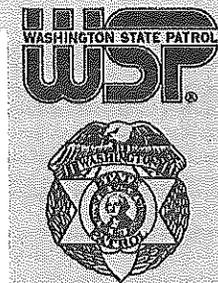


# INTEROFFICE COMMUNICATION

## WASHINGTON STATE PATROL



**TO:** Dr. Fiona J. Couper, Toxicology Laboratory Division

**FROM:** Ms. Amanda Black, Toxicology Laboratory Division

**SUBJECT:** Diphenhydramine and dextromethorphan quantitation

**DATE:** June 13, 2019

The confirmation test method "*Confirmation of select basic drugs by liquid chromatography – tandem mass spectrometry*" (TCb12744) was validated and approved for use in casework as of 8/7/2018. The method is used for quantitation/confirmation of bupropion, citalopram, venlafaxine, o-desmethylvenlafaxine, diphenhydramine, dextromethorphan and cyclobenzaprine.

During method validation, whole blood pooled controls were prepared, with replicates analyzed, at multiple levels (30, 400, 800, 1500 and 5000 ng/mL). Spiked control replicates were also prepared at 30, 400 and 800 ng/mL. The within-run and between-day precision and accuracy results from analysis of both pooled and spiked replicates across the range of the calibration curve are attached (as reviewed with validation records 7/2018). Performance in pooled and spiked replicates was acceptable for all compounds, including for dilutions of high concentration pools (1500 and 5000 ng/mL).

Prior to the implementation of the LC-MSMS test method, the GC-NPD/GC-MS SIM test method "*Basic Drug Identification/Confirmation by Gas Chromatography – Mass Spectrometry/Nitrogen Phosphorus Detection*" (TCb12714) was used for quantitation of bupropion, citalopram, venlafaxine, tramadol, diphenhydramine and dextromethorphan. Use of the GC method was discontinued 8/7/2018 (upon implementation of the LC-MSMS test method), except for NPD quantitation of tramadol and SIM analysis of tramadol, methadone and lidocaine.

Since the implementation of the LC-MSMS method, results in case specimens have been checked for agreement with estimated concentrations from the basic drug screen, and have been routinely consistent with screening estimates. However, Forensic Scientists recently attempting LC-MSMS test method certification have experienced low recovery of diphenhydramine and dextromethorphan in spiked test samples, when compared to target concentrations, particularly in samples with target concentrations greater than 1000 ng/mL (analyzed at full volume and dilution). This occurred with multiple scientists, different preparations of standard/internal standard solutions and different LC-MSMS instruments.

LC-MSMS materials, equipment, instrumentation and test method acquisition/data analysis have been evaluated to determine the cause, but no specific issue has been identified. While evaluation of the LC-MSMS method continues, testing was performed to demonstrate that the GC-NPD/SIM test method previously used for diphenhydramine and dextromethorphan quantitation is appropriate for use and to verify continued performance of the LC-MSMS test method for bupropion, citalopram and venlafaxine (o-desmethylvenlafaxine and cyclobenzaprine are not included in the GC-NPD/SIM method).



Dr. Fiona Couper  
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Forensic Scientist Asa Louis analyzed a batch of case specimens with the LC-MSMS and GC-NPD test methods, and Andrew Gingras analyzed the lower-concentration cases with the GC-MS SIM test method. The resulting data supports that the GC-NPD and GC-MS SIM methods previously used for quantitation of diphenhydramine and dextromethorphan (until replaced with LC-MSMS) continue to be fit-for-purpose. The data also confirms performance of the LC-MSMS method for bupropion, citalopram and venlafaxine. A summary spreadsheet of comparison values is attached for review.

To gather additional information on LC-MSMS performance, Asa analyzed a dilution control in the LC-MSMS batch, which contained diphenhydramine and venlafaxine spiked to a target of 2000 ng/mL in 2 mL whole blood (analyzed at full volume and 1:10 dilution). Both dilution and full volume results were within  $\pm 20\%$  of the spiked target.

Performance of diphenhydramine and dextromethorphan in the GC-NPD and GC-MS SIM testing batch demonstrate this method continues to be fit-for-purpose for quantitative analysis of these compounds.

Results of the case comparisons confirm performance of the new LC-MSMS method for case specimens. However, since the performance of spiked certification samples remains inconsistent for diphenhydramine and dextromethorphan, I recommend use of the GC-NPD or GC-MS SIM methods for quantitation of these compounds, pending further evaluation of LC-MSMS method. Results for diphenhydramine and dextromethorphan may be reported qualitatively from the LC-MSMS method.

ab

AB:ab

cc: Mr. Brian Capron, Toxicology Laboratory Division  
Dr. Brianna Peterson, Toxicology Laboratory Division  
Ms. Brianna E. O'Reilly, Toxicology Laboratory Division  
Ms. Elizabeth Wehner, Toxicology Laboratory Division  
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Ms. Katie Harris, Toxicology Laboratory Division

Concur. Recommendations approved.

  
6-14-19

**BASIC DRUG IDENTIFICATION/CONFIRMATION BY GAS  
CHROMATOGRAPHY - MASS SPECTROMETRY/NITROGEN PHOSPHORUS  
DETECTION**

Approved for quantitation of diphenhydramine and dextromethorphan as of 6/14/19. AB 6/18/19  
(supersedes watermark below dated 8/6/18)

**14.1 METHOD** Quantitation piece in use for tramadol (scan/SIM),  
methadone (SIM) and lidocaine (SIM) only, as of 8/7/2018 AB 8/6/18

This test method may be used to identify and/or confirm the presence of select basic drugs in biological samples (see APPENDIX A). The targeted compounds and metycaine internal standard are isolated from biological matrices by the use of liquid-liquid extraction (LLE). Following LLE, the extracts are injected into a gas chromatograph (GC) coupled with both a nitrogen phosphorus detector (NPD) and a mass spectrometer (MS) detector equipped with an electron ionization source.

This test method may also be used to identify and/or confirm other basic drugs not included in the standard mixes described for this procedure (see 14.9).

**14.2 SPECIMENS**

The specimen volume is 1 mL. Specimens include, but are not limited to, whole blood, serum, plasma, urine, and tissue homogenate. Dilutions of specimens may be analyzed at the Forensic Scientist's discretion.

Matrix-matching of the full calibration curve and all positive control levels is required for quantitation in liver (tissue) homogenate and serum/plasma specimens (see 14.4.3.2).

**14.3 REAGENTS, MATERIALS AND EQUIPMENT**

**14.3.1 REAGENTS**

- Acetonitrile (ACN)
- Ammonium carbonate ((NH<sub>4</sub>)<sub>2</sub>CO<sub>3</sub>), saturated
- Ammonium hydroxide (NH<sub>4</sub>OH), concentrated
- N-butyl chloride
- Certified blank blood and/or other biological matrices
- Chloroform (CHCl<sub>3</sub>)
- Deionized water (DI H<sub>2</sub>O)
- Ethyl acetate (EtAC)
- Hydrochloric acid (HCl), concentrated
- 3N HCl

Add 125 mL concentrated hydrochloric acid to 300mL DI H<sub>2</sub>O in a glass flask. Dilute to 500 mL with DI H<sub>2</sub>O. Store the acid in a glass bottle at room temperature for up to one year.

- Methanol (MeOH)
- Sodium borate decahydrate ( $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$ )
- 0.13M sodium borate solution (saturated)

In a glass flask, dissolve 4.9 g  $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$  in approximately 75 mL DI  $\text{H}_2\text{O}$ . Dilute to 100mL with DI  $\text{H}_2\text{O}$  and mix thoroughly (may require low heating). The weighed contents may not go completely into solution. This is normal. Store the solution in a glass bottle at room temperature for up to six months.

NOTE: Adjustments to final volumes of prepared reagents are permitted as long as the proportions are maintained.

