Hair analysis for the detection of drug use – is there potential for evasion?

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ABSTRACT

Background: Hair analysis for illicit substances is widely used to detect chronic drug consumption or abstention from drugs. Testees are increasingly seeking ways to avoid detection by using a variety of untested adulterant products (e.g. shampoos, cleansers) widely sold online. This study aims to investigate adulteration of hair samples and to assess effectiveness of such methods.

Methods: The literature on hair test evasion was searched for on PubMed/MEDLINE, Psycinfo, and Google Scholar. Given the sparse nature of peer-reviewed data on this subject, results were integrated with a qualitative assessment of online sources, including user-orientated information/commercial websites, drug fora and 'chat rooms'. Over four million web sources were identified in a Google search by using 'beat hair drug test' and the first 86 were monitored on regular basis and considered for further analysis.

Results: Attempts to influence hair test results are widespread. Various 'shampoos', 'cleansers' among other products, were found for sale, which claim to remove analytes. Often advertised with aggressive marketing strategies, which include discounts, testimonials and unsupported claims of efficacy. However, these products may pose serious health hazards and are also potentially toxic. **In addition, many anecdotal reports suggest that Novel Psychoactive Substances (NPS) are also consumed as an** evasion technique, as these are not easily detectable via standard drug test. Recent changes on NPS legislations such as New Psychoactive Bill in the UK might further challenge the testing process.

Conclusion: Further research is needed by way of chemical analysis and trial of the adulterant products sold online and their effects as well as the development of more sophisticated hair testing techniques.

Key Words: Hair test, hair analysis, drugs, NPS, evasion; Psychoactive Substances Bill

Introduction

Drug testing, including hair analysis, is increasingly utilized in some employment sectors, especially where there are safety concerns around drug use (Karch 2016; Ironmonger 2014; UIC 2008). **There is weak evidence however,** linking drug testing to reducing employee drug use rates, or accident and injury incidence (Pidd & Roche 2014). After ingestion, traces of substances and their metabolites are deposited into hair via the bloodstream and into the growing follicle. A 3cm sample of hair (usually taken from the scalp) is sufficient to test for drug use in the preceding three months, **accepting that variations in growth rate of between 0.7 and 3.6 cm/month are possible (Schultz et al. 1993).** Despite the existence of very reliable assays, **such as those based on MS techniques, most immunoassay kits are designed to test chronic drug use, meaning a single incident of drug use may escape detection.** Very recent drug use is also usually missed as affected hair has not had sufficient time to grow out of the scalp (Pragst & Balikova 2006). Studies on the appearance of drugs in beard hair reveal variations in incorporation rates with **amphetamines and cocaine appearing within one day of intake whilst morphine was detectable after one week (W**ennig, 2000). A large number of parameters can affect the appearance of drugs and their metabolites in hair including (i) amount of sweating, (ii) size and structure of the parent drug, (iii) protein binding in blood, and (iv) polarity and charge of the drug (Wennig, 2000). A further consideration is hair colour, with several studies revealing **higher** levels of drug uptake into darker hair (Cone et al. 1993; Joseph et al. 1996; Gygi et al. 1996).

In forensic and clinical toxicology, hair testing is typically used in preference to urine or blood tests, as the former may provide additional information such as indications as to the extent and historical pattern of drug usage (Klein et al. 2000; Friguis et al. 2012). As the use of novel psychoactive substances (NPS) becomes widespread across the globe (Corazza 2013a; Papaseit 2014), developments in the potential of hair testing techniques to detect a wide range of NPS using various chromatographic techniques have gained attention (Smith 2015). Recent advances in analytical methods have improved both hardware and software capabilities, lowering detection limits along with the possibility of increasing the numbers of compounds analysed in a single chromatographic run. The approach of initial screening followed by quantitative analysis of libraries of drugs and their metabolites has opened new horizons for drug detection in hair (Shah et al. 2014). A key feature is the ability to add any newly discovered drug to the method in a few simple steps, thus expanding the library of compounds that can be detected in a 10-minute analytical run. Currently however, the full potential of hair testing is not being routinely used as most immunoassays used are 'unsuitable for the detection of these compounds' (Gottardo et al. 2014).

