

Introduction

Drug detection involves initial screening of samples for drugs. The screening procedure eliminates all negatives and positive results require confirmation using confirmatory methods. A multi-analytical approach, enabling the simultaneous screening of drugs, would be advantageous to consolidate testing and increase screening capacity during the drug testing process. Biochip array technology enables the simultaneous detection of multiple analytes from a single sample. This study reports the applicability of a biochip array to the multiplex screening of a broad range of drugs in human whole blood, which increases the detection capacity in testing settings.

Results

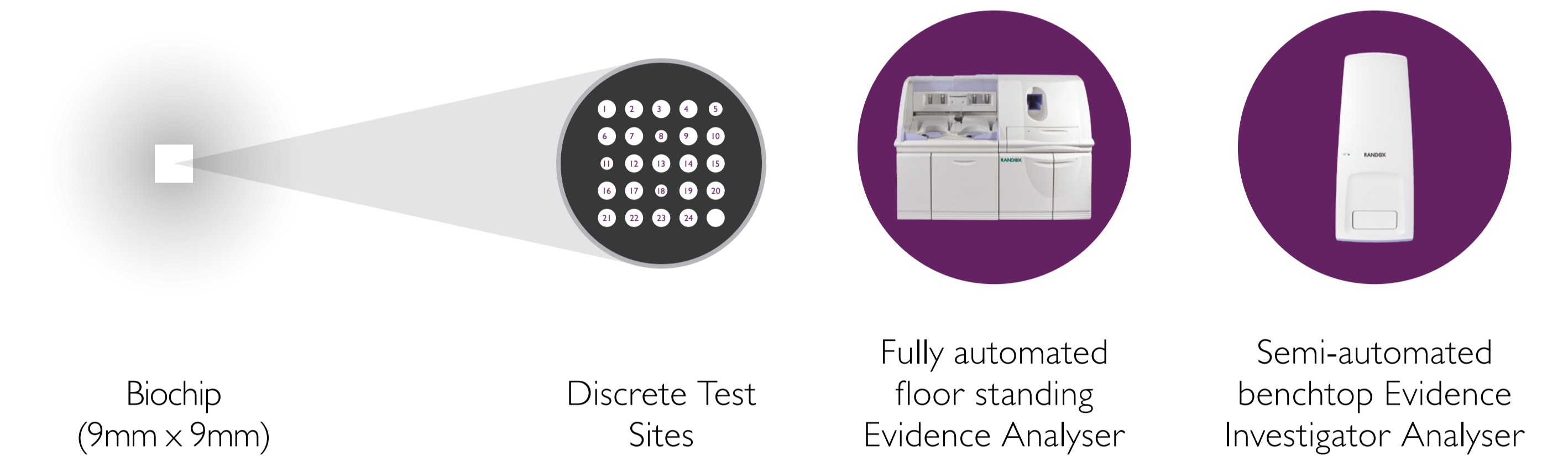
Specificity/Cross-reactivity (CR)

Amphetamine assay	Methamphetamine assay	Benzodiazepines 1 assay
Compound CR >20%	Compound CR >20%	Compound CR >20%
S(+)-Amphetamine*	S(+)-Methamphetamine*	Oxazepam*
(±)-MDA	PMMA HCl	Temazepam
PMA HCl	MDMA	Nordiazepam
BDB	(±)-Methamphetamine	alpha-OH-Alprazolam
(±)-Amphetamine	Barbiturates assay	Alprazolam
Phentermine	Compound CR >20%	Diazepam
Benzodiazepines 2 assay	Phenobarbital*	Estazolam
Compound CR >20%	Secobarbital	Clobazam
Lorazepam*	Butobarbital	Nitrazepam
Phenazepam	Pentobarbital	2-OH-Ethylflurazepam
Clonazepam	Alphenal	Prazepam
Lorazepam glucuronide	Cyclopentobarbital	Midazolam
Buprenorphine assay	p-OH-phenobarbital	Flunitrazepam
Compound CR >20%	Butalbital	Flurazepam
Buprenorphine*	Amobarbital	Phenazepam
Buprenorphine-3B-D-glucuronide	Barbital	Desalkylflunitrazepam
Benzoyllecgonine assay	Cannabinoids assay	Lormetazepam
Compound CR >20%	Compound CR >20%	Chlordiazepoxide
Benzoyllecgonine*	(-)-11-nor-9-Carboxy-Δ ⁹ -THC*	Triazolam
Cocaine	(±)-11-Hydroxy-Δ ⁹ -THC	Etizolam
m-Hydroxybenzoyllecgonine	Fentanyl assay	N-Desmethylflunitrazepam
Cocaehtylene	Compound CR >20%	Bromazepam
Dextromethorphan assay	Fentanyl*	Meprobamate assay
Compound CR >20%	α-Methylfentanyl	Compound CR >20%
Dextromethorphan*	p-Fluorofentanyl	Meprobamate*
Dextrorphan tartrate salt	Benzylfentanyl	Carisoprodol
(±)-Nordextromethorphan	Butyrylfentanyl HCl	Oxycodone 1 assay
Methadone assay	Norfentanyl	Compound CR >20%
Compound CR >20%	Oxycodone 2 assay	Oxycodone*
Methadone*	Compound CR >20%	Hydrocodone
Phencyclidine assay	Oxycodone*	Noroxycodone
Compound CR >20%	Oxymorphone	Generic opioids assay
PCP*	Opiates assay	Compound CR >20%
Tramadol assay	Compound CR >20%	Oxycodone*
Compound CR >20%	Morphine*	Hydrocodone
Tramadol*	6-MAM	Ethylmorphine HCl
O-Desmethyltramadol	6-Acetylcodeine	Codeine
Tricyclic antidepressants assay	Heroin	6-Acetylcodeine
Compound CR >20%	Desomorphine	Dihydrocodeine
Nortriptyline*	Codeine	Hydromorphone
Imipramine N Oxide	Morphine-6BD-glucuronide	Desomorphine
Imipramine	Ethylmorphine HCl	Morphine-3BD-glucuronide
Trimipramine	Hydromorphone	
Desipramine	Hydrocodone	
Cyclobenzaprine	Zolpidem assay	
Amitriptyline	Compound CR >20%	
Opipramol	Zolpidem*	
Promazine	Metabolite I: (4-carboxyzolpidem)	
Maprotiline		
Doxepin		
Clomipramine		
Protryptiline		
Cyproheptadine		
Lofepamine		
Dothiepin		
Chlorpromazine		

Analyte	Cut-off (ng/mL)	Analyte	Cut-off (ng/mL)
Amphetamine	20	Meprobamate	100
Barbiturates	50	Methamphetamine	20
Benzodiazepines 1	10	Methadone	10
Benzodiazepines 2	10	Opiates	10
Buprenorphine	5	Oxycodone 1	10
Cannabinoids (THC)	10	Oxycodone 2	10
Cocaine Metabolite (BZG)	50	Phencyclidine	5
Dextromethorphan	5	Tramadol	5
Fentanyl	2	Tricyclic Antidepressants (TCA)	60
Generic Opioids	10	Zolpidem	10

Methodology

Drugs of Abuse Ultra Array: Test menu	
Amphetamine	Meprobamate
Barbiturates	Methamphetamine
Benzodiazepines 1	Methadone
Benzodiazepines 2	Opiates
Buprenorphine	Oxycodone 1
Cannabinoids	Oxycodone 2
Cocaine metabolite (Benzoyllecgonine)	Phencyclidine
Dextromethorphan	Tramadol
Fentanyl	Tricyclic antidepressants (TCAs generic)
Generic Opioids	Zolpidem



Drugs of Abuse Ultra Array	
Simultaneous competitive chemiluminescent biochip-based immunoassays	
Ligands immobilized and stabilized on the biochip surface defining an array of discrete test sites	
Reagents and biochips ready for use	
Assays applicable to the fully automated biochip analyser Evidence or the semi-automated analyser Evidence Investigator (EV4055A/B, EV4054A/B, EV4056, EV3600, EV3602, Randox Toxicology Ltd., Crumlin, UK)	
Sample volume required: 60µl of whole blood (4-fold dilution)	
The light signal generated from each of the test sites on the biochip detected using digital imaging technology and compared to that from a stored calibration curve	
The signal output is inversely proportional to the concentration of drug in the sample	
The systems have dedicated software to process, report and archive the data produced	

Results

Sensitivity

Assay	Evidence		Evidence Investigator	
	Limit of Detection (neat sample) (ng/mL)	Limit of Detection (neat sample) (ng/mL)	Limit of Detection (neat sample) (ng/mL)	Limit of Detection (neat sample) (ng/mL)
Amphetamine	2.76	5.97	Methadone	1.46
Barbiturate	3.67	5.10	Methamphetamine	10.00
Benzodiazepines 1	0.21	0.07	Oxycodone 1	1.01
Benzodiazepines 2	0.60	0.53	Oxycodone 2	0.73
Benzoyllecgonine	1.03	1.27	Opiate	0.5
Buprenorphine	0.11	0.004	Generic Opioids	1.23
Cannabinoids	2.96	1.45	Phencyclidine	0.27
Dextromethorphan	0.07	0.01	Tramadol	0.34
Fentanyl	0.09	0.09	TCAs	2.77
Meprobamate	7.23	9.23	Zolpidem	0.35

Intra-assay precision

Intra-assay precision for different concentration levels expressed as CV (%), was ≤20 for all the assays with both analysers.

Inter-assay precision and recovery

Inter-assay precision for concentration levels -50% cut-off, cut-off, and +50% cut-off, expressed as CV (%), was ≤20 for all the assays in both analysers.

Recovery values for concentration levels -50% cut-off, cut-off, and +50% cut-off, ranged from 75% to 132% with the Evidence analyser and from 70% to 126% with the Evidence Investigator analyser.

EV4055 A/B 231116.pl, EV4056 261016.pl

Conclusion

The results indicate applicability of Drugs of Abuse Ultra Array to the simultaneous screening of a broad range of drugs in whole blood. The simultaneous immunoassays arrayed on the biochip surface and applicable to the Evidence or Evidence Investigator biochip analysers, allow the multi-analytical screening of samples. The systems incorporate dedicated software to process and archive the multiple data generated. This multi-analytical approach leads to test consolidation and increases the screening capacity in test settings.

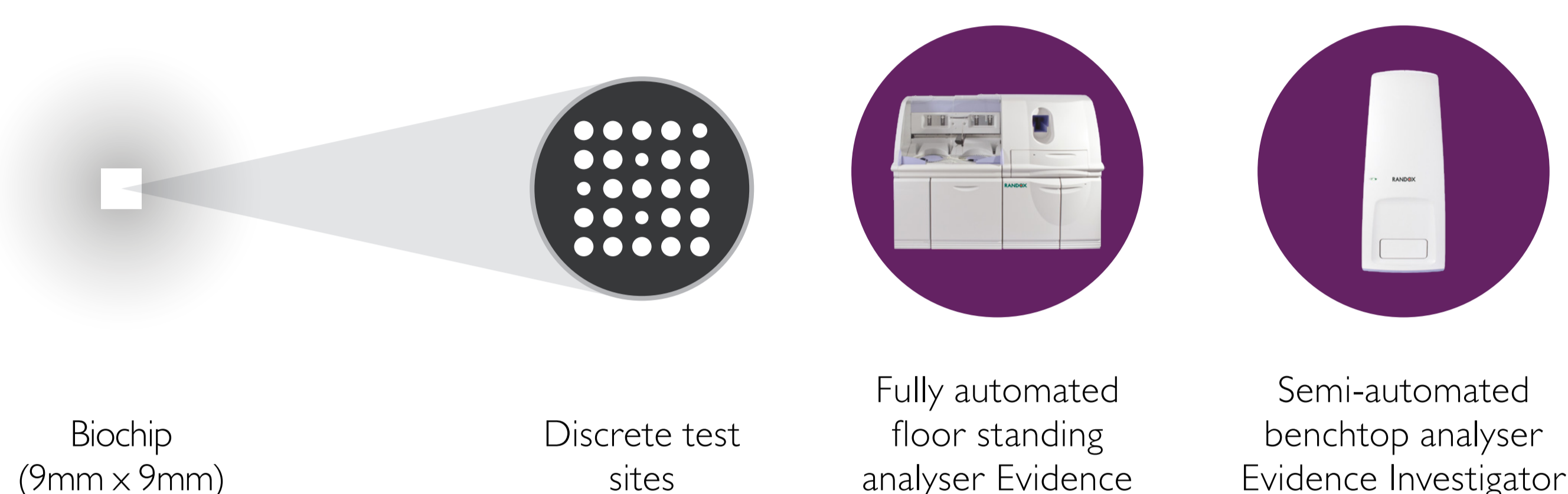
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Drug detection involves initial screening of samples for drugs. The screening procedure eliminates all negatives and positive results require confirmation using confirmatory methods. A multi-analytical approach, enabling the simultaneous screening of drugs, would be advantageous to consolidate testing and increase screening capacity during the drug testing process.

