

Recent scientific developments in hair strand testing and racial bias in current practices of hair strand testing

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The use of hair strand testing for drugs and alcohol has been around for over twenty-five years, and is now commonplace in the family courts. Despite case law setting out its limitations as examined below, a positive hair strand test will often lead to the seemingly irrefutable conclusion that drugs or excessive alcohol have been

consumed. Often conclusions are drawn about the amount of drugs consumed from the tests alone.

A positive drug test in the face of a denial about using substances (or using them at the levels suggested) will lead to professionals, working with that family, to accuse them of being dishonest about their substance misuse problems, lacking insight or being in denial.

Despite the certainty with which these results are often treated, studies and data accumulated over the past 10 years cast doubt on the reliability of previously drawn conclusions.

This article explores the recent academic research into this evolving scientific field and highlights areas where caution must be exercised in drawing definitive conclusions. It demonstrates that in many cases the standardised use of cut off levels used for interpretation and reporting hair strand testing, employed by the majority of testing companies, creates a racial bias and therefore caution must always be exercised when results are presented as 'positive' or 'negative'.

Drug testing basics

When a person uses drugs the presence of the drug within the blood stream becomes incorporated into the hair as it grows. This isn't the only way drugs can be incorporated into the hair, as is explored below. Also below, we explain the mechanism behind why hair is tested for drug use.

When a drug is metabolised by the body, a metabolite associated with that drug is produced and can be found in the hair as an

indicator of active consumption. Hair strand testing must always test for the constituent or parent drug as well as metabolites. Some metabolites are only produced when the body processes a drug, although some can be found or produced outside of the body, such as the main metabolite of cocaine benzoylcegonine formed when cocaine is exposed to moisture.

A sample of hair is taken from the scalp and often cut into segments to correspond with approximate time periods to identify when any drugs identified were used. The hair samples are then washed to exclude environmental contaminants before being tested for the presence of the drug and the metabolite. Some testing companies provide the results of the washes, which in some cases can assist the expert in deciding on whether the presence of the drug can be attributable to exposure and not use. Simply put, a high quantity of drug found in the washes relative to the hair make it more likely the presence of the drug is due to contamination, or that contamination is likely to have been a significant contributory factor. Present reporting methods assume that the presence of the drug and metabolite provides conclusive proof that a drug has been consumed by the person whose hair has been tested but this is not always the case.

The limitations of hair strand test reporting for drugs

It has long been established by the family courts that the use of hair strand testing in isolation should not be relied upon. Hayden J in *London Borough of Islington v M and another* [2017] EWHC 364 (Fam) at para [32] said as follows:

‘32. It is particularly important to emphasise that each of the three experts in this case confirmed that hair strand testing should never be regarded as determinative or conclusive. They agree, as do I, that expert evidence must be placed within the context of the broader picture, which includes e.g. social work evidence; medical reports; the evaluation of the donor’s reliability in her account

etc. These are all ultimately matters for the Judge to evaluate.’

Notwithstanding this, a test above the cut off level for both drug and metabolite are more often than not taken by professionals as conclusive proof that a parent has abused the identified drug.

More worrying still, social workers and parenting assessors often equate the levels of drugs detected in the hair as evidence of the amount of drugs consumed by that parent. This is dangerous and wrong for a number of reasons.

First, every testing company employs different criteria for classifying whether a sample is high, medium or low. Furthermore, results from the same sample of hair tested by different companies can produce widely different results. Data now shows that significant levels of drug can be found in non-users and low levels, or no drug, found in regular users of the drug.

In *Re H (A Child: Hair Strand Testing)* [2017] EWFC 64, [2018] 1 FLR 762 the court looked at the results of testing from three companies. Peter Jackson J (as he then was) observed that the results from one of these companies were two or three times higher than those reported by other companies for the matching hair sample.

Secondly as explored in greater detail below, an individual incorporates drugs into the hair at different rates and there are a number of processes that can elevate or decrease the amount of drug identified in the test which has nothing to do with consumption.

Other recommendations, contained within para [59] of his judgment, have not been fully assimilated into hair strand testing report writing, in particular at para [59(5)] it is recommended that:

‘(5) Where there is reason to believe that environmental contamination may be an issue, this should be fully described, together with an analysis of any factors

that may help the reader to distinguish between the possibilities.’

Court orders routinely require parents who are to undergo hair strand testing to not dye, bleach, straighten or otherwise chemically treat their hair. This is because the use of dye, bleach or chemical treatments can reduce the amount of drug in the hair and produce a false negative or even false positive results.

