



**510(k) SUBSTANTIAL EQUIVALENCE DETERMINATION
DECISION SUMMARY
ASSAY ONLY**

I Background Information:

A 510(k) Number

K201228

B Applicant

Psychemedics Corporation

C Proprietary and Established Names

Psychemedics Homogeneous Enzyme Immunoassay for Cocaine in Hair

D Regulatory Information

Product Code(s)	Classification	Regulation Section	Panel
JXO	Class II	21 CFR 862.3250 - Cocaine and Cocaine Metabolite Test System	TX - Clinical Toxicology

II Submission/Device Overview:

A Purpose for Submission:

New Device

B Measurand:

Cocaine

C Type of Test:

Qualitative homogeneous enzyme immunoassay (HEIA)

III Intended Use/Indications for Use:

A Intended Use(s):

See Indications for Use below.

B Indication(s) for Use:

The Psychomedics homogeneous enzyme immunoassay for cocaine in hair is an enzyme immunoassay for the preliminary qualitative detection of cocaine in human head and body hair using a cocaine calibrator of 5 ng/10 mg hair for the purpose of identifying cocaine use. This product is intended exclusively for in-house professional use and not for sale to anyone.

The Psychomedics EIA Cocaine Assay provides only a preliminary analytical test result. To confirm positive results, a more specific alternate chemical method (e.g. LC/MS/MS) must be used. Clinical consideration and professional judgement should be applied to the interpretation of any drug-of-abuse test result.

C Special Conditions for Use Statement(s):

OTC - Over The Counter

D Special Instrument Requirements:

The Psychomedics HEIA For Cocaine in Hair assay requires an Automated Clinical Chemistry Analyzer at 340 nm. The Olympus AU 640 analyzer was used for validation of the candidate assay.

The confirmation assay uses an AB Sciex 3200 LC/MS/MS linked to two LC-20AD Prominence Liquid Chromatograph Pump and a LEAP PAL HTC-xt autosampler or a AB Sciex 6500 LC/MS/MS linked to two Shimadzu LC-30AD pumps and a LEAP PAL-HTC-xt autosampler with a DLW wash system.

IV Device/System Characteristics:

A Device Description:

The Psychomedics homogeneous enzyme immunoassay (HEIA) test for cocaine in hair consists of two parts; a pre-analytical hair treatment procedure (to extract cocaine from the solid hair matrix to a measurable liquid matrix) and the screening assay, the Psychomedics Cocaine HEIA.

Performance of the HEIA requires a sample extract solution and cocaine-glucose-6-phosphate dehydrogenase (G6PDH) conjugate. The Psychomedics Cocaine HEIA consists of reagents R1 (anti-cocaine monoclonal antibody with substrate) and R2 (cocaine labeled recombinant G6PDH).

The confirmation assay consists of an AB Sciex 3200 LC/MS/MS linked to two LC-20AD Prominence Liquid Chromatograph Pump and a LEAP PAL HTC-xt autosampler or a AB Sciex 6500 LC/MS/MS linked to two Shimadzu LC-30AD pumps and a LEAP PAL-HTC-xt autosampler with a DLW wash system.

B Principle of Operation:

Hair sample extracts are combined with antibody and glucose-6-phosphate dehydrogenase (G6PDH)-cocaine immunoconjugate in a cuvette in a clinical chemistry analyzer. The assay is

based on competition between the cocaine-labeled G6PDH and free drug from the extracted hair sample for a fixed amount of specific antibody binding sites. In the absence of free drug from the samples, the specific antibody binds the cocaine-G6PDH and causes a decrease in enzyme activity. This phenomenon creates a direct relationship between the drug concentration in hair and enzyme activity. The enzyme activity is determined spectrophotometrically at 340 nm by measuring the conversion of nicotinamide adenine dinucleotide (NAD) to NADH.

For samples that are presumptive positive by the screening assay, a new aliquot of the hair sample is weighed, washed extensively to remove externally derived cocaine, extracted by a different procedure and confirmed by LC/MS/MS for the presence of cocaine.