Biochip array technology enables the simultaneous detection of multiple analytes from a single sample. This study reports the applicability of a biochip array to the multiplex screening of a broad range of drugs in human whole blood, which increases the detection capacity in testing settings.

Methodology

Drugs of Abuse Ultra Array: Test menu			
Amphetamine	Buprenorphine	Meprobamate	Oxycodone 2
Barbiturates	Cannabinoids (THC)	Methamphetamine	Phencyclidine (PCP)
Benzodiazepines 1	Dextromethorphan	Methadone	Tramadol
Benzodiazepines 2	Fentanyl	Opiates	Tricyclic antidepressants (TCA)
Benzoyllecgonine (Cocaine Metabolite)	Generic Opioids	Oxycodone 1	Zolpidem



- Drugs of Abuse Ultra Array**
- Simultaneous competitive chemiluminescent biochip-based immunoassays
 - Ligands immobilized and stabilized on the biochip surface defining an array of discrete test sites
 - Reagents and biochips ready for use
 - Assays applicable to the fully automated biochip analyser Evidence or the semi-automated analyser Evidence Investigator (EV4055A/B, EV4054A/B, EV4056, EV3600, EV3602, Randox Toxicology Ltd., Crumlin, UK)
 - Sample volume required: 60µl of whole blood (4-fold dilution)
 - The light signal generated from each of the test sites on the biochip detected using digital imaging technology and compared to that from a stored calibration curve
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Results

Specificity/Cross-reactivity (CR)

