TRAINING UPDATE

Lab Location:	SGMC & WOMC	**Date Distributed:**	1/6/2020
Department:	Core Lab	**Due Date:**	1/31/2020
		Implementation:	**1/15/2020**

DESCRIPTION OF PROCEDURE REVISION

Name of procedure:

Carbon Dioxide by Dimension Vista® System SGAH.C93 v3

Description of change(s):

Minor changes to SOP, type of water used as diluent updated in response to CQA inspection deficiency

Section	Reason
Header	Change WAH to WOMC
7.3	Add reagent grade water
10.6	Specify water type for manual dilution; updated instruction if above CRR
16	Updated SOP titles
17	Updated insert dates

This revised SOP will be implemented on January 15, 2020

Document your compliance with this training update by taking the quiz in the MTS system.

Technical SOP

Title	**Carbon Dioxide by Dimension Vista® System**		
Prepared by	Ashkan Chini	Date:	6/25/2012
Owner	Robert SanLuis	Date:	2/5/2014

Laboratory Approval	**Local Effective Date:**	
Print Name and Title	**Signature**	**Date**
Refer to the electronic signature page for approval and approval dates.		

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1. TEST INFORMATION

Assay	Method/Instrument	Local Code
Carbon Dioxide	Dimension Vista® System	CO2

Synonyms/Abbreviations
ECO2, CO2, included in Batteries/Packages: BMP, COMP, LYTE and RENP

Department
Chemistry

2. ANALYTICAL PRINCIPLE

The enzymatic carbonate method for the Dimension Vista® System employs a phosphoenolpyruvate carboxylase-malate dehydrogenase coupled enzymatic reaction and a stable analog of the cofactor NADH. The bicarbonate anion reacts with phosphoenolpyruvate in the presence of phosphoenolpyruvate carboxylase (PEPC) and Mg++ to form oxaloacetate and inorganic phosphate (Pi). The oxaloacetate is reduced to malate by malate dehydrogenase (MDH) with simultaneous oxidation of the reduced form of an analog (aNADH) of the cofactor, NADH.

$$HCO_3^- + \text{Phosphoenolpyruvate} \xrightarrow{\text{PEPC, } Mg^{++}} \text{Oxaloacetate} + P_i$$

$$\text{Oxaloacetate} + \text{aNADH} + H^+ \xrightarrow{\text{MDH}} \text{Malate} + \text{aNAD}^+$$

3. SPECIMEN REQUIREMENTS

3.1 Patient Preparation

Component	Special Notations
Fasting/Special Diets	N/A
Specimen Collection and/or Timing	Normal procedures for collecting and storing serum and plasma may be used for samples to be analyzed by this method.
Special Collection Procedures	N/A
Other	N/A

3.2 Specimen Type & Handling

Criteria	
Type -Preferred **-Other Acceptable**	Plasma (Lithium Heparin) Serum
Collection Container	Plasma: Mint green top tube (PST) Serum: Red top tube, Serum separator tube (SST)
Volume - Optimum **- Minimum**	1.0 mL 0.5 mL
Transport Container and Temperature	Collection container or Plastic vial at room temperature
Stability & Storage Requirements	Room Temperature: 8 hours
	Refrigerated: 2 days
	Frozen: 6 months
Timing Considerations	Total Carbon Dioxide concentration may be decreased by 6 mmol/L when uncapped specimens are exposed to the air for one hour. Serum or plasma should be physically separated from cells as soon as possible with a maximum limit of two hours from the time of collection.
Unacceptable Specimens & Actions to Take	Specimens that are unlabeled, improperly labeled, or those that do not meet the stated criteria are unacceptable. Request a recollection and credit the test with the appropriate LIS English text code for "test not performed" message. Examples: Quantity not sufficient-QNS; Wrong collection-UNAC. Document the request for recollection in the LIS.
Compromising Physical Characteristics	Gross hemolysis. Reject sample and request a recollection. Credit the test with the appropriate LIS English text code explanation of HMT (Specimen markedly hemolyzed)
Other Considerations	Allow Red Top or SST to clot completely prior to centrifugation.

