

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.
- The aim of this poster is to demonstrate examples of actual post mortem cases where analysis of hair provided valuable information which was not made available from analysis of routine samples such as blood, urine and other specimens.
- 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 derivitisation using MBTFA 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 metabolite will be detected in hair, but concentrations may be elevated.

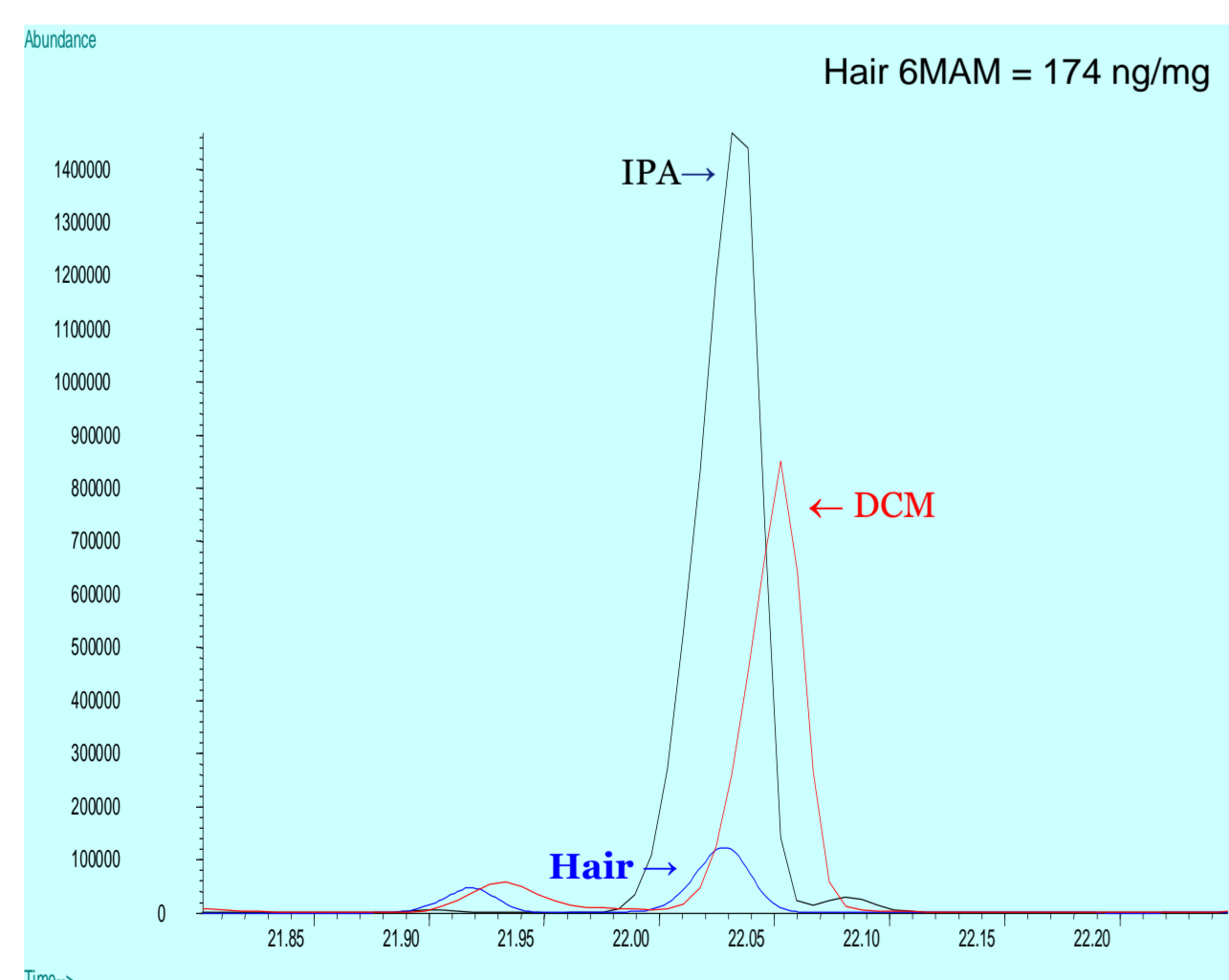
Environmental contamination

- 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 have contributed 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 smoker (fig.1) and an i.v. heroin user (fig.2).