Evasion is a common issue on other types of drug test. Urine samples, which are often provided in private by the testee, can be easily adulterated, substituted or diluted (Beard, 2016; Jaffee, Trucco, Levy & Weiss 2007; Jones et al. 2015; Cody & Valtier 2001; Dasgupta 2007). Blood tests are generally considered tamper-proof (due to the sample being obtained by a professional), but samples must be acquired within much shorter timeframes than urine or hair, especially for drugs with exhibit a short plasma half-life. Testing methods with shorter detection periods see some users temporarily suspending drug use in order to pass the test. They are also considered by many to be highly invasive, and blood samples require specialist extraction and transportation (Koster et al. 2014; Friguls et al. 2012). Hair analysis circumvents many of the issues around detection windows, collection procedures and tampering potential (Deshmukh et al. 2010; Accornero et al. 2002). Recently, however, a dramatic increase in websites selling products to avoid detection have been recorded, supported by a growing literature, suggesting that large numbers of testees are attempting to evade detection (Hill et al. 2014; Polla et al. 2009; Gerada & Gilvarry 2005; Dolan et al. 2004). This study explores the evasion methods discussed in the literature and in Internet fora, discussion threads, online shops and other types of web content. Particular attention is given to the use cleansing shampoos, and NPS, which in some instances, are used in the belief that these will not be tested for in a hair analysis.

Methods

The literature on evasion and adulteration of hair testing was initially searched in PyschInfo and PubMed databases. Considering the sparse nature of peer-reviewed publications on this topic, results were integrated with a qualitative assessment of relevant websites and online fora. Over a three-month period, between February and April 2016, exploratory qualitative searches were carried out in English and Italian. Generic and specific keywords were used, such as 'pass'/evade/avoid detection/cheat/beat/tamper' 'hair drugs/substance test' along with names of specific substances. The first 86 web results were used for analysis, as the search reached a saturation point, and these were monitored on a regular weekly basis. Any personal data collected from online fora were removed for anonymity. Permission for the study was granted by the School of Pharmacy Ethics Committee, Hatfield, United Kingdom (November 2013 PHAEC/10-42). This study assesses the nature of the products sold claiming to remove drug traces from the hair, the marketing strategies employed by sellers, and the potential side effects and efficacy as reported by users.

Results

A limited amount of academic literature into the deliberate adulteration of hair samples was found (Hill et al. 2014; Polla et al. 2009; Gerada & Gilvarry 2005). Other studies have addressed how bleaching and other cosmetic treatments can affect the quality of hair samples, and the degree to which analytes can be detected, although this might not be done deliberately (ASAM 2013; Martins et al. 2008; Yegles 2005). Most of the emerging evidence on circumvention focused on other specimen types, such as urine and blood (Jaffee, Trucco, Levy & Weiss 2007; Jones et al. 2015; Cody & Valtier 2001; Dasgupta 2007). The range and sophistication of some of those evasion methods (including even the use of a fake penis which delivers warm artificial urine) lends support to the assumption that substance users will seek to evade detection on the hair analysis also.

There is an abundance of journalistic and anecdotal evidence that users are attempting to evade detection (e.g. Featherstone, 2015; Brown 2014; Hill et al. 2014; Wales Online article, 2013). In searching for qualitative user data on this topic, a simple Google search with fewer more colloquial terms, was found to be more effective. The search term 'beat drug hair test' for example produced 3,660,000 results at the start of the research period, and by the end (three months after), was producing more than four million, suggesting increasing interest in this area. Most of these appeared to relate to user content (fora, blogs) or evasion-aiding seller sites. Techniques to increase the likelihood of passing the test discussed online include abstaining for a sufficient period, shaving the hair off, using commercially available products **(shampoos, hair cleansers)** or home remedies to 'strip' away evidence of drug use, switching to a lesser tested-for substance, and offering excuses for any positive detection (perhaps prompting a later-date retest).