NOTE: Labeling requirements for all reagents, calibrators and controls include: (1) Open date, (2) Substance name, (3) Lot number, (4) Date of preparation, (5) Expiration date, (6) Initials of tech, and (7) Any special storage instructions. Check all for visible signs of degradation. When placed onboard the analyzer, the instrument captures the date / time loaded and calculates and tracks the opened expiration.

4. REAGENTS

The package insert for a new lot of kits must be reviewed for any changes before the kit is used. A current Package Insert is included as a Related Document.

4.1 Reagent Summary

Reagents	Supplier & Catalog Number
Carbon Dioxide	Siemens, Flex® reagent cartridge, Cat. No. K1137

4.2 Reagent Preparation and Storage

Reagent	**Carbon Dioxide**
Container	Reagent cartridge
Storage	Store at 2-8°C
Stability	• Stable until expiration date stamped on reagent cartridges. • Sealed wells on the instrument are stable for 30 days. • Open well stability: 1 day for wells 1 - 12
Preparation	All reagents are liquid and ready to use.

5. CALIBRATORS/STANDARDS

5.1 Calibrators/Standards Used

Calibrator	Supplier and Catalog Number
CHEM 3 CAL	Siemens Dimension Vista®, Cat. No. KC130A

5.2 Calibrator Preparation and Storage

Calibrator	CHEM 3 CAL
Preparation	Calibrator is ready for use. No preparation is required.
Storage/Stability	• Store at 2 – 8°C • **Unopened Calibrator:** until expiration date on the box. • **Opened Calibrator:** once the stopper of the vial is punctured, assigned values are stable for 24 hours when stored on board the Dimension Vista System.

5.3 Calibration Parameter

Criteria	**Special Notations**
Reference Material	CHEM 3 CAL
Assay Range	1 – 45 mmol/L
Suggested Calibration Level	See Reagent Package Insert for lot specific assigned values in mmol/L
Frequency	• Every new reagent cartridge lot. • Every 90 days for any one lot • When major maintenance is performed on the analyzer. • When control data indicates a significant shift in assay.
Calibration Scheme	2 levels, n = 5

5.4 Calibration Procedure

Auto Calibration:

1. Place the required calibrator vials in a carrier. Make sure the barcode labels are entirely visible through the slots.
2. Place the carrier in the loading area.
3. Position the carrier with the labels facing away from the user.
4. Press the **Load** button.
5. Automatic calibration requires that calibrators be on the instrument. As the time for processing approaches, the instrument reviews onboard inventory for the appropriate calibrators.

Manual Calibration:

1. Verify that calibrators and reagents are in inventory on the instrument.
2. Press **System > Method Summary > Calibration**.
3. Select a method from the sidebar menu. Press the **Order Calibration** button on the screen.
4. Verify that the information on the screen is correct. Verify that the calibrator lot is correct using the drop-down menu.
   a. When calibrating using Vials press **OK**.
   b. When calibrating using Cups, check the Use Cups box. This displays the rack and cup position fields. For additional cups use the positions in ascending order. Be sure to use the number of calibration levels and cups as specified in the method IFU. Scan the rack barcode and place calibrator cups in an adapter in position 1 on a rack. Press **OK** and load the rack on the instrument.
5. The status field in the calibration screen changes sequentially to Awaiting Scheduling, Preparing Calibrators and Processing.

5.5 Tolerance Limits

IF……	THEN……
If result fall within assay-specific specification, and QC values are within acceptable limits,	proceed with analysis
If result falls outside assay-specific specification, or QC values are out of Acceptable limits,	troubleshoot the assay and/or instrument and repeat calibration

6. QUALITY CONTROL

6.1 Controls Used

Controls	Supplier and Catalog Number
Liquid Assayed Multiqual® Levels 1 and 3	Bio-Rad Laboratories Cat. No. 337 and 339

6.2 Control Preparation and Storage

Control	Liquid Assayed Multiqual® Levels 1 and 3
Preparation	Allow the frozen control to stand at room temperature (18-25°C) for 30 minutes or until completely thawed. Swirl the contents gently to ensure homogeneