Analyzer Carryover Testing
Technical Procedure 3050

Chemistry and Immunoassay Analyzers

Intended Use

This procedure will be used to delineate the procedure for carryover testing on chemistry and immunoassay analyzers.

Clinical Significance

Automatic pipetting systems must be evaluated for carryover at defined intervals. After initial validation is performed by the manufacturer, it is necessary to assure the analyzers are operating within acceptable limits.

The term carryover is used to describe the transfer of material (samples or reagents) from a sample container or reaction mixture to another, and may be unidirectional or bidirectional. Carryover can result in a significant positive or negative bias of patient results to the extent that there are clinical consequences and/or potential adverse patient outcomes. Possible carryover situations are test-to-test (or reaction vessel-to-reaction vessel) carryover, sample-to-sample (or tube-to-tube) carryover, and carryover from reagent(s) by a reagent probe.

Testing for drug carryover (DAUs and TDMs), and common elevated analytes such as BhCG, CK and LD can cause carryover problems. Different types of reagents used for testing can also carry over, such as those containing glycerol.

Test-to-test, or reaction vessel-to-reaction vessel carryover situations may occur when a cuvette or reaction vessel containing a high concentration of an analyte is followed by one or more cuvettes or reaction vessels containing lower analyte concentrations. Residual analyte may carry over from the high sample cuvette and falsely elevate subsequent result(s). This carryover may occur due to inadequate washing of a sample pipetting probe or if the cuvette washing system is not functioning properly.

Reagent carryover may occur when reagent from an initial assay clings to a reagent probe and contaminates the reaction mixture of the next test. Inadequate washing of cuvettes can also result in residual reagent from one test remaining in a cuvette and contaminating the reaction mixture for the next assay whose reagents are pipetted in the same cuvette.

Sample-to-sample, or tube-to-tube carryover situations may occur when a patient specimen with a high concentration of analyte contaminates the sampling probe with residual analyte. The next specimen container that the probe encounters will be contaminated by the analyte if sample probe washing is compromised. This type of carryover needs to be considered when patient specimens are tested on multiple systems, such as an automated line, or when a sample container is physically moved from analyzer to analyzer (e.g. DxC800 to DxI800) where the first analyzer's sample pipetting system is compromised.

Carryover testing will be performed on the DxC800 analyzers at least semi-annually. It is recommended that carryover studies be repeated after major maintenance or repair of the pipetting assembly of the instruments, or whenever carryover is suspected.

Carryover testing on the DxI is an automated procedure that is performed when pipette integrity is compromised (e.g., obstruction errors).

The Centaur XP will not require carryover testing because it uses disposable pipet tips.

The Arkray AX-4280 has a known carryover issue. The manufacturer recommends that bloody samples not be run on the analyzer to avoid carryover.

The Advanced Instruments Osmometer also has a known carryover issue. Carryover is avoided by running samples in duplicate until results agree within 2 mOsm/Kg.

Methodology

For all carryover testing, the following template is used as defined from a CAP carryover worksheet:

POSITION	SAMPLE
1	Low 1 (L1)
2	Low 2 (L2)
3	High 3 (H3)
4	Low 4 (L4)

POSITION	SAMPLE
1	Low 5 (L5)
2	High 6 (H6)
3	Low 7 (L7)
4	Low 8 (L8)

POSITION	SAMPLE
1	High 9 (H9)
2	Low 10 (L10)

For reagent carryover on the DxC800, Triglyceride and Uric Acid are used because there is glycerol in the uric acid reagent that is measured in the Triglyceride assay. This will test each analyzer's ability to properly wash the reagent probes and cuvettes.

For sample carryover, CREm (MC sampling), LD, CK, PHY, Amphetamine, Cocaine Metabolite and/or OP (CC sampling) will be used.

For sample contamination, TBhCG will be used. A sample with a very high TBhCG will be run on the DxC800 followed by a sample with a low or negative TBhCG. The samples will then be run on the DxI800 to determine how well the DxC sample pipettors are working.

Five large sample volume tests (ALT, AST, FE, AMM, LD) are run on the low and high TBhCG samples first, then loaded on a DxI800 to determine TBhCG results. These results will be used to calculate carryover and determine sample contamination. Samples with low and high results can be searched for immediately prior to running carryover studies, or found in advance and saved in the freezer until needed for carryover studies.