V Substantial Equivalence Information:

A Predicate Device Name(s):

Psychemedics Cocaine EIA

B Predicate 510(k) Number(s):

K111925

C Comparison with Predicate(s):

Device & Predicate Device(s):	<u>K201228</u>	<u>K111925</u>
Device Trade Name	Psychemedics Homogeneous Enzyme Immunoassay for Cocaine in Hair	Psychemedics Cocaine Assay
General Device Characteristic Similarities		
Intended Use/Indications For Use	Same	For the detection of Cocaine in human hair. The assay provides only a preliminary analytical test result. A more specific alternative chemical method must be used in order to obtain a confirmed analytical result.
Product Code	Same	JXO
Measurand	Same	Cocaine
Confirmation Method	Same	LC/MS/MS
Sample Matrix	Same	Human Hair
Cutoff	Same	5 ng/10 mg hair
General Device Characteristic Differences		
Method of Measurement	Automated Clinical Chemistry Analyzer at 340 nm	Microplate reader, read at 450 nm

Device & Predicate Device(s):	<u>K201228</u>	<u>K111925</u>
Type of Test	Homogeneous Enzyme Immunoassay	Microplate Enzyme Immunoassay
Extraction Method	Acidic aqueous buffer	Patented Digestion Method

VI Standards/Guidance Documents Referenced:

None referenced.

VII Performance Characteristics (if/when applicable):

A Analytical Performance:

1. Precision/Reproducibility:

Precision of the Psychomedics HEIA for Cocaine in Hair assay

Precision studies were performed by spiking negative hair before digestion to achieve concentrations of negative, the cutoff concentration of 5 ng cocaine/10 mg hair, and +/- 75%, +/-50% and +/-25% of the cutoff concentration.

Intra-Assay Precision - Four samples at each concentration were tested in replicates of 2 on a single day. Results are summarized in the table below.

Inter-Assay Precision – Testing was performed for 10 days, with 2 runs per day in replicates of 4. Results are summarized in the table below.

Summary Intra-Assay Precision		
Level	NEG	POS
-100%	8	0
-75%	8	0
-50%	8	0
-25%	8	0
+25%	0	8
+50	0	8
+75%	0	8
+100%	0	8

Summary Inter-Assay Precision		
Level	NEG	POS
-100%	80	0
-75%	80	0
-50%	80	0
-25%	80	0
+25%	0	80
+50	0	80
+75%	0	80
+100%	0	80

Precision of the LC-MS/MS method

Intra-assay precision was determined around the cutoff of 5 ng cocaine per 10 mg hair, 0.5 ng of benzoylecgonine, cocaethylene and norcocaine per 10 mg of hair and 1 pg/mg of para-hydroxy cocaine, meta-hydroxy cocaine and ortho-hydroxy cocaine with 5 replicates for each concentration per drug metabolite.

Intra-assay Precision Around the Cutoff for Cocaine, Benzoylecgonine, Cocaethylene and Norcocaine.