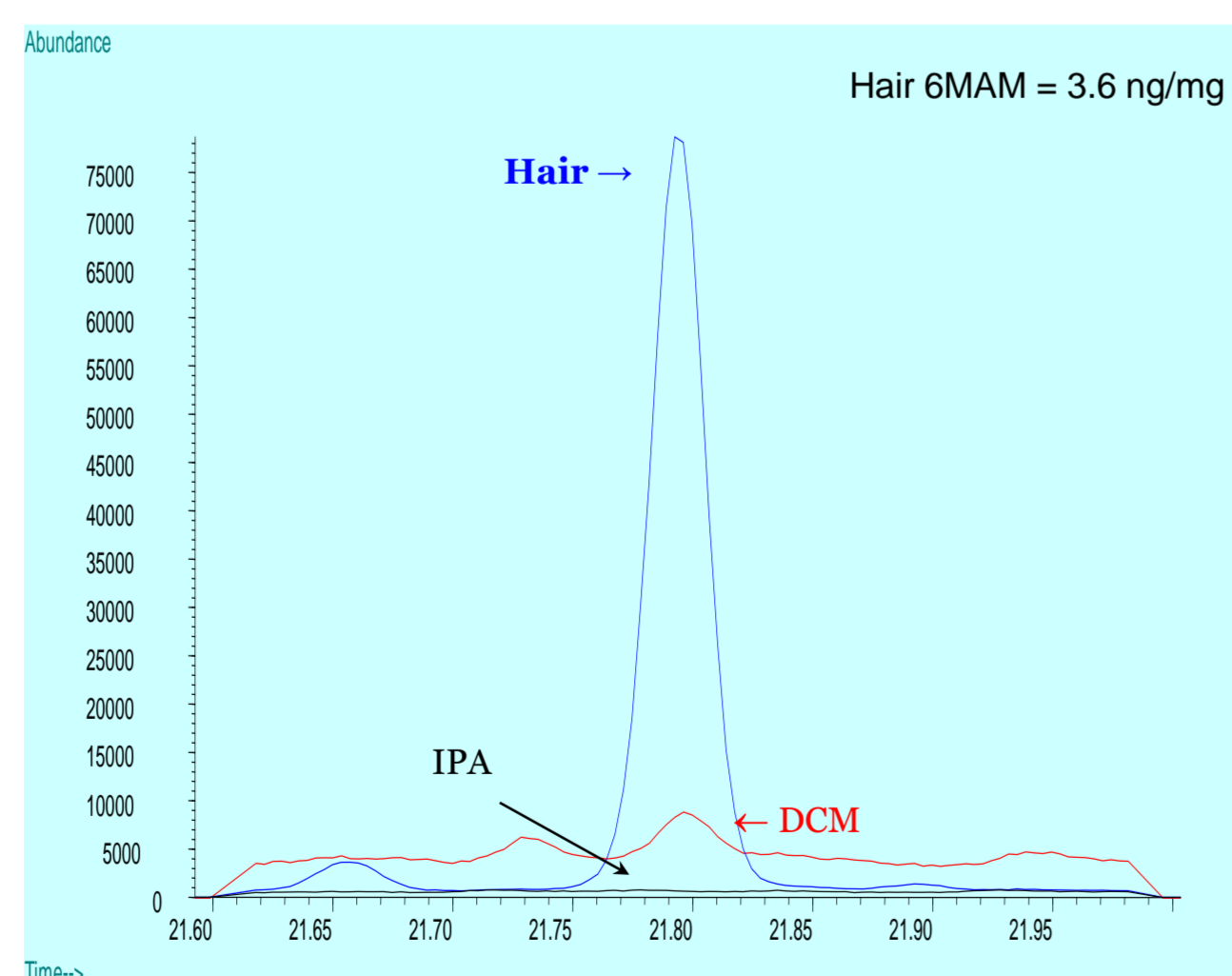
6MAM in washes and extract

Fig. 1 Significant environmental contamination



Heroin smoker

Fig. 2 Drug free solvent washes



I.V. heroin user

(DCM = dichloromethane, IPA = iso-propyl alcohol)