Shampoos and hair cleansers

Whilst academic literature on deliberate adulteration products is limited, a number of papers attest to the idea that certain cosmetic treatments, such as bleaching, colouring, chemically straightening hair, can affect the speed at which drug analytes leave the hair sample (Hill et al. 2014; Hill 2016). Jurado et al. 2007 discovered that 'in all cases, the drug content in hair that had undergone treatment decreased in comparison with untreated hair' with mean differences of between approximately 40-60% depending on the substance, type of treatment, and the extent of hair damage. This has been further supported by the Society of Hair testing guidelines for drug testing in hair (Cooper, Kronstrand & Kintz 2012) and the American Society of Addiction Medicine (2013).

Based on the evidence of drug analytes leaching out of hair following some types of treatment, a myriad of commercial products has emerged which claim to strip metabolites from the hair. These are often branded and sold online in brightly coloured boxes as "hair cleansers", "cleansing systems", or

"hair detoxifiers" with different names, such as Nexus Aloe Rid, Clear Choice, Two Steps Ahead, Synergy Detox, Supreme Kleen, Test Pass Detox Shampoo, Toxin Wash, Zydot Ultraclean, among others. Many of the sites selling these products utilise misleading marketing strategies by offering apparently neutral and factual information and advice, designed to lend a sense of honesty and trustworthiness. Scientific language is often used **on these sites** to describe how drug metabolites enter the hair shaft, and how these are then tested for as well as medical terminology and specific claims to reinforce the assumption that the products have been clinically researched (DrugRehabAlliance.com; Theweedblog.com, accessed April 2016). Skeptics are reassured with claims such as: '500,000 hair tests passed since 1998' (PassYourTest.com), or with a 'Talk to a drug test expert' button to allow for live chat with an expert. Links to the vendors' Facebook page, Twitter, YouTube, Google+ and even RSS feed, are available to connect to recognizable, trusted brands, and to sustain contact with potential buyers, and even include a money-back guarantee (e.g. Theweedblog.com). Special offers are also common with further unit price reductions in case of multiple buys (e.g. PassYourTest.com).

A small number of sites genuinely appear to be nothing more than information brokers – they do not sell or endorse any commercial product, stating they have not been proven to be effective in clinical trials and they provide home remedies, involving vinegar, salicylic acne treatment, fabric detergent, and hair dye (e.g. hairfollicletest.info; WikiHow). Video online tutorials for these procedures are also available on the YouTube (Youtube 2015) with mix of positives, negatives, and general questions from users/potential users.

The price of these products is very high, ranging from £50 - £827 for a bottle of hair cleansing shampoo and conditioner. Amazon is a particularly interesting vendor of these products, as the reviews left cannot be altered by the seller. For instance, Zydot Ultra Clean has 10 reviews (with an average of 2.5 stars but with only three 5-star and six 1-star reviews – suggesting on balance it hasn't been successful for these users). The US version of the site has a larger range of hair products aimed at the drug test market, with far larger numbers of reviews, but they too hover around the half-pass mark at best. Variable results were reported on forum discussions (marijuana.com, Reddit, 420 magazine, accessed April 2016), but on independent selling sites, no negative comments or reports of failure were found, suggesting that comments may be moderated, or contain falsified 'testimonies' of efficacy.

A selection of user feedback regarding these products is illustrated in Table 1.

(Table 1)

It is problematic to establish effectiveness from user feedback alone, as some drug use may go undetected without any particular method having been employed (Hill et al. 2014). While hair testing demonstrates very high specificity, its sensitivity can be variable (ASAM 2013). Recent studies have reported that Gas Chromatography/Mass Spectrometry techniques detected between 34.4% and 77% of moderate to heavy Cannabis users with lower rates for some other substances (Taylor et al. 2016; Gycznski et al. 2014; Junkuy 2014). In contrast, Musshoff et al. (2012) compared two types of immunoassay procedures for drug testing in hair samples and found much higher sensitivities (65-99% depending on substance tested and method used). The authors advocate for lower cut-off values in order to capture positive results, recommendations for which are set by the European Workplace Drug Testing Society. However, lowering cut off points could raise other potential problems, such as contamination. Confirmatory testing should also be provided for any positive results obtained from screening. The wide variety of hair tests available, and consequent variations in terms of performance, also contribute to these differences (Vincenti et al. 2014; Baciu et al. 2015), although an internationally-recognised standard for accredited methods does exist - ISO/IEC 17025 (Nutt et al. 2014), and the EWDTS have published a common framework to guide those involved in the testing procedure (EWDTS 2015).