Intra-assay Precision Around the Cutoff					
ng analyte/10 mg hair					
Cocaine	2.5	3.75	5	6.25	7.5
Average	2.588	3.884	5.305	6.748	8.172
S.D	0.086	0.056	0.212	0.200	0.217
%C.V.	3.31	1.44	3.99	2.96	2.65
95% C.I.	2.512 – 2.663	3.835 – 3.933	5.120 – 5.491	6.572 – 6.923	7.983 – 8.361
% of Target	103.5	103.6	106.1	108.0	109.0
Benzoylecgonine	0.25	0.375	0.50	0.625	0.75
Average	0.2516	0.3672	0.4962	0.6340	0.7992
S.D	0.019	0.027	0.022	0.032	0.029
%C.V.	7.40	7.25	4.34	5.06	3.66
95% C.I.	0.235-0.267	0.343-0.390	0.477-0.515	0.605-0.662	0.773-0.824
% of Target	100.6	97.9	99.2	101.4	106.6
Cocaethylene	0.25	0.375	0.50	0.625	0.75
Average	0.258	0.389	0.514	0.686	0.823
S.D	0.010	0.007	0.016	0.013	0.020
%C.V.	3.99	1.85	3.18	1.96	2.43
95% C.I.	0.249-0.267	0.382-0.395	0.500-0.528	0.674-0.698	0.805-0.840
% of Target	103.4	103.8	102.9	109.8	109.7
Norcocaine	0.25	0.375	0.50	0.625	0.75
Average	0.256	0.399	0.532	0.680	0.803
S.D.	0.007	0.018	0.019	0.019	0.021
%C.V.	2.93	4.60	3.68	2.91	2.65
95% C.I.	0.249-0.262	0.382-0.415	0.515-0.549	0.663-0.698	0.785-0.822
% of Target	102.4	106.4	106.5	108.9	107.2

Intra-assay Precision Around the Cutoff for Para-Hydroxycocaine, Meta-Hydroxycocaine and Ortho-Hydroxycocaine.

Intra-assay Precision Around the Cutoff					
ng analyte/10 mg hair					
Para-HO-Cocaine	0.5	0.75	1.0	1.25	1.5
Average	0.467	0.716	0.934	1.243	1.418
S.D	0.008	0.031	0.027	0.029	0.040
%C.V.	1.66	4.33	2.84	2.33	2.85
95% C.I.	0.460-0.474	0.689-0.743	0.911-0.957	1.218-1.268	1.383-1.453
% of Target	93.5	95.6	93.5	99.5	94.6
Meta-HO-Cocaine	0.5	0.75	1.0	1.25	1.5
Average	0.467	0.721	0.913	1.186	1.369

Intra-assay Precision Around the Cutoff					
ng analyte/10 mg hair					
S.D	0.023	0.032	0.027	0.049	0.058
%C.V.	4.97	4.39	2.90	4.12	4.22
95% C.I.	0.446-0.487	0.693-0.749	0.890-0.937	1.143-1.229	1.318-1.419
% of Target	93.4	96.2	91.4	94.9	91.3
Ortho-HO-Cocaine	0.5	0.75	1.0	1.25	1.5
Average	0.471	0.734	0.959	1.176	1.392
S.D	0.014	0.040	0.018	0.048	0.053
%C.V.	2.96	5.43	1.89	4.07	3.82
95% C.I.	0.459-0.483	0.699-0.769	0.943-0.975	1.134-1.218	1.345-1.438
% of Target	94.3	97.9	95.9	94.1	92.8

Inter-assay Precision for Cocaine, Benzoylecgonine, Cocaethylene and Norcocaine

Inter-assay precision for cocaine, benzoylecgonine, and cocaethylene, was determined using 50, 100 and 150 µL of the cocaine in hair assay 5 ng standard; inter-assay precision for norcocaine was determined using 50, 100 and 150 µL of the cocaine in hair assay 0.5 ng norcocaine standard and the cocaine in hair assay 0.01 ng hydroxy cocaine standard. Inter-assay precision was performed over 5 separate days, testing each respective sample concentration in quintuplicate with results summarized below.

Inter-assay Precision												
ng Analyte/10 mg hair												
	Cocaine			Benzoylecgonine			Cocaethylene			Norcocaine		
	2.5	5	7.5	0.25	0.5	0.75	0.25	0.5	0.75	0.25	0.5	0.75
Average	2.56	5.02	7.57	0.257	0.527	0.827	0.251	0.501	0.767	0.247	0.500	0.762
S.D.	0.1180	0.2687	0.4092	0.0216	0.0322	0.0463	0.0152	0.0244	0.0434	0.0136	0.0329	0.0501
%CV	4.61	5.35	5.41	8.42	6.11	5.60	6.04	4.88	5.65	5.50	6.57	6.58
95% Confidence Interval	2.45 - 2.66	4.78 - 5.25	7.21 - 7.92	0.238 - 0.276	0.499 - 0.555	0.786 - 0.868	0.238 - 0.264	0.480 - 0.522	0.729 - 0.805	0.235 - 0.259	0.471 - 0.529	0.718 - 0.806
% of Target	102.27	100.39	100.88	102.67	105.42	110.21	100.51	100.15	102.28	98.78	100.06	101.61

Inter-assay Precision for para-hydroxycocaine, meta-hydroxycocaine and ortho-hydroxycocaine.