There are many factors which might lead to a false positive result, or an elevated result which are infrequently properly considered.

- Typical relevant factors which affect hair strand testing that must be established and accommodated in all cases for reliable interpretation of test results include:
- Natural hair colour
- Use of hair treatments:
 - permanent dye, bleaching with frequency and brands
 - thermal treatments with frequency, where applied on the scalp and hair
- Exceptional exposure to UV eg sun beds, holidays in hot climates
- Frequency of hair washing and conditioning
- Brands of shampoo and conditioners used
- Swimming frequency (and periods), with or without caps
- If / when the scalp or body hair was shaved
- Hair style (straight, curly, tight curls (eg Afro Caribbean), dreadlocks, head coverings)
- Living environments, periods of exposure to drug, type and profiles of exposure
- Dates for pregnancy, term, birth

All these factors and more have a varying impact on each case. It is not sufficient for a

report to only note ‘the use of treatments’ when the impact they may have on the results in that specific case has not been fully accommodated in the interpretation and opinion provided. When reporting using cut-off levels, reports often provide caveats on the possible effects the influence factor may have had; this is not acceptable and only serves to provide more confusion. As highlighted by one of the experts in *Re H (A Child: Hair Strand Testing)* who summarised why the 5 experts in this case could not agree on whether the results represented drug use or not:

‘there are variables in relation to hair colour, race, hair condition (bleaching and straightening damages hair), pregnancy and body size. Then there are the variables inherent in the testing process.’

The influences specific to this case and their likely impact were not established in this case and therefore could not be considered. Put simply, the level of drug found in the hair cannot be looked at in isolation, out of all case-specific influencing factors, to decide on whether a client is using a drug or not, or the level of drug use.

Yet a thorough investigation to establish all influencing factors and taking a detailed account from the parent providing the hair sample is still not commonplace among most hair strand testers. Without this context and history being taken, it is not possible to provide a reliable interpretation of the test results.

For example, the application of hair dye or bleach can remove an average of around 60% of the drug from the hair sample and multiple use can remove all detectable levels. Even cases where drugs such as cocaine are used daily, following the repetitive use of permanent hair dye, the levels of cocaine and metabolites in the hair can fall below reporting cut-off levels and can be reported as negative.¹

1 C Jurado, P. Kintz, M. Menéndez, M. Repetto, ‘Influence of the cosmetic treatment of hair on drug testing’, *Int J Legal Med* (1997) 110 : 159–163.

One hair testing company in the UK² has now introduced a test for oxidative markers in hair which provides an objective assessment of the amount of hair damage in each segment of hair. The wider use of such testing, combined with more in-depth investigations, would be a big step forwards in understanding if the client's hair is representative of their drug use or not.

The use of cut off levels

Hair presents a significant challenge for hair strand testers compared to the testing of blood or urine because hair exists outside the body, and is therefore at risk of damage and environmental contamination. In an attempt to distinguish between exposure to drugs and active use of the drug, the use of cut off levels was introduced. Some limited and uncontrolled studies on unsegmented hair revealed that levels of commonly abused drugs like cocaine, heroin and cannabis would usually exceed certain thresholds when these drugs were regularly used. When levels fell below these thresholds, in some cases the results could be attributed to regular exposure to, but not active use of the drug.

These thresholds were standardised into cut off levels by the Society of Hair Strand Testing ('SoHT') and formed the basis for reporting 'negative' and 'positive' results within care proceedings. When hair testing was first introduced over 25 years ago, this provided labs with a simple standardised screening process to identify drug use. However, these standardised cut off levels were established by screening a population as a whole. This did not take into account all the individual factors and influences in each case that are now known to have a significant impact on the presence, level and profile of drugs in the hair. As we now know, on a case-by-case basis in care proceedings, this over-simplified reporting leads to the misreporting of many results, both false positive and false negative interpretations.

In *Re H (A Child: Hair Strand Testing)* Peter Jackson J (as he then was) when referencing the drug levels and application of cut-offs, provided the following guidance:

'It would be artificial to require valid data to be struck from the record because it falls below a cut-off level when it may be significant in the context of other findings.'

And goes on to explain:

'In this context all Laboratories reporting results for court proceedings have a duty to report all results, irrespective of the concentration detected and the respective industry guideline cut-off values.'

'It is at the interpretation stage where the results can be judged in the full context of the case and all associated influencing factors.'