#### 14.3.2 MATERIALS

- Disposable extraction tubes (16 x 100mm recommended) and screw-cap or centrifuge tubes with closures
- Disposable transfer pipettes
- GC Column (Agilent HP-5MS; 30 m x 0.250 mm i.d. x 0.250  $\mu\text{m}$  film thickness, or equivalent)
- Glass autosampler vials with inserts and caps
- Laboratory glassware (graduated cylinders, flasks)

#### 14.3.3 EQUIPMENT

- Agilent GC (6890 or equivalent) equipped with an NPD detector
- Agilent MS (5973 or equivalent)
- Calibrated, adjustable piston pipettes and verified, adjustable repeater-pipette with disposable pipette tips
- General-use equipment (centrifuge, rotary mixer, vacuum aspirator, vortex mixer)

### 14.4 STANDARDS, CALBRATORS AND CONTROLS

#### 14.4.1 STANDARDS

- Working standard (Group A): 10 ng/ $\mu\text{L}$
- Working control standard (Group A): 10 ng/ $\mu\text{L}$
- Working standard (Group B): 10 ng/ $\mu\text{L}^*$
- Working internal standard: 10 ng/ $\mu\text{L}$

\*alprazolam – 15 ng/ $\mu\text{L}$ , amitriptyline, nortriptyline, fluoxetine, verapamil – 20 ng/ $\mu\text{L}$ , trazodone – 33.3 ng/ $\mu\text{L}$

NOTE: Metycaine HCl internal standard is purchased as a solid reference material and weighed at time of working internal standard preparation. Standards used in qualitative confirmation (retention time/diagnostic ion references) or SIM quantitation may include prepared standards (e.g.,

methadone WS, lidocaine WS) or direct dilutions from a certified reference material or reference material.

#### 14.4.2 CALIBRATORS

For quantitative testing, calibrators are prepared in certified blank blood at the time of analysis, as detailed in 14.5 SAMPLE PREPARATION. Quantitation in liver (tissue) homogenate or serum/plasma specimens requires that a calibration curve be prepared in blank alternative matrix. If testing only an alternate matrix, a whole blood calibration curve is not required.

#### 14.4.3 CONTROLS

- 14.4.3.1 At least one negative whole blood control and two positive whole blood controls are tested with every batch, prepared as described in 14.5. If testing only an alternate matrix, whole blood controls are not required.
- 14.4.3.2 For qualitative analysis, one positive and one negative control must be included for each matrix type tested in the batch. For quantitative analysis of alternate matrices, matrix-matching of the full calibration curve and all positive control levels are required.
- 14.4.3.3 Controls (positive or negative) must make up at least 10% of the extracted batch (based on number of case specimen samples), with case specimens bracketed by positive controls.

NOTE: When quantifying compounds in multiple matrices, controls must make up at least 10% of the extracted batch for each alternate matrix.

### 14.5 SAMPLE PREPARATION

- 14.5.1 Label a clean extraction tube for each member of the test batch. (i.e., calibrator, control, case sample).
- 14.5.2 Add 1 mL 0.13M sodium borate solution to each tube.
- 14.5.3 Using a calibrated pipette, add 1 mL of certified blank whole blood into each calibrator tube, the positive control tubes and the negative control tube(s).
- 14.5.4 If performing quantitative testing, prepare a 1:10 dilution of the Group A working standard. (1 ng/μL)
  - a. Using a calibrated pipette, combine 0.1 mL of the working standard with 0.9 mL of ACN or MeOH in a labeled tube.
  - b. Cap and vortex mix. This dilution shall be disposed of after calibrator preparation.
- 14.5.5 If performing quantitative testing: Using a calibrated pipette, spike the calibrators according to the following table, using the Group A working standard and the prepared dilution.

Calibrator Description	Volume (µL) Added	Standard Concentration	Dilution of WS (or WS)
Calibrator 1 – 100 ng/mL	100	1 ng/µL	1:10
Calibrator 2 – 250 ng/mL	25	10 ng/µL	WS
Calibrator 3 - 500 ng/mL	50	10 ng/µL	WS
Calibrator 4 - 1000 ng/mL	100	10 ng/µL	WS

If screening only:

Using a calibrated pipette, add 30µL of the Group A working standard and 30 µL of the Group B working standard to the respective positive control tubes.

Add 15 µL of the methadone working standard to the methadone positive control tube (target concentration is 150 ng/mL).

Where applicable, 15 µL of the cocaine working standard may also be added to the methadone positive control tube (e.g., if the batch is expected to contain cocaine positive specimens, as directed by immunoassay results or case history).