Inter-assay Precision									
	para-HO-Cocaine			meta-HO-Cocaine			ortho-HO-Cocaine		
pg analyte/mg hair									
	0.5	1	1.5	0.5	1	1.5	0.5	1	1.5
Average	0.525	1.015	1.502	0.502	0.992	1.491	0.509	1.038	1.520
S.D.	0.0463	0.0739	0.0815	0.0484	0.0803	0.1118	0.0377	0.0826	0.0994
%CV	8.81	7.28	5.43	9.65	8.10	7.50	7.40	7.96	6.54
% Confidence Interval	0.489 - 0.571	0.950 - 1.080	1.431 - 1.573	0.460 - 0.544	0.922 - 1.062	1.393 - 1.589	0.476 - 0.542	0.966 - 1.110	1.433 - 1.607
% of Target	105.10	101.50	100.14	100.44	99.16	99.39	101.84	103.80	101.31

2. Linearity:

The screening immunoassay is a qualitative test only; therefore, a linearity evaluation is not applicable.

Linearity of the LC-MS/MS confirmation method

The linearity of the confirmation method was evaluated by spiking cocaine and cocaine metabolites into negative hair. The following concentrations were analyzed in replicates of 5 for each analyte: 0.0, 0.25, 0.50, 1.0, 3.0, 5.0, 50, 100 and 150 ng cocaine per 10 mg hair; 0.0, 0.25, 0.50, 1.0, 3.0, 5.0, 50 and 100 ng benzoylecgonine, cocaethylene and norcocaine per 10 mg hair; 0.0, 0.25, 0.3, 0.5, 0.75, 1.0, 10, 20, 100, 200 and 300 pg of para-, meta-, and ortho-hydroxycocaine per mg hair. over the range of 0 to 1000 pg/mg hair.

All results were within 20% of the target concentrations. Agreement of the 5 determinations at each concentration was $\leq 10\%$ CV. The regression coefficient was > 0.995 .

3. Analytical Specificity/Interference:

Specificity of the immunoassay

Immunoassay: Interference from structurally unrelated compounds

The following potentially interfering compounds were tested using the screening immunoassay on 3 negative hair samples confirmed negative for cocaine, opioids, PCP, amphetamines and marijuana. The negative hair samples were spiked with cocaine at $\pm 50\%$ of the cutoff to assess possible positive or negative interference. All potential interferents listed below were tested at a concentration of 100 ng/10 mg hair. No positive or negative interference was observed in this study.

Anhydroecgonine methyl ester, Atropine, Bupropion, Cotinine, Cannabinol, Chlorpheniramine maleate, O-Desmethylvenlafaxine, Desipramine, Doxylaminesuccinate, 1S, 2R (+)-Ephedrine, Naproxen, Nicotine, Nortriptyline, H-Propoxyphene, R,R (-)Pseudoephedrine, Thioridazine, cis-Tramadol, Venlafaxine, ($\pm$)-11-nor-9-Carboxy- Δ^9 -THC,

