

Hair Proficiency Testing

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***Drug Testing Advisory Board
Open Session***

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Objectives

- Design and Results of SAMHSA's Hair Pilot Proficiency Testing (PT) Program, 2000 to 2007
- Design and Results of Society of Hair Testing (SoHT) Hair Proficiency Testing Program, 1995-present
- Design of Other Hair Proficiency Testing Programs

Background

SAMHSA's Pilot Hair PT Program

- April 1997, DTAB meeting discussed drug testing in alternate matrices
- Duration: 2000-2007
- Up to 13 laboratories participated
- 23 cycles of samples tested
 - Cycles 1-8: Method Optimization
 - Cycles 9-11: Same samples over 6 months
 - Cycles 12-23: Inter- and intra-lab variability

Background

SAMHSA's Pilot Hair PT Program

- Important finding was a large variation in reported results
- 2006-2007 PT samples evaluated laboratory variability and sample stability

Design of Pilot PT Program 2007

- 6 or 7 participant laboratories
- Laboratories investigated accuracy and precision
- Single PT production
 - Decontaminated hair samples in PT production
 - Authentic hair fortified with drug analytes or known drug users
 - Stored ambient temperature prior to shipments

Design of Pilot PT Program (Continued)

- Three sample sets sent to each lab over 1 year
(0, 3, 6, 12 months)
- Concentrations were 1.5 to 3 times the 2004 proposed confirmatory test cutoffs
- Laboratories quantitated each analyte 5 times in multiple batches

Design of Pilot PT Program (Continued)

- Set 1 (pg/mg):
 - THCA (0.82)*
 - THCA (0.15)
 - AMP/MAMP/MDA/MDEA/MDMA (900)
 - AMP/MAMP/MDA/MDEA/MDMA (450)
- Set 2 (pg/mg):
 - COC (5770)/BE (2547)/CE(54)/ NCOC (85)*
 - COC (750)/NCOC (75)/CE (75)
 - COC (1500)
 - BE (75)
- ***Drug User Hair**

Design of Pilot PT Program (Continued)

- Set 3 (pg/mg):
 - 6-AM (1411)/MOR (630)/COD (183)*
 - 6-AM/MOR/COD (600)
 - 6-AM/MOR/COD (300)
 - PCP (450)
- No decontamination
- Confirmatory testing only
- ***Drug User Hair**

NLCP Pilot Hair PT — Methods

- Deuterated internal standards
- Not all analytes reported by all labs
- Powdering vs. Strands
- Pre-Treatment Techniques
 - None/DI H₂O/Solvent (MeOH/MeCl₂/Acetone)
- Digestion Techniques
 - None/Acidic/Basic/Enzymatic
- Extraction Techniques
 - L/L and SPE

NLCP Pilot Hair PT — Confirmatory Testing

- Confirmatory Testing
- Quantitation and identification by a confirmatory mass spectrometry method
- PT result reports with group statistics sent to each lab for self-assessment

Laboratory Pilot Hair PT Results:2007

(pg/mg)	AMP (450)	MAMP (450)	MDA (450)	MDMA (450)	MDEA (450)	THCA (0.15)
0 months (Cycle 1)	397	411	421	316	278	0.17
3 months (Cycle 2)	463	493	460	397	432	0.16
6 months (Cycle 3)	436	469	467	399	398	0.15
12 months (Cycle 4)	449	481	455	408	412	0.13
Mean \pm SD	436 \pm 29	464 \pm 36	451 \pm 20	380 \pm 43	380 \pm 69	0.15 \pm 0.02

2007 Pilot Hair PT Results: AMPS

Lab	Cycle 12	Cycle 15	Cycle 18	Cycle 21
E	564	950	1023	866
G	926	885	939	836
L	597	612	781	946
M	1084	1148	1134	1054
Q	1097	529	1081	970

2007 Pilot Hair PT Results: COC

Lab	Cycle 13	Cycle 16	Cycle 19	Cycle 22
E	632	608.4	667.4	735.4
G	634	603	639	582.6
L	527.2	591.6	531.8	479.8
M	720.4	682.8	693.2	599.6

2007 Pilot Hair PT Results: THCA

Lab	Cycle 12	Cycle 15	Cycle 18	Cycle 21
G	0.13	0.11	0.11	0.09
M	0.17	0.26	0.18	0.15
Q	0.21	0.12	0.17	0.16

System Variance Over 1 Year by Cycle

Cycle	AMP 900	AMP 450	MAMP 900	MAMP 450	MDA 900	MDA 450	MDMA 900	MDMA 450	MDEA 900	MDEA 450	THCA 0.82	THCA 0.15
0 months (Cycle 1)	31.3	38.9	30.8	40.1	31.4	42.2	33.0	39.3	35.7	36.2	28.0	28.2
3 months (Cycle 2)	29.3	21.9	29.1	22.6	28.3	21.7	31.8	24.0	24.1	18.8	29.8	45.5
6 months (Cycle 3)	13.6	20.3	15.6	22.0	15.8	18.2	16.3	19.7	16.7	22.1	33.0	24.2
12 months (Cycle 4)	11.5	11.6	11.0	13.7	12.7	11.6	13.9	15.0	7.7	14.2	21.7	24.6
Urine (2004-2005)*	7.4	7.4	8.5	8.5	4.6	4.6	7.1	7.1	7.6	7.6	10.3	10.3