- 14.5.6 If performing quantitative testing: Using a calibrated pipette, spike the positive controls according to the following table, using the Group A control working standard.

Control Description	Volume (µL) Added	Standard Concentration	Dilution of QC (or QC)
Control 1 – 200 mg/L	20	10 ng/µL	QC
Control 2 - 800 mg/L	80	10 ng/µL	QC

If screening only: The Group A and Group B calibrators prepared in 14.5.5 serve as the positive controls for the batch.

- 14.5.7 Using a calibrated pipette, sample 1 mL of each case sample into its respective tube.
- 14.5.8 Using a calibrated pipette or verified repeater-pipette, add 50 µL of the working internal standard solution to each tube. Final concentration of the internal standard is 500 ng/mL.
- 14.5.9 Add 3 mL n-butyl chloride to each tube.
- 14.5.10 Cap the tubes and place on a rotary mixer for 20 minutes.
- 14.5.11 Centrifuge the tubes at 3500 rpm (recommended for 16 x 100 mm tubes) for 10 minutes.
- 14.5.12 Transfer the organic layer to clean, labeled 10 mL centrifuge or screw-cap tubes.

- 14.5.13 Add 200  $\mu$ L 3N HCl to each tube.
- 14.5.14 Cap the tubes and place on a rotary mixer for 5 minutes.
- 14.5.15 Centrifuge the tubes for 5 minutes at 2000-2500 rpm.
- 14.5.16 Aspirate the organic layer to chemical waste.
- 14.5.17 Add 100  $\mu$ L saturated ammonium carbonate to each tube.
- 14.5.18 Add 100  $\mu$ L concentrated ammonium hydroxide to each tube and vortex-mix.
- 14.5.19 Add 150  $\mu$ L chloroform to each tube and vortex mix for at least 30 seconds.
- 14.5.20 Cap tubes and centrifuge for 5 minutes at 2000 rpm.
- 14.5.21 Transfer the bottom (chloroform) layer to glass autosampler vials with inserts and cap.

#### 14.6 INSTRUMENTAL PARAMETERS/DATA ANALYSIS

- 14.6.1 Group A (quantitative, scan)
  - Acquisition method – BASIC (instrumental parameters in Appendix B)
  - Calibration curve – linear, 1/a weighting factor, origin excluded
  - Updating calibrator (retention times  $\pm 2\%$ ) – Cal 3
  - Result comparisons – truncated whole integer values in units of ng/mL
- 14.6.2 Group A and B (qualitative, scan)

Same as 14.6.1 above, but using Group A and Group B positive controls to create two-point (positive control, origin) calibration curves (linear, 1/a weighting factor). Two-point calibration curves may also be created to obtain estimated concentrations when performing qualitative analysis of other compounds (e.g., methadone, cocaine/ cocaethylene).
- 14.6.3 Batch and case specimen acceptance criteria are found in the *General Requirements for Chromatographic Test Method Batch Analysis and Acceptance* (PQ12707), sections 7.3 and 7.4.

#### 14.7 REPORTING

Quantitative results (Group A scan and Group A/other compounds SIM) are reported in units of milligrams per liter (mg/L), truncated to two significant figures. Group A quantitative results are reported from NPD data; however, quantitation based on MSD data is allowable if the reason is documented and approved. Qualitative results are reported as positive.

See PQ12707, section 7.4.4, for specific criteria for reporting qualitative and quantitative results in specimens.

## 14.8 METHOD PERFORMANCE

### 14.8.1 Group A (quantitative, scan)

- Lower limit of quantitation: 0.1 mg/L
- Dynamic range: 0.1 – 1.0 mg/L
- Upper limit of quantitation: 1.0 mg/L

### 14.8.2 Group A or other compounds (quantitative, SIM)

Dynamic range listed in 14.9 below, with lowest and highest calibrator levels serving as the lower and upper limits of quantitation.

Approved for quantitation of diphenhydramine and dextromethorphan as of 6/14/19. AB 6/18/19 (supersedes watermark below dated 8/6/18)

## 14.9 SIM ANALYSIS

Quantitation piece in use for tramadol (scan/SIM),

methadone (SIM) and lidocaine (SIM) only, as of 8/7/2018 AB 8/6/18

- 14.9.1 Confirmation/quantitation of Group A and other compounds may be performed in selected-ion mode (SIM), using the sample preparation procedure outlined in 14.5. Calibrator, positive control and internal standard concentrations, diagnostic ions and updating calibrators are listed below.