Pentazocine, Amoxicillin, Propanolol, Promethazine, Phenmetrazine, Phendimetrazine, Benzocaine, Ecgonine, Dextromethorphan, Amitriptyline, R-(-)Phenylephrine, Glutethimide, Meprobamate, Lidocaine, Carbamazepine, Diazepam, Nordiazepam, AM-2201, JWH-019, JWH-081, JWH-122, Acetaminophen, Caffeine, Dyphylline, Methaqualone, Theophylline, CP47.497, CP47.497 C8 Homologue, HU-211, JWH-200, JWH-250, Ibuprofen, Naproxen, R,R-(-)-Pseudoephedrine, Ethosuximide, (±) Epinephrine, Norepinephrine, Barbitol, Metanephine, Normetanephine, Methocarbamol, Alprazolam, Cimetidine, Citalopram, Clopidogrel, bisulfate, Fluconazole, Hydrochlorothiazide, Lamotrigine, L-Thyroxine, Methyl Phenidate, Omeprazole, Amlodipine Besylate, Atorvastatin, Azithromycin, Bupivacaine, Certrizine, Dimenhydrinate, Lisinopril, Methsuximide, Phensuximide, N-Normethyl Suximide, Butabarbital, Amobarbital, Secobarbital, Hexobarbital, Phenobarbital, Mephytoin, Ethotoin, Mephobarbital, PEMA, 10,11-Dihydro-carbamazepine, Medazepam, Chlorpramazine, Flurazepam, Lorazepam, Temazepam, Bromazepam, Primodone, 5,5-Diphenyl Hydantoin, Triamterene, Nordoxepin, Oxazepam, Levitriacetam, Metformin, Phenytoin, R-Phenylephrine, Sertraline, Topiramate, Zolpidem Tartrate, Vanilmandelic acid, 5-Hydroxy Indole 3-Acetic acid

Immunoassay: Cross-reactivity with structurally related compounds

Hair samples (8 mg each) were spiked with the compounds listed in the tables below. Compounds that are potentially unlikely to cross-react were tested in duplicate at concentrations of 100 ng/10 mg hair. Potentially cross-reacting compounds were tested individually in duplicate up to concentrations of 1000 ng/10 mg hair. The samples were then extracted and analyzed by the assay device, followed by comparison to results from the cutoff calibrator. For structurally related compounds that were expected to show cross-reactivity, additional concentrations were tested to determine the concentration that is equivalent to the cutoff shown in the 1st table below. Compounds that did not show cross-reactivity are shown in the 2nd table below.

Cross Reactivities of Structurally Related Compounds		
Compound	% Cross Reactivity	Concentration Equivalent to 5.0 ng Cocaine/10 mg Hair
Benzoyllecgonine	2.0	250
Norcocaine	20	25
Cocaethylene	55.5	9
Ecgonine	<1	>500
Ecgonine Methyl Ester	<1	>500
Anhydroecgonine Methyl Ester	<1	>500

Compounds That were not found to Cross React in the Cocaine HEIA (1000 ng/10 mg hair)				
Lisinopril Dihydrate	Atropine	Bupropion	Cotinine	Cannabinol
Chlorpheniramine maleate	O-Desmethylenlafaxine	Desipramine	Doxylamine succinate	1S, 2R Ephedrine
Amitriptyline	Dextromethorphan	Lidocaine	Methocarbamol	Nordoxepin
Pentazocine	Phenylephrine	Triamterene	Naproxen	Nicotine