References

R. Cordero, S. Paterson. Simultaneous quantification of opiates, amphetamines, cocaine and metabolites and diazepam and metabolite in a single hair sample using GC-MS. Journal of Chromatography B. 850: 423-431 (2007)

Society of Hair testing. Recommendations for hair testing in forensic cases. Forensic Sci Int 145:83-84 (2004)

S. Paterson, R. Cordero, E. Stearns. Chronic drug use by hair analysis: it's role in understanding both the medical cause of death and the circumstances surrounding the death. In submission.

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 (9 months)

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

	Blood (ug/mL)	Hair (ng/mg)		
		S1	S2	S3
Cocaine	ND	18.4	39.4	48.6
BE	ND	2.6	6.0	8.8
EME	ND	0.2	0.3	0.3
Cocaethylene	ND	1.0	0.9	0.9
Morphine	0.35	9.2	14.0	14.9
6-MAM	ND	18.8	29.3	34.5
Codeine	ND	1.5	2.1	2.3
Methadone	ND	Pos	Pos	Pos
Papaverine	ND	Pos	ND	ND
Ethanol	35 mg/100mL			

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. Codeine (from acetyl-codeine) 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 blood is consistent with the ingestion of a fatal 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 drug 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)

	Blood (ug/mL)	Stomach	Hair (ng/mg)		
			S1	S2	S3
Cocaine	ND	ND	1.2	0.6	0.5
BE	ND	ND	0.2	0.3	0.2
EME	ND	ND	ND	ND	ND
Cocaethylene	ND	ND	0.2	0.1	ND
Citalopram	High Therapeutic	Pos	Pos	Pos	Pos
Ethanol	15 mg/100mL				

In this case the hair, blood and stomach contents all provided evidence that this individual was taking citalopram regularly as treatment for depression. The hair results however, confirmed that the deceased had also been a regular, low level cocaine user during this 9 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 (13mg)

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

	Blood (ug/mL)	Urine	Hair (ng/mg)
Cocaine	ND	Pos	1.9
BE	ND	Pos	0.6
EME	ND	Pos	0.8
Cocaethylene	ND	ND	ND
Morphine	0.08	Pos	ND
6-MAM	ND	Pos	ND
Codeine	ND	Pos	ND
Amphetamine	ND	Pos	ND
Methamphetamine	ND	Pos	ND
Methadone	ND	ND	ND
Ethanol	264 mg/100mL	202 mg/100mL	

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 0.08 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 (13mg)

	Blood (ug/mL)	Urine	Stomach	Hair (ng/mg)
Cocaine	ND	ND	ND	56.5
BE	ND	Pos	ND	0.5
EME	ND	Pos	ND	ND
Cocaethylene	ND	ND	ND	ND
Morphine	0.10	Pos	ND	2.0
6-MAM	ND	ND	ND	2.0
Codeine	ND	ND	ND	0.2
Methadone	0.07	Pos	ND	ND
Dothiepin	ND	ND	Pos	ND
Ethanol	< 10 mg/100mL	< 10 mg/100mL		

The deceased was a known heroin user with a blood morphine concentration of 0.10 ug/mL and with evidence of cocaine, methadone and dothiepin use at the time of death. Hair analysis confirmed the use of cocaine and heroin in the 3.5 months prior to death.

In this case although the sample was limited, significant concentrations of cocaine, heroin and their metabolites were found in the hair. As the blood morphine was similar to that found in case 3 this suggests that if the individual described in case 3 was a habitual user then heroin constituents would have been detected in the hair. A hair sample smaller than 50 mg may be viable, but results have to be interpreted with extra caution.