### Group A SIM

Calibrator Description	Volume (µL) Added	Standard Concentration	Dilution of WS (or WS)
Calibrator 1 – 50 ng/mL	50	1 ng/µL	1:10
Calibrator 2 – 100 ng/mL	100	1 ng/µL	1:10
Calibrator 3 – 150 ng/mL	150	1 ng/µL	1:10
Calibrator 4 - 200 ng/mL	20	10 ng/µL	WS
Calibrator 5 - 250 ng/mL	25	10 ng/µL	WS

Control Description	Volume (µL) Added	Standard Concentration	Dilution of QC (or QC)
Control 1 – 75 mg/L	75	1 ng/µL	1:10
Control 2 - 200 mg/L	20	10 ng/µL	QC

Internal Standard: Metycaine (200 ng/mL target), add 20 µL working IS  
 Diagnostic Ions (qual/target): Metycaine (246/112), bupropion (224/100, 139/100), citalopram (324/58, 238/58), dextromethorphan (150/271, 214/271), diphenhydramine (165/58, 73/58), tramadol (263/58, 135/58), venlafaxine (58/134, 179/134)  
 Updating Calibrator: Cal 3

LIDOCAINE SIM

Calibrator Description	Volume (µL) Added	Standard Concentration	Dilution of WS (or WS)
Calibrator 1 – 100 ng/mL	100	1 ng/µL	1:10
Calibrator 2 – 250 ng/mL	25	10 ng/µL	WS
Calibrator 3 – 500 ng/mL	50	10 ng/µL	WS
Calibrator 4 - 750 ng/mL	75	10 ng/µL	WS
Calibrator 5 - 1000 ng/mL	100	10 ng/µL	WS

Control Description	Volume (µL) Added	Standard Concentration	Dilution of QC (or QC)
Control 1 – 200 mg/L	20	10 ng/µL	QC
Control 2 - 800 mg/L	80	10 ng/µL	QC

Internal Standard: Metycaine (500 ng/mL target), add 50 µL working IS  
 Diagnostic Ions: Metycaine (246/112), lidocaine (120/86, 234/86)  
 Updating Calibrator: Cal 3

Methadone SIM

Calibrator Description	Volume (µL) Added	Standard Concentration	Dilution of WS (or WS)
Calibrator 1 – 25 ng/mL	25	1 ng/µL	1:10
Calibrator 2 – 50 ng/mL	50	1 ng/µL	1:10
Calibrator 3 – 100 ng/mL	100	1 ng/µL	1:10
Calibrator 4 - 250 ng/mL	25	10 ng/µL	WS
Calibrator 5 - 500 ng/mL	50	10 ng/µL	WS
Calibrator 6 – 1000 ng/mL	100	10 ng/µL	WS

Control Description	Volume (µL) Added	Standard Concentration	Dilution of QC (or QC)
Control 1 – 75 mg/L	75	1 ng/µL	1:10
Control 2 - 800 mg/L	80	10 ng/µL	QC

Internal Standard: Metycaine (500 ng/mL target), 50 µL working IS  
 Diagnostic Ions: Metycaine (246/112), Methadone (294/72, 223/72)  
 Updating Calibrator: Cal 4

- 14.9.2 Calibration curves, and result comparisons will be as described in 14.6.1. Retention times (±2% tolerance) and qualifier ion ratios (±20% tolerance) will be updated with the listed calibrator (14.9.1). A copy of the acquisition method will be included in the batch file.