Compounds That were not found to Cross React in the Cocaine HEIA (1000 ng/10 mg hair)				
Nortriptyline	Propoxyphene	R,R-pseudoephedrine	Thioridazine	Cis-Tramadol
Venlafaxine hydrochloride	8- (-)-11-nor-9-carboxy-delta 9 THC	11-nor-9-carboxy-delta 9 THC	Amoxicillin	Propanolol
Promethazine	Phenmetrazine	Phendimetrazine	Benzocaine	Dimenhydrinate
Metanephrin	Carbamazepine	Diazepine	Nordiazepam	Oxazepam
Acetaminophen	Caffeine	Dyphylline	Methaqualone	Theophylline
Amphetamine	Phenmetrazine	Imipramine	Methamphetamine	Phencyclidine
Phenylpropanolamine	Amitriptyline	Dextromethorphan	Lidocaine	Methocarbamol
Nordoxepin	Pentazocine	Phenylephrine	Triamterene	Ethosuximide
Alpha-methyl-alpha-propylsuccinimide	Metharbital	Barbital	Methsuximide	Phensuximide
N-Normethsuximide	Mephyton	Ethotoin	Mephobarbital	PEMA
Phenobarbital	Methyl PEMA	10, 11-Dihydrocarbamazepine	Primidone	5,5-Diphenylhydantoin
4-Methylprimidone	Butabarbital	Amobarbital	Secobarbital	Hexobarbital
Phenobarbital	Glutethimide	Methaqualone	Diazepam	Chlorpromazine
Flurazepam	AM2201	JWH-019	JWH-081	JWH-122
CP47,497 (±)	CP47, 497 (±), C8 Homologue	HU-211	JWH-200	JWH-250
Ibuprofen	Ephinephrine (±)	Norephenephrine (±)	Metanephrine (±)	Normetanephrine (±)
Vanilmandelic acid (±)	5-Hydroxyindole-3-acetic acid	Homovanillic acid	Alprazolam	Cimetidine
Citalopram HBr	Clonazepam	Clopidogrel bisulfate	Dextromethorphan	Fluconazole
Hydrochlorothiazide	Lamotrigine	L-Thyroxine	Methylphenidate HCl	Omeprazole
Levetiracetam	Sertaline HCl	Topiramate	Zolpidem Tartrate	Zonisamide
Amlopidine Besylate	Atorvastatin Calcium Salt	Azithromycin Dihydrate	Bupivacaine HCl	Cetirizine Di-HCl

Immunoassay: Effect of cosmetic treatments

Ten cocaine-negative head hair samples were treated with perm, dye, shampoo and relaxer and the results compared to the same samples without treatments. Seven cocaine-positive head hair samples were treated with perm, dye, shampoo and relaxer and the results compared to the same samples without the treatments. All of the positive samples were previously analyzed by the confirmation procedure for cocaine. After the treatments these samples and an aliquot of the same hair samples untreated were extracted for cocaine analysis and then assayed by the HEIA cocaine assay. The EIA results with and without treatment are compared

to detect interference in the assay or loss of drug due to the treatments. In each case of the 10 negative samples treated with a type of cosmetic product, all samples remained negative before and after the treatments. In each case of the 7 cocaine positive samples treated with a type of cosmetic product, all samples remained positive before and after the treatments.

Specificity of the LC-MS/MS method

An interference study was conducted for the LC-MS/MS method by spiking potential interferents into hair specimens containing cocaine and cocaine metabolites, and the results were compared to hair specimens containing cocaine and cocaine metabolites without potential interferent. All of the samples spiked with the potential interfering compounds and cocaine (2 ng/10 mg hair) and cocaine metabolites (Benzoylecgonine, Cocaethylene, Norcocaine each at 0.2 ng/10 mg hair and Para-hydroxycocaine, Meta-hydroxycocaine, Ortho-hydroxycocaine each at 0.4pg/mg hair) produced a concentration within $\pm 20\%$ of the target value. The sponsor concluded that the potentially interfering compounds listed below did not cross-react or cause interference with the LC-MS/MS assay.