Amphetamine assay	Methamphetamine assay	Benzodiazepines 1 assay	Benzodiazepines 2 assay	Barbiturates assay	Buprenorphine assay
Compound CR >20%	Compound CR >20%	Compound CR >20%	Compound CR >20%	Compound CR >20%	Compound CR >20%
S(+)-Amphetamine*	S(+)-Methamphetamine*	Oxazepam*	Lorazepam*	Phenobarbital*	Buprenorphine*
(±)-MDA	PMMA HCl	Temazepam	Phenazepam	Secobarbital	Buprenorphine-3B-D-glucuronide
PMA HCl	MDMA	Nordiazepam	Clonazepam	Butobarbital	Fentanyl assay
BDB	(±)-Methamphetamine	alpha-OH-Alprazolam	Lorazepam glucuronide	Pentobarbital	Compound CR >20%
(±)-Amphetamine	Cannabinoids assay	Alprazolam	Tricyclic antidepressants assay	Alphenal	Fentanyl*
Phentermine	Compound CR >20%	Diazepam	Compound CR >20%	Cyclopentobarbital	α-Methylfentanyl
Benzoyllecgonine assay	(-)-11-nor-9-Carboxy-Δ ⁹ -THC*	Estazolam	Nortriptyline*	p-OH-phenobarbital	p-Fluorofentanyl
Compound CR >20%	(±)-11-Hydroxy-Δ ⁹ -THC	Clobazam	Imipramine N Oxide	Butalbital	Benzylfentanyl
Benzoyllecgonine*	Methadone assay	Nitrazepam	Imipramine	Amobarbital	Butyrylfentanyl HCl
Cocaine	Compound CR >20%	2-OH-Ethylflurazepam	Trimipramine	Barbital	Norfentanyl
m-Hydroxybenzoyllecgonine	Methadone*	Prazepam	Desipramine	Generic opioids assay	Opiates assay
Cocaethylene	Dextromethorphan assay	Midazolam	Cyclobenzapine	Compound CR >20%	Compound CR >20%
Meprobamate assay	Compound CR >20%	Flunitrazepam	Amitriptyline	Oxycodone*	Morphine*
Compound CR >20%	Dextromethorphan*	Flurazepam	Opipramol	Hydrocodone	6-MAM
Meprobamate*	Dextrorphan tartrate salt	Phenazepam	Promazine	Ethylmorphine HCl	6-Acetylcodeine
Carisoprodol	(±)-Nordextromethorphan	Desalkylflunitrazepam	Maprotiline	Codeine	Heroin
Oxycodone 2 assay	Oxycodone 1 assay	Lormetazepam	Doxepin	6-Acetylcodeine	Desomorphine
Compound CR >20%	Compound CR >20%	Chlordiazepoxide	Clomipramine	Dihydrocodeine	Codeine
Oxycodone*	Oxycodone*	Triazolam	Protryptiline	Hydromorphone	Morphine-6BD-glucuronide
Oxymorphone	Hydrocodone	Etizolam	Cyproheptadine	Desomorphine	Ethylmorphine HCl
Zolpidem assay	Noroxycodone	N-Desmethylflunitrazepam	Lofepamine	Morphine-3BD-glucuronide	Hydromorphone
Compound CR >20%	Tramadol assay	Bromazepam	Dothiepin	Phencyclidine assay	Hydrocodone
Zolpidem*	Compound CR >20%		Chlorpromazine	Compound CR >20%	
Metabolite I: (4-carboxyzolpidem)	Tramadol*			PCP*	
	O-Desmethyiltramadol				

*CR=100%

Assay	Cut-off (ng/mL)	Assay	Cut-off (ng/mL)	Assay	Cut-off (ng/mL)	Assay	Cut-off (ng/mL)
Amphetamine	20	Buprenorphine	5	Meprobamate	100	Oxycodone 2	10
Barbiturates	50	Cannabinoids (THC)	10	Methamphetamine	20	Phencyclidine (PCP)	5
Benzodiazepines 1	10	Dextromethorphan	5	Methadone	10	Tramadol	5
Benzodiazepines 2	10	Fentanyl	2	Opiates	10	Tricyclic Antidepressants (TCA)	60
Benzoyllecgonine (Cocaine Metabolite)	50	Generic Opioids	10	Oxycodone 1	10	Zolpidem	10

Sensitivity

Assay	Evidence		Assay	Evidence Investigator	
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Amphetamine	2.76	5.97	Methadone	1.46	0.13
Barbiturate	3.67	5.10	Methamphetamine	10.00	5.74
Benzodiazepines 1	0.21	0.07	Oxycodone 1	1.01	1.02
Benzodiazepines 2	0.60	0.53	Oxycodone 2	0.73	0.47
Benzoyllecgonine	1.03	1.27	Opiate	0.5	0.35
Buprenorphine	0.11	0.004	Generic Opioids	1.23	0.84
Cannabinoids	2.96	1.45	Phencyclidine	0.27	0.32
Dextromethorphan	0.07	0.01	Tramadol	0.34	0.29
Fentanyl	0.09	0.09	TCA	2.77	1.19
Meprobamate	7.23	9.23	Zolpidem	0.35	0.07

Intra-assay precision

Intra-assay precision for different concentration levels expressed as CV (%), was ≤20 for all the assays with both analysers.

Inter-assay precision and recovery

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EV4055 A/B 231116.pl, EV4056 261016.pl

Conclusion

The results indicate applicability of Drugs of Abuse Ultra Array to the simultaneous screening of a broad range of drugs from a single whole blood sample. The simultaneous immunoassays arrayed on the biochip surface and applicable to the Evidence or Evidence Investigator biochip analysers, allow

the multi-analytical screening of samples. The systems incorporate dedicated software to process and archive the multiple data generated. This multi-analytical approach leads to test consolidation and increases the screening capacity in test settings.