The DxI800 has its own carryover procedure and acceptable limits built into the analyzer software. The test will check carryover on the sample pipettor and the 4 reagent pipettors using System Check and Wash Buffer II.

Procedure

Note: No other samples (patients, calibrations, QC) should be running or loaded on the analyzer while carryover testing is in performed.

Use the following tables to set up the carryover testing. If required, samples may be pooled to ensure adequate testing volume. When running high samples for carryover, ORDAC, OH, SD, or other error codes obtained as a result are acceptable. Numerical results are required for low sample results.

MC Sample Carryover – run every 3 months

Run Creatinine. Select a sample having a value within the normal range for the Low value.

POSITION	SAMPLE
1	Low **CREAT** (L1)
2	Low **CREAT** (L2)
3	High **CREAT** (H3)
4	Low **CREAT** (L4)

POSITION	SAMPLE
1	Low **CREAT** (L5)
2	High **CREAT** (H6)
3	Low **CREAT** (L7)
4	Low **CREAT** (L8)

POSITION	SAMPLE
1	High **CREAT** (H9)
2	Low **CREAT** (L10)

CC Sample Carryover – run every 3 months

1. Run either LDH **or** CK. Select a sample having a value within the normal range or lower for the Low value.

POSITION	SAMPLE
1	Low **CK** (L1)
2	Low **CK** (L2)
3	High **CK** (H3)
4	Low **CK** (L4)

POSITION	SAMPLE
1	Low **CK** (L5)
2	High **CK** (H6)
3	Low **CK** (L7)
4	Low **CK** (L8)

POSITION	SAMPLE
1	High **CK** (H9)
2	Low **CK** (L10)

OR

POSITION	SAMPLE
1	Low **LD** (L1)
2	Low **LD** (L2)
3	High **LD** (H3)
4	Low **LD** (L4)

POSITION	SAMPLE
1	Low **LD** (L5)
2	High **LD** (H6)
3	Low **LD** (L7)
4	Low **LD** (L8)

POSITION	SAMPLE
1	High **LD** (H9)
2	Low **LD** (L10)

2. Run Phenytoin. Select samples having a value around 3.0 ug/mL for the Low value.

POSITION	SAMPLE
1	Low **PHY** (L1)
2	Low **PHY** (L2)
3	High **PHY** (H3)
4	Low **PHY** (L4)

POSITION	SAMPLE
1	Low **PHY** (L5)
2	High **PHY** (H6)
3	Low **PHY** (L7)
4	Low **PHY** (L8)

POSITION	SAMPLE
1	High **PHY** (H9)
2	Low **PHY** (L10)

3. Run urine Amphetamines, Cocaine Metabolites **or** Opiates. Select a Negative urine for the Low value, and a Positive urine for the High value.

POSITION	SAMPLE
1	Low **AMPH** (L1)
2	Low **AMPH** (L2)
3	High **AMPH** (H3)
4	Low **AMPH** (L4)

POSITION	SAMPLE
1	Low **AMPH** (L5)
2	High **AMPH** (H6)
3	Low **AMPH** (L7)
4	Low **AMPH** (L8)

POSITION	SAMPLE
1	High **AMPH** (H9)
2	Low **AMPH** (L10)

OR

POSITION	SAMPLE
1	Low **COCM** (L1)
2	Low **COCM** (L2)
3	High **COCM** (H3)
4	Low **COCM** (L4)

POSITION	SAMPLE
1	Low **COCM** (L5)
2	High **COCM** (H6)
3	Low **COCM** (L7)
4	Low **COCM** (L8)

POSITION	SAMPLE
1	High **COCM** (H9)
2	Low **COCM** (L10)

OR

POSITION	SAMPLE
1	Low **OP** (L1)
2	Low **OP** (L2)
3	High **OP** (H3)
4	Low **OP** (L4)

POSITION	SAMPLE
1	Low **OP** (L5)
2	High **OP** (H6)
3	Low **OP** (L7)
4	Low **OP** (L8)

POSITION	SAMPLE
1	High **OP** (H9)
2	Low **OP** (L10)

Reagent Carryover
Select any sample(s) for this carryover evaluation.