Interferents tested at 20 ng/10mg hair: Clonazepam, Estazolam, Flurazepam, Flunitrazepam, Midazolam, Nitrazepam, Prazepam, Triazolam, Zolpidem, Phentermine, R,R-(-)-Pseudoephedrine; **Interferents tested at 50 ng/10 mg hair:** Ibuprofen, Meprobamate, Naproxen, (+)-Propoxyphene; **Interferents at 200 ng/10 mg hair:** Morphine, Oxycodone, Codeine, Phencyclidine, S-(+)-Methamphetamine, S-(+)-Amphetamine, ($\pm$)-Methadone, Phenobarbital, Phenytoin, R-(-)-Phenylephrine HCl, Carbamazepine, Salicylic Acid, Valproic Acid; **Interferents tested at 500 ng/10 mg hair:** Oxcarbazepine, Gabapentin, Acetaminophen, (-)-Cotinine, S-(-)-Nicotine, Caffeine; **Interference Mix 1 (200 ng/10 mg hair):** ($\pm$)-Methadone, Buprenorphine (SYN), cis-Tramadol HCl, Codeine, Fentanyl, Hydrocodone, Hydromorphone, Meperidine, Morphine, Naloxone, Naltrexone, Oxycodone, Oxymorphone; **Interference Mix 2 (500 ng/10 mg hair):** Gabapentin, Pregabalin, Salicylic acid, Valproic acid, Vigabatrin; **Interference Mix 3 (100-2000 ng/10 mg hair):** (+)-Propoxyphene, Aripiprazole, Lacosamide, Oxcarbazepine, Rufinamide, Warfarin; **Interference Mix 4 (100 ng/ 10 mg hair):** Carbamazepine, Levetiracetam, Metformin HCl, Phenobarbital, Phenytoin, R-(-)-Phenylephrine HCl, Sertraline hydrochloride, Topiramate, Zolpidem tartrate, Zonisamide; **Interference Mix 5 (2.5-50 ng/ 10 mg hair):** Amlodipine besylate, Atorvastatin calcium salt, Azithromycin dihydrate, Bupivacaine HCl.1H₂O, Cetirizine dihydrochloride, Dimenhydrinate, Lisinopril dihydrate, Loratadine; **Interference Mix 6 (25-50 ng/ 10 mg hair):** Montelukast sodium salt, Pioglitazone hydrochloride, Prednisolone, Prednisone, Procainamide HCl, Simvastatin.

4. Assay Reportable Range:

Not applicable. The screening immunoassay is a qualitative test only.

5. Traceability, Stability, Expected Values (Controls, Calibrators, or Methods):

Traceability:

The cocaine calibrator is traceable to a commercial standard with a certified reference material Certificate of Analysis.

Sample Storage and Shipping Stability:

Five hair samples containing cocaine were stored in the same collection foil and card-envelope provided with the hair collection kit. After a period of 5 months, the samples were shipped overnight to another location and returned to the original location by overnight shipping. Samples were tested by the routine LC-MS/MS procedure both before being shipped and after their return. The sponsor stated that all samples that tested positive via the HEIA device and confirmed positive via LC-MS/MS before shipping and storage remained positive after shipping and storage.

6. Detection Limit:

The screening immunoassay is a qualitative test only; therefore, a detection limit evaluation is not applicable. See section VII.A.1. above for sensitivity around the immunoassay device cutoff.

Detection Limit of the LC-MS/MS method

The sponsor performed a study to determine the Lower limit of Quantitation (LLOQ) of the LC-MS/MS assay for cocaine and cocaine metabolites.

The LLOQ is the lowest claimed concentration that can be quantitated within 20% of the expected value for COC, BE, CE and NCOC, and within $\pm 25\%$ for *p*-OHCOC, *m*-OHCOC, *o*-OHCOC. This was found to be 0.25 ng/10 mg hair for COC, BE, CE and NCOC and 0.4 pg/mg hair for *p*-OHCOC, *m*-OHCOC, and *o*-OHCOC.

7. Assay Cut-Off:

Analytical performance of the device around the claimed cutoff is described in precision section VII.A.1 above.

B Comparison Studies:

1. Method Comparison with Predicate Device:

Accuracy of the immunoassay screening method

A total of 92 de-identified hair samples were used to compare the results of the Psychemedics HEIA for Cocaine in Hair with the LC-MS/MS method. The studies were comprised of the following hair samples: 79 samples from males, 13 samples from females; 39 black hair samples, 47 brown hair samples (from light brown to dark brown), 6 salt/pepper hair samples, 65 head hair samples, and 27 body hair samples. The hair samples were then tested using the Psychemedics Microplate EIA for Cocaine in Hair assay and the Psychemedics LC-MS/MS confirmatory assay, results from both methods were compared. The comparison of Psychemedics Microplate EIA for Cocaine in Hair assay with LC-MS/MS confirmatory assay is shown in the following table.