This variation in sensitivity means many users will receive an unexpectedly negative result (falling below the minimum cut-off level), inadvertently supporting the claims of any commercial product they may have been used. Much of the 'success' therefore, in the claims of these product vendors, could be attributed to these inevitable false negatives.

NPS consumption to avoid drug detection: a growing trend?

Substance substitution - the swapping of a commonly tested-for substance for one less likely to be detected, such as NPS - is another evasion strategy method widely identified in the course of this research (e.g. Topix.com; Drugs Forum; High Existence). NPS have posed significant challenges to policy-makers due to the rapid pace at which chemical structures are altered in response to legislation to control individual substances, creating huge numbers of new NPS (Griffiths, Brown & Sedefov 2013). The introduction of the Psychoactive Substances Bill to the UK in May 2016, however, made any substance that has an effect on normal brain functioning (other than tobacco, alcohol and caffeine) automatically banned, a move which has attracted criticism from scientists and experts due to the inherent difficulties in defining and controlling a limitless number of substances (Reuter & Pardo 2016). A number of studies indicate that NPS are attractive to users regardless of their 'legal' status, because they are less often tested for in toxicology (Soussan & Kjellgren 2016; Brown 2015; Gunderson et al. 2014; ASAM 2013; Simmons et al. 2011).

However, it must be noted that hair analysis has the potential to detect any substance, depending on the analytes it has been 'programmed' to recognize (Smith et al. 2015; Shah et al. 2014; **Fisichella et al. 2014**). Indeed, a number of hair analysis kit sellers were identified online who claim to sell tests capable of detecting a large number of substances including one who say they can test for over 2000 (e.g. DNA Legal). Research into the practical potential for quantifying NPS in drug testing is limited (Ambach et al. 2015). However, it appears that generally speaking, commercially-available hair tests are only capable of detecting a small selection of the most commonly abused drugs, and employers are often requesting tests for a limited number of better known substances of abuse, leaving room for NPS to go undetected (Gottardo et al. 2014).

Many NPS have effects equal to or greater than traditional drugs, and far less is known about them. However, for some they produce a false 'sense of security' largely generated by the marketing strategies of online sellers, which make unsupported claims regarding their safety, efficacy and even health benefits (Corazza et al. 2013b).

As the use of NPS becomes more widespread, the challenges around detection and monitoring of use become more pertinent. Although information is available about individual brands of test and the analytes they are capable of detecting. It is currently not clear to what extent overall current methods are able to detect the use of NPS. For example, there is currently no information available on the market share of each brand of drug test, nor what percentage of currently available NPS may be detected. Indeed, there is no exhaustive list of all NPS; some may trigger a positive result because they have previously been included in the chromatography library of detectable substances. Other NPS might be detectable as they have a similar molecular structure to existing illicit drugs. However, a proportion of NPS are either unknown at this time**, not routinely included, and sufficient** different to other drugs to be currently undetectable.

Numerous conversation threads were discovered where users discussed their use of NPS in order to avoid detection (Topix.com; Drugs Forum; High Existence)**, although there** is a high degree of uncertainty within the user community on the detectability of NPS. For example, while synthetic cannabinoids will not react to traditional THC immunoassays (Smith et al. 2015), many users have reported testing positive for traditional substances, possibly as a result of their (often) chemical similarity, but also possibly as a result of substance mislabeling; Smith et al. (2015) and Brandt et al. (2010) discuss the documented presence of controlled psychoactive substances in the so-called 'legal

highs' being sold before the recent blanket ban. The opposite has also been encountered – A study of 679 nightclub and festival goers by Palamar et al. (2016) detected high levels of NPS via hair analysis in those self-reporting MDMA use but with no lifetime use of NPS, suggesting the contamination goes both ways. Poly drug use is widespread, with many users mixing NPS and more traditional illicit drugs, by choice or by supplier adulteration. Researchers monitoring the presence of NPS in samples previously submitted for drug testing have recorded high prevalence – up to 37% - with rapid growth in recent years (Hondebrink et al. 2015; Salomone et al. 2013; Rust et al. 2012).

Other potential methods for evading drug hair testing

Many of the sites, including those offering commercial preparations, will begin by advising users to consider abstention from drugs, or shaving their hair in the first instance (e.g. HairFollicleDrugTest.com; hairfollicledrugtest.info, wikihow; AlwaysTestClean.com - accessed April 2016). Cropping hair closely (and shaving body hair) prevents a sufficient sample from being collected for hair testing, which may therefore be substituted by a shorter detection window test, such as those using saliva, blood or urine. Occasional mention was made of whole body cleaners ('consumables'), ingested by mouth, which remove drug traces and metabolites from hair, urine and blood. An example is "Nutracleanse" offered by PassYourTest.com with a full guarantee, while "Total Detoxification System", sold by TestingClean.com, also prescribes a set diet for users to follow in combination with the treatment. No **plausible testimonies** were identified from users achieving a clear test result via the use of consumables only.

A number of information sites (e.g. UKCIA) offer possible 'excuses' that users could give in the event of a positive result. This opens up potential for those with a deservedly positive result to call for a retest. AlwaysStayClean.com for example, makes the dubious claim that 'about 5%' of tests give a false positive and list reasons including the use of prescriptions and over-the-counter medications as well as poppy seeds in bagels. However, studies administering poppy seeds to testees appears have shown that a false positive result was 'highly unlikely' (Hill et al. 2005). Controversially, the ethnicity of testees has also **been offered as** a reason for false positive tests (for example, AlwaysStayClean.com). Kidwell, Smith & Shepherd (2015) demonstrated that some ethnic hair care products can significantly exacerbate the absorption of environmental contaminants and earlier studies measured higher levels of drug uptake into darker hair due to **the higher presence** of melanin (Cone et al. 1993; Joseph et al. 1996; Gygi et al. 1996). However, a comprehensive laboratory analysis failed to find any statistical correlation between ethnicity and incidence of false-positive drug tests (Kelly et al. 2000).

Study limitations

Internet sources: One could wonder about the limitations of carrying out an analysis of online information**, and indeed it** may be inappropriate to trust data obtained from the Internet without some means of independent verification. However, in the absence of relevant peer-reviewed data, this seems to be the only valid method to obtain preliminary information about new and emerging phenomena.

Query: a number of set key words were used for the searches and these did not include street names used to sell the adulterant products.

Search: Similarly, searches were performed with a wide range of search terms, but the language surrounding the use of these substances is often very colloquial and regionally dependent. With more time and resources, interesting directions to continue this research would be to examine the content of the products sold purporting to help secure a negative result, and to assess the extent to which the most widely used hair tests are able to detect NPS.

Conclusions

Overall, the attempted evasion of substance hair testing is a large, rapidly growing and lucrative market. Various 'shampoos', 'cleansers' among other products, were found for sale, which claim to remove analytes. Evidence surrounding the effectiveness of commercial products sold for this purpose is mixed, but when the quality of sources is considered, generally disputes efficacy. Clearly, there are high numbers of individuals self-reporting success in evading detection on hair tests. Minimum recommended cut-off levels set by the European Workplace Drug Testing Society might not be sufficient to detect light or infrequent drug use and outcomes might thus be interpreted by testees as a false confirmation of a successful evasion attempt. However, a large number of individuals describe their drug use as heavy and/or frequent, and this body of anecdotal evidence, combined with research evidence around the dissipation of drug metabolites from treatment-damaged hair samples, means that these products warrant further investigation. Another important area in need of attention that emerged from this study was the use of NPS to substitute illicit drug use for the purposes of evading detection, especially as it currently unclear which NPS can be detected and by what proportion of available tests. As discussed, the recent introduction of the Psychoactive Substances Bill in the UK and similar legislations further challenge the testing process. Novel testing solutions will need to be found in order to face the unknown and growing number of NPS available in the illicit drug markets as well as a large trial of the adulterant products sold online and their effects.

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