Further guidance was presented at The International Association of Forensic Toxicologists in 2019 where Professor A Robert W Forrest presented a paper 'Hair Strand Analysis Evidence in Court' and provided the following guidance:

'Toxicologists reporting hair strand analysis results should move away from simply providing results by the application of cut-offs, to a process of assisting the Courts as experts by providing evidence-based opinions.'

The relevance of hair colour to hair strand testing

Melanin is the natural pigment that determines the colour of your hair. The more dark pigment (eumelanin) present, the darker the hair. Blonde and red hair has very little eumelanin. As a person ages, the levels of eumelanin fall progressively, leading to the hair becoming grey/white.

So, what does this have to do with hair strand testing? Numerous studies dating back from 1998³ confirmed that the amount

² www.forensic-testing.co.uk.

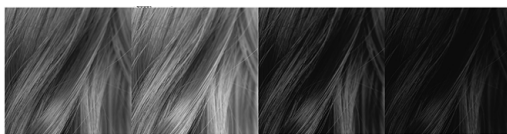
³ The incorporation of drugs into hair: relationship of hair color and melanin concentration to phencyclidine incorporation M H Slawson, D G Wilkins, D E Rollins J Anal Toxicol 1998 Oct 22.

of dark pigment (eumelanin) in hair affects its drug incorporation. Many drugs, including Cocaine and Opiates (eg Heroin) are incorporated into black hair to a greater extent than non-pigmented hair (blonde or grey). Simply put, studies show that the darker your hair, the more of the drug you have consumed will end up in your hair and is picked up in a hair strand test.

Due to the use of cut-offs to interpret hair strand testing used by most of the industry, the impact of this is significant. When consuming the same amount of drug, having black hair, means you are more likely to test positive than if you have blonde, grey, red or light brown hair. You are more likely to lose custody of your child if you are African, Afro Caribbean or Asian based on drug testing alone, than if you are blonde or red haired.

By way of illustration, a study⁴ involved controlled administration of the opiate codeine to a group with a range of hair colours. All participants received the same dose at the same frequency over the same period. Hair samples covering the period of administration were collected and tested. Results showed that those with black hair had ten times higher levels than those with blonde hair and over 15 times higher than those with ginger hair. The studies also show that Asian black hair contains higher levels of dark pigment and produces higher drug levels compared Caucasian black hair.

Codeine concentrations (pg/mg hair)



Negative	Negative	Positive	Positive
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Red	Blonde	Brown	Black
66.6	119.6	250.8	1134

The use of hair straighteners on drug testing, recent scientific developments

AEME (anhydroecgonine methylester) is a pyrolysis product formed when cocaine is heated. AEME is therefore usually found in the hair of those who use the ‘crack’ form of cocaine, which is smoked as opposed to snorted. It is used as a marker to assist in differentiating those using crack cocaine from those using powder cocaine. However, AEME is not a metabolite of crack cocaine, it is a bi-product of heating cocaine and therefore does not confirm that crack cocaine has been used. The use of crack cocaine is often taken to be more harmful and dangerous than powder cocaine in the family courts, being more addictive and having a greater impact on parenting capacity.

A 2019 study⁵ demonstrated that AEME may be produced by thermal hair straightening. It found that the presence of AEME in hair should not be used as an irrefutable proof of crack cocaine use. Instead, it might demonstrate the presence of cocaine in the hair with the use of hair straighteners. It concludes:

‘our study shows the importance of documenting thermal straightening during hair collection and that it is mandatory to consider this parameter for the interpretation of cocaine results in hair.’

Notwithstanding this clear conclusion, very few hair strand testing companies provide a detailed history of the use of hair straighteners within their reports. Heating cocaine in an oven or microwave to dry

4 The effect of hair color on the incorporation of codeine into human hair. Rollins DE, Wilkins DG, Krueger GG, Augsburg MP, Mizuno A, O’Neal C, Borges CR, Slawson MH. *J Anal Toxicol.* 2003 Nov-Dec;27(8):545–51. doi: 10.1093/jat/27.8.545.
 5 ‘AEME production in cocaine positive hair after thermal hair treatment’, *Forensic Science International* 302 2019, Sept. Nicolas Gambier, Jenny Warling, Nicolas Van Elsue, Michel Yegles.

before snorting is sometimes carried out and this can also produce AEME in the cocaine which is then inhaled.