Comparison of Cocaine HEIA Screening Results with Unwashed Cocaine LC/MS/MS				
HEIA Result	LC/MS/MS Result, ng Cocaine/10 mg hair (% of cutoff calibrator)			
	< 2.50 (< 50% below cutoff)	2.50 – 4.99 (≥ 50% below cutoff to cutoff)	5.00 – 7.50 (cutoff to ≤50% above cutoff)	> 7.50 (> 50% above cutoff)
Positive	0	2	4	35
Negative	44	7	0	0

Comparison of Cocaine HEIA Screening Results with Washed Cocaine LC/MS/MS				
HEIA Result	LC/MS/MS Result, ng Cocaine/10 mg hair (% of cutoff calibrator)			
	< 2.50 (< 50% below cutoff)	2.50 – 4.99 (≥ 50% below cutoff to cutoff)	5.00 – 7.50 (cutoff to ≤ 50% above cutoff)	> 7.50 (> 50% above cutoff)
Positive	0	2	8	31
Negative	48	3	0	0

Discordant Results Between HEIA and Unwashed LC/MS/MS

Sample	HEIA Result	LC/MS/MS Result (ng Cocaine/10 mg hair)
1	POS	4.43
2	POS	4.96

Discordant Results Between HEIA and Washed LC/MS/MS

Sample	HEIA Result	LC/MS/MS Result (ng Cocaine/10 mg hair)
1	POS	3.75
2	POS	4.27

A separate set of 30 de-identified samples were prepared by weighing approximately 12 mg per new sample aliquot. The samples were then confirmed unwashed by LC/MS/MS. The studies were comprised of the following hair samples: 29 samples from males, 1 sample from a female; 21 black hair samples, 7 brown hair samples (from light brown to dark brown), 2 salt/pepper hair samples; 14 head hair samples and 16 body hair samples. The hair samples were then tested using the Psychomedics Microplate EIA for Cotinine in Hair assay and the Psychomedics LC-MS/MS confirmatory assay, results from both methods were compared. The comparison of Psychomedics Microplate EIA for Cotinine in Hair assay with LC-MS/MS confirmatory assay is shown in the following table.

Comparison of Cocaine HEIA Screening Results with Unwashed Cocaine LC/MS/MS				
HEIA Result	LC/MS/MS Result, ng Cocaine/10 mg hair (% of cutoff calibrator)			
	< 2.50 (< 50% below cutoff)	2.50 – 5.0 (≥ 50% below cutoff to cutoff)	5.01 – 7.50 (cutoff to ≤50% above cutoff)	> 7.50 (> 50% above cutoff)
Positive	0	0	3	13
Negative	11	1	2	0

Discordant Results Between HEIA and Unwashed LC/MS/MS		
Sample	HEIA Result	LC/MS/MS Result (ng Cocaine/10 mg hair)
1	POS	4.43
2	POS	4.96

2. Recovery Study

Recovery from LC-MS/MS Analysis

The sponsor conducted a study to evaluate recovery for cocaine, benzoylecgonine, cocaethylene and norcocaine at a concentration of 5 ng/10 mg hair. Ten tubes were prepared and analyzed by LC/MS/MS. The recovery of the analytes ranged from 97% to 100%.

3. Matrix Comparison:

Not Applicable.

C Clinical Studies:

1. Clinical Sensitivity:

Not Applicable.

2. Clinical Specificity:

Not Applicable.

3. Other Clinical Supportive Data (When 1. and 2. Are Not Applicable):

Not Applicable.

D Clinical Cut-Off:

Not Applicable.

E Expected Values/Reference Range:

Not Applicable.

VIII Proposed Labeling:

The labeling supports the finding of substantial equivalence for this device.

IX Conclusion:

The submitted information in this premarket notification is complete and substantially equivalent to the predicate.