APPENDIX A

Group A – Screening control: positive control target 300 ng/mL

Bupropion  
Citalopram  
Dextromethorphan  
Diphenhydramine  
Tramadol  
Venlafaxine

Group B – Screening control: positive control target 300 ng/mL\*\*

Alprazolam  
Amitriptyline  
Chlorpheniramine  
Chlorpromazine  
Clonidine  
Cocaethylene  
Cocaine  
Codeine  
Cyclobenzaprine  
Doxepin  
Doxylamine  
Fentanyl  
Fluoxetine  
Hydrocodone  
Lidocaine  
MDA  
MDMA  
Meperidine  
Methamphetamine  
Nordiazepam  
Nortriptyline  
Oxycodone  
Propoxyphene  
Sertraline  
Trazodone  
Verapamil  
Zolpidem

\*\*fluoxetine, amitriptyline, nortriptyline, verapamil – 600 ng/mL, alprazolam – 450 ng/mL,  
trazodone – 1000 ng/mL

Methadone (cocaine/cocaethylene) - Screening control: positive control target 150  
ng/mL

APPENDIX B  
 BASIC TEST METHOD INSTRUMENTAL PARAMETERS

GAS CHROMATOGRAPH

Split/Splitless Inlet	
Mode	Pulsed Splitless
Inlet Liner	4mm gooseneck w/glass wool plug
Temperature	250°C
Pulse Pressure	45.0 psi
Pulse Time	1.00 min
Purge Flow	3.0 mL/min
Purge Time	0.00 min
Autosampler	
Gas Type	Helium
Injection Volume	3.0 µL
Solvent Wash A	Ethyl acetate
Solvent Wash B	Ethyl acetate
Pre-injection Wash	4
Post-injection Wash	4
Sample Pumps	2

Oven/Column	
Carrier Gas Mode	Constant Flow
Carrier Gas Flow	1.5 mL/min
Initial Temperature	90°C
Initial Time	1.00 min
Ramp Rate	15.00°C/min
Final Temperature	180°C
Final Time	0.00 min
Ramp Rate	10.00°C/min
Final Temperature	300°C
Final Time	10.00 min
Front Detector/NPD	
Temperature	320°C
H <sub>2</sub> Flow	3.0 mL/min
Air Flow	50.0 mL/min
N <sub>2</sub> Flow (Makeup)	15.0 mL/min

MASS SPECTROMETER

Solvent Delay	3.00 min	MS Quad Temperature	150°C
EM Offset	200	MS Source Temperature	230°C
Mode	Scan	Scan Range	40-550
Transfer Line Temperature	280°C		

LIST OF CHANGES

Revision Date	Description	Page Number
10/03/12	Method approved by Washington State Toxicologist. See DRA dated 09/28/12. Method released for use in evidentiary testing on 10/03/12.	All
04/22/13	References to "Group B positive control" throughout were changed to "Group B calibrator." Spiked positive controls were introduced in place of prepared, pooled, whole blood controls. See detailed changes in DRA dated 04/12/13.	3-10
10/28/13	Removed ketamine and methadone from Group A Working Standard and the list of compounds in 14.6.1.2. Added chlorpromazine to list of compounds in Group B Working Standard in 14.6.1.2. See detailed changes in DRA dated 10/17/13.	3-4
3/16/15	Amended wording for deviation approval by a member of TLD Management in 14.1. Reagent and sample preparation sections modified to reflect use of 0.13M sodium borate solution instead of pH9 phosphate buffer. See DRA dated 3/11/15.	1, 2, 6
9/30/16	Added note regarding CRM expiration dates in 14.6.1.3 and 14.6.1.4 and clarification to 14.6.3.2.c for use of same CRM in preparation of working standard and working control standard. Edited 14.12.1.3 to reflect that only two significant figures are used for reporting and added "Printed Copies are Uncontrolled" to the footer. Other minor edits throughout.	All
4/9/18	Removed policy, purpose and principle sections, summarizing under new section METHOD. Added specific wording regarding matrix-matching in 14.2 SPECIMENS. Specified use of calibrated pipettes for measurement of blank blood, specimens, and standards throughout section 14.5 SAMPLE PREPARATION. Edited STANDARDS section - this information is now included in APPENDIX A and in the revised Standard Solution Preparation procedure. Criteria for batch acceptance (calibrators, controls) and specimen acceptability criteria, and specific data analysis and reporting information are now included in the General Requirements for Chromatographic Test Method Batch Analysis and Acceptance. Section 14.9 details SIM analysis for Group A compounds, lidocaine and methadone. Test method parameters for BASIC moved to APPENDIX B. Formatting and minor edits throughout.	All