Hair – A valuable resource in post-mortem toxicology

INTRODUCTION

• Analysis of hair in post-mortem toxicology provides a retrospective record of an individual’s drug history prior to death. This can provide important information to the pathologist, coroner and the family of the deceased in understanding both the cause and circumstances surrounding the death.

• Drugs present in the bloodstream circulate the hair follicle and become incorporated in the hair matrix during growth. Once incorporated the drug becomes fixed in the hair and remains fixed as the hair grows.

• Head hair is the recommended sample for analysis and a mean growth rate of 1 cm per month is used for interpretation. Hair from other sites of the body can be used, but these will have different rates of growth.

• Segmental analysis can provide information on patterns of use.

• Drugs were extracted from the hair samples using 0.1 M HCl followed by solid phase extraction clean-up. The extracts were submitted to dual derivatization using MSTFA and MSTFA and analysed by GC-MS in both SIM and scan modes.

• A major concern for interpretation of results is the risk of external contamination.

CONTAMINATION

There are two types of external contamination -

Passive incorporation from active use

• Hair is a very porous material and adsorption of drugs can occur from urine, sweat and sebum. Parent drug and metabolites will be detected in hair, but concentrations may be elevated.

• Environmental contamination

• External contaminants e.g. smoke and powders can also be absorbed into the hair matrix. These elevate the parent drug concentration in the hair; however no metabolite would be present.

• All hair segments are subjected to shampoo and solvent washes to remove surface contamination. The solvent washes are analysed to determine the presence of significant external contamination. This may contribute to the hair-drug concentration and needs to be considered during interpretation.

• The following figures demonstrate examples of results from solvent washes from a heroin user (Fig 1) and an i.v. heroin user (Fig 2).

Case 1 – Habitual drug user

• 43 year old female

• Previous history of drug and alcohol dependency and depression. Deceased had allegedly taken heroin that morning and later collapsed at home.

• 3 sections of head hair - 3 cm (3 months)

N.B. S1 = hair growth closest to the scalp; most recent growth

This case demonstrates the typical hair results obtained for a habitual drug user. Cocaine ingestion was confirmed by the presence of cocaine metabolites: BE, EME and cocaethylene, and heroin use by the presence of 6-MAM and morphine. Cocaine (from snorting/cocaine) is a common contaminant of heroin and papaverine is a constituent of street heroin. The deceased had also taken methadone during this 9 month period.

The concentration of morphine found in the hair is consistent with the ingestion of a lethal dose, depending on the tolerance of the individual. In this case the hair results indicate this individual was a habitual user, although their use was decreasing, and demonstrates a degree of tolerance.

Case 2 – Confirmation of drug history

• 27 year old female

• Deceased had a previous history of depression and had reportedly taken recreational drugs in the past. She was found suspended from her bedroom door.

• 3 sections of head hair - 3 cm (9 months)

In the case the hair, blood and stomach contents all provided evidence that this individual was taking clonazepam regularly as treatment for depression. The hair results however, confirmed that the deceased had also been a regular low level cocaine user during the 8 month period.

Long term cocaine use has been linked with adverse psychological effects of overt depression, dysphoria and paranoia and has been associated with suicidal intent. The hair results suggest that although the deceased had been taking her antidepressant medication, her depression may have been exacerbated by her cocaine use.

The use of recreational drugs was suggested in the case history, but the potential link between cocaine abuse with suicide would not have been considered had the hair not been analysed.

Case 3 – Limited sample A: Loss of tolerance

• 44 year old male

• Deceased was a known heroin addict. He had been released from prison and was found the following day collapsed at home. He had apparently obtained some heroin and a recent needle mark was found on his arm. A bottle of methadone along with drug paraphernalia were found.

• 1 section of head hair - 2 cm (2 months)

• Limited sample of hair (3mg)

For our hair method comprehensive drug screening requires 50 mg of hair.

In this case the blood and urine results confirm that the deceased had taken street heroin along with cocaine, amphetamine, methamphetamine and ethanol at the time of death.

As the deceased was a known heroin addict a blood morphine concentration of 0.06 ug/mL may not have been considered significantly high due to possible tolerance. The hair results confirmed the use of cocaine in the 2 months prior to death, but no other drugs were detected. The absence of heroin constituents in the hair indicate abstinence in this time period. As the deceased had recently been in prison his drug habits were likely to have altered.

Case 4 – Limited sample B: Proof of previous use

• 33 year old male

• Known heroin smoker, found collapsed.

• 1 section of head hair - 3.5 cm (3.5 months)

• Limited sample of hair (3mg)

In this case the specimen was from a known heroin user and was submitted as a hair sample. The hair had a lower concentration of 0.10 ug/mL and was suggestive of cocaine, heroin and morphine being found in the hair.

In summary:

1. Hair analysis is a valuable resource in toxicology.
2. It is important to determine the quality of the sample.
3. Interpretation of results includes consideration of sampling parameters.
4. The relationship between hair and blood results should be considered.
5. The integration of toxicology results with other evidence is crucial for a comprehensive understanding of the case.

References:


Figures:

1. Significant environmental contamination

2. Drug free solvent washes

3.Hair (ng/mg) Blood (ng/mL) Urine (ng/mL)

4. Cocaine: ND

5. Morphine: ND

6. EME: ND

7. Methadone: ND

8. Papaverine: ND

9. Ethanol: ND

This table provides a summary of the drug levels found in the hair, blood, and urine samples of the deceased. All drugs detected were above the limit of detection (LOD) and are presented in ng/mg for hair and ng/mL for blood and urine.

Table 1: Drug Levels

<table>
<thead>
<tr>
<th>Drug</th>
<th>Hair (ng/mg)</th>
<th>Blood (ng/mL)</th>
<th>Urine (ng/mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cocaine</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>Morphine</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>EME</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>Methadone</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>Papaverine</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>Ethanol</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
</tr>
</tbody>
</table>

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