Until this is remedied, it is essential that we as lawyers address this with our clients when a positive result for crack cocaine is suggested by hair strand testing which is denied by a client. AEME can also contaminate the hair when exposed to environments where others are smoking crack cocaine.

Similarly, the use of thermal hair straighteners were found to increase the levels of Ethyl Glucuronide, one of the markers for the testing of chronic excessive alcohol consumption, in heat treated hair by on average 20%. The variation on results again depended on hair colour.

Despite this body of research, hair testing companies do not all reliably take a history of the use of hair straighteners when collecting the sample.

Growth rate

In addition to standardised cut off levels, standardised approximate growth rates of 1cm per month is adopted by hair strand testing companies. Hair growth varies between ethnicities with Asian hair growing the fastest (about 1.4 cms a month) followed by Caucasian hair (at around 1.2 cms a month) followed by African hair which has the slowest growth rate of approximately 0.9 cms a month. A segmented section of hair representing three monthly sections should therefore be treated with some caution as the period tested may be a longer or shorter period depending on ethnicity. This will be particularly important when considering when a person may have achieved abstinence, or when a person claims to have last used drugs. Afro-Caribbean hair also has a slightly increased proportion of the hair in the telogen or resting phase compared to other groups.

In addition, in the recent case a forensic toxicology expert was unable to answer, and was unaware of any studies that could

answer, whether if hair grows at half the normal rate, would a 1cm sample show a greater concentration because it is testing 2 months' worth of consumption of drugs, but analysing it on the basis that it was only one months' worth? Such dark corners still remain within this scientific field.

What might this all mean for a client in care proceedings? An Afro Caribbean woman who has recreationally used cocaine some months ago and regularly uses hair straighteners may produce a positive result for use of crack cocaine, whereas a Caucasian woman who bleaches her hair and does use crack cocaine may produce a negative result for drugs.

Conclusions, what should we do?

What do we do as lawyers, not scientists, to help our clients who might challenge the results of hair strand testing? While the limitations of the current practice of hair strand testing remain, practitioners should be aware of those limitations and ensure they are brought to the attention of the tribunal hearing deciding the case. It is our responsibility to remind every tribunal of the words of Hayden J.

If a result is challenged, part 25 questions should be raised of hair strand testing companies.

- Does the reporting of test results fully comply with latest guidance from:
 - High Court?
 - The International Association of Forensic Toxicology?
- Is the hair sample representative of client's pattern of drug / alcohol use?
- Are opinions provided evidence-based as opposed to use of Cut-Offs?
- Do the opinions achieve Balance of Probabilities in every case?
- Does the report address the questions presented in each case?
- Were you aware of the use of xx product, what impact might that have on the results?
- Were you aware of the use of thermal

hair straighteners, what impact might that have on the results?

Nail testing has proved to be a useful and reliable tool for determining the long-term use and abuse of drugs producing precise and accurate results.⁶ Studies supporting the use of nails for drug detection reach back to 1984.⁷

Nail testing cannot currently provide sectional analysis but does not encounter the same difficulties as hair strand testing with growth rates, hair colour or use of products or straighteners. Nail analysis can complement hair analysis and provide additional information, crucial in many cases for a correct interpretation of the results. Studies show that most drugs of

abuse and pharmaceuticals are detected in nails. If there is a significant dispute, the hair is compromised or there's no hair available, then nail testing should be sought. For laboratories with extensive experience and case data from nail testing this additional evidence has been shown to assist the expert in forming more reliable opinions.

As practitioners we should be careful about relying on 'the science' unquestioningly without challenge. The results of hair strand testing can often make the difference between whether a child is rehabilitated to a parent or potentially placed for adoption. It is incumbent on us all to ensure we are up to date on developments and mount challenges where appropriate.

⁶ 'Nail analysis for the detection of drugs of abuse and pharmaceuticals: a review', Delphine Cappelle, Michel Yegles, Hugo Neels, Alexander L. N. van Nuijs, Mireille De Doncker, Kristof Maudens, Adrian Covaci Cleo L. Crunelle

⁷ 'Simultaneous Detection and Quantitation of Morphine, 6-Acetylmorphine, and Cocaine in Toenails: Comparison with Hair Analysis', Mariano Cingolani, Sabrina Scavella, Roberto Mencarelli, Dora Mirtella, Rino Froldi, and Daniele Rodriguez Institute of Legal Medicine, University of Ancona, Ospedale Regionale, I-60020, Italy and Institute of Legal Medicine, University of Macerata, Via Don Minzoni 9, I-62000, Italy