs

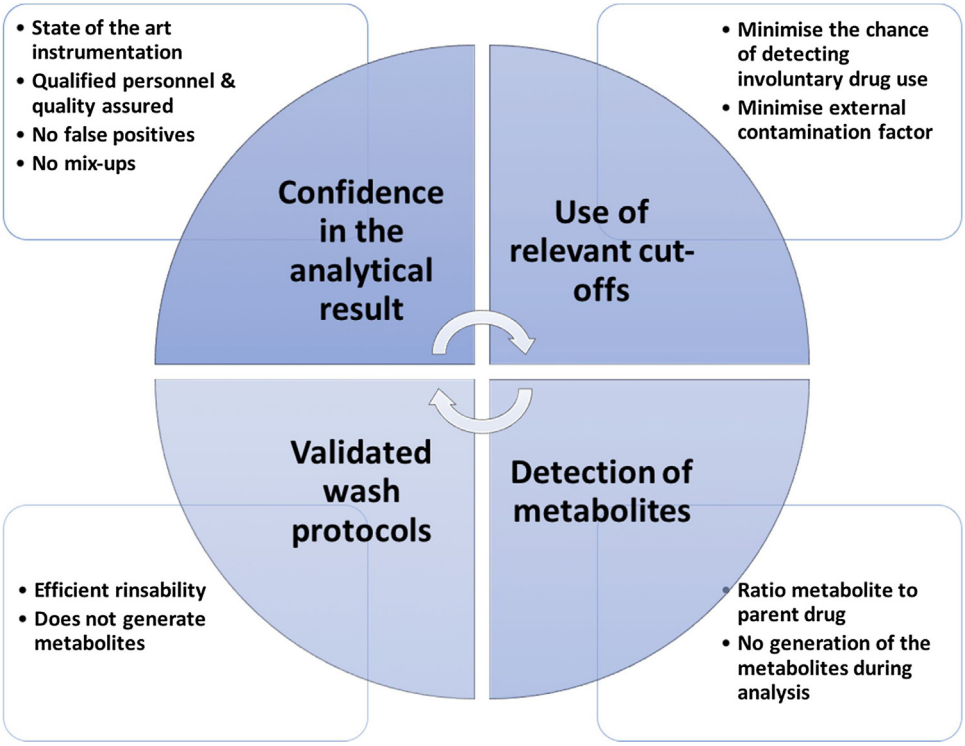

Fig. 1. Diagnostic tools for confirmation of drug use in hair drug testing.