System Variance Over 1 Year by Cycle

PT Program	6AM	COD	MOR	PCP	THC / THCA	AMP	MAMP	BE
Urine NLCP Maintenance PTs (2006)	8.3	7.4	7.7	7.7	10.7	7.7	7.4	6.4
Hair Pilot PTs (2006-2007)	14.5	23.1	29.7	20.1	32.2	28.1	29.3	29
Oral Fluid Pilot PTs (2006-2007)	11.1	7.9	15.8	11.8	23.9	13.3	11.4	14.4

Summary 2006 Pilot PT Program

- Stable material for all drugs over 1 year
- Results for the system of participating hair-testing laboratories are not currently consistent
- For some analytes, there was increased variability in results after 1 year, illustrative of the laboratory challenge of maintaining performance
- Material performed well for all analytical methods

***SOCIETY OF HAIR TESTING HAIR
PROFICIENCY PROGRAM***

Background

Society of Hair Testing (SoHT)

- “...*development of proficiency tests (PTs), so that all laboratories which perform hair analysis can produce comparable results, or at least detect the same compounds*” (Forens Sci Intl, 2003)
- Voluntary Program
- PT Rounds
 - 18-36 participating laboratories
 - 1995, 1997, 2001, 2007-2012 (2)
 - 2008, 2009, 2010 (EtG Special PT)
 - Qualitative and Quantitative results

Design of SoHT PT Program - 2001

- Goals
 - Accuracy of Detection and Quantification
 - Performance of Extraction Methods
- 15 Participating Labs & 3 Reference Labs
- Samples
 - Short Hair Segments
 - Drug User Hair- COC, BE, MDMA, MDEA, THC
 - Drug User Hair- COC, BE, 6AM, MOR, COD, DHC
 - Drug Free Hair

Results for SoHT Hair PT Program - 2001

- Not all analytes reported by all labs
 - Amphetamines - 8
 - Cannabis - 9
- Qualitative results
 - False Negatives - 1 (BE, 6AM, MOR), 3 (COD)
 - False Positive - 1 (COD, 6AM)
- Quantitative results
 - Mean inter-laboratory %CVs — 41.7% to 71% except THC (93.1%)
 - Extraction procedures — source of variation

Design of SoHT PT Program - 2011

- Goals
 - Accuracy of Detection and Quantification
- 36 Participating Labs & 3 Reference Labs
- Samples
 - Short Hair Segments
 - Drug User Hair- COC, BE, 6AM, MOR, COD, THC
 - Drug User Hair- COC, BE, MAMP, THC
 - Drug Free Hair

Results for SoHT Hair PT Program - 2011

- Z-score ($Z\text{-score} = (x - \chi) / IQR$)
 - Satisfactory (>2.0)
 - Questionable ($2 < Z\text{-score} \leq 3$)
 - Unsatisfactory (≥ 3.0)
- Quantitative results - Sample 1
 - 6-AM: 2 Not analyzed; 1 questionable
 - MOR: 1 Not analyzed; 1 questionable
 - COD: 13 Not analyzed or Neg; 1 unsatisfactory
 - THC: 10 Not analyzed or Neg; 1 unsatisfactory

Results for SoHT Hair PT Program - 2011

- Quantitative results -
 - COC: 1 Not analyzed; 2 questionable
 - BE: 4 Not analyzed
 - MAMP: 7 Not analyzed or Neg; 1 questionable
- Mean inter-laboratory %CVs — 34% to 55%
except COD (306%)

Comparison of Hair PT Programs

- Worldwide 5 Hair PT Programs
- Professional and governmental programs
- Hair PT Programs
 - GTFCh - German Society of Toxicological and Forensic Chemistry (late 1990s to Present)
 - HAIRVEQ - Germany and Spain (2004, 2006)
 - NLCP - National Laboratory Certification Program (2000-2007)
 - SFTA - French Society of Analytical Toxicology (1992-1999)
 - SoHT - Society of Hair Testing (1995 to Present)

Comparison of Hair PT Programs

Hair PT Program	Hair Type	PT Type	Analytes	Conc.	Washing	Preparation
GTFCH	Authentic	Spiked; Drug User	All but PCP; +THC (addition of further analytes possible)	≥ SAMHSA PCP: NR	Not Reported Also powdered	Lab Choice
HAIRVEQ	Authentic	Drug User	opiates, cocaine, MDMA, and methadone	≥ SAMHSA PCP: NR	Not Reported Also powdered	Lab Choice; Standardized
SFTA	Authentic	Drug User	All but PCP; +CBD	≥ SAMHSA PCP: NR	Step in PT Production	Standardized
SoHT	Authentic	Drug User	All but PCP; +THC	≥ SAMHSA PCP: NR	Not Reported	Lab Choice
NLCP	Authentic	Spiked; Drug User	AMP/MAMP MDA/MDMA/MDEA COC/BE COD/MOR/6AM THCA PCP	AMP: 200 COC: 500 OPI: 200 THCA: 0.05 PCP: 300	Step in PT Production	Lab Choice

Conclusions

- Performance Testing is a necessary quality control measure
- Results for the systems of participating hair-testing laboratories are not currently consistent
- Inter-laboratory and Intra-laboratory results remain higher than other hair testing matrices
- PT materials in authentic hair samples are stable
- Laboratory preparation and analytical treatment of hair contribute to the variability of PT results

References

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