POSITION	SAMPLE
1	TG (L1)
2	TG (L2)
3	URIC ACID (H3)
4	TG (L4)

POSITION	SAMPLE
1	TG (L5)
2	URIC ACID (H6)
3	TG (L7)
4	TG (L8)

POSITION	SAMPLE
1	URIC ACID (H9)
2	TG (L10)

Sample Contamination – run every 6 months
Carryover evaluation for Sample Contamination is performed first on the DxC800 (running several high-

volume tests), then on a DxI (for TBhCG). Inadequate washing of the DxC800 sample probe may allow carryover of TBhCG, which will be seen when the samples are run on the DxI800.
Select samples with a TBhCG less than 20 mIU/mL for the Low value, and samples with TBhCG close to 100,000 mIU/mL for the High value. Samples with Low and High values are not required for the DxC tests. Samples may have to be pooled to have enough sample volume to run the carryover studies.

Run **ALT, AST, FE, AMM, LD** on the Low and High TBhCG samples.

POSITION	SAMPLE
1	ALT, AST, FE, AMM, LD **(L1)**
2	ALT, AST, FE, AMM, LD **(L2)**
3	ALT, AST, FE, AMM, LD **(H3)**
4	ALT, AST, FE, AMM, LD **(L4)**

POSITION	SAMPLE
1	ALT, AST, FE, AMM, LD **(L5)**
2	High ALT, AST, FE, AMM, LD (H6)
3	ALT, AST, FE, AMM, LD **(L7)**
4	ALT, AST, FE, AMM, LD **(L8)**

POSITION	SAMPLE
1	ALT, AST, FE, AMM, LD **(H9)**
2	ALT, AST, FE, AMM, LD **(L10)**

Run **TBhCG** on the **SAME SAMPLES** on either of the DxI800s.

POSITION	SAMPLE
1	Low **TBhCG** (L1)
2	Low **TBhCG** (L2)
3	High **TBhCG** (H3)
4	Low **TBhCG** (L4)

POSITION	SAMPLE
1	Low **TBhCG** (L5)
2	High **TBhCG** (H6)
3	Low **TBhCG** (L7)
4	Low **TBhCG** (L8)

POSITION	SAMPLE
1	High **TBhCG** (H9)
2	Low **TBhCG** (L10)

Results

After running the samples, carryover calculations can then be performed.

POSITION	SAMPLE
1	Low 1 (L1)
2	Low 2 (L2)
3	High 3 (H3)
4	Low 4 (L4)

POSITION	SAMPLE
1	Low 5 (L5)
2	High 6 (H6)
3	Low 7 (L7)
4	Low 8 (L8)

POSITION	SAMPLE
1	High 9 (H9)
2	Low 10 (L10)

The following calculations are performed for each of the evaluations:

A = Average of L after H (results from L4, L7 and L10)

B = Average of L after L (results from L2, L5 and L8)

Difference of Averages = A - B

$$\text{Percent Carryover (\%)} = \frac{\text{Difference of Averages}}{B} \times 100$$

EXCEL spreadsheets on the S-drive will auto-calculate the results when results are entered. Save a copy of the results, using the date of evaluation and instrument ID as part of the file name.

Acceptable Limits

CREATININE	<10%
ENZYMES (LD, CK)	<5%
TDMs (PHY)	<10%
DAUs (AMPH, COCM, OP)	<1.5%
TBhCG	<10%
TRIGLYCERIDES	<3%

If any test fails carryover, do not load patient samples on the analyzer. Instrument loading should also be paused in PrepLink to prevent the automation line from routing samples to the analyzer. Patient results shall be reviewed and/or repeated on another analyzer. Perform troubleshooting by observing for any obvious problems. If you are unable to determine cause of carryover problem, generate a service call for the analyzer. Do not run any patients on the analyzer until all carryover problems have been corrected.

References

Boneno, Joseph, Fokakis, Michaelle, Armbruster, Dave, “Reagent Carryover Studies: Preventing Analytical Error with Open Clinical Chemistry Systems”, Lab Medicine, Volume 36, Number 11, November 2005, 705-710

Haeckel, R., 'for definition and determination of carryover effects”, Journal of Automatic Chemistry, Vol. 10, No. 4 (October-December 1988), pp. 818-183

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Prepared By	Date Adopted	Supersedes Procedure #
Michael Inn	12/03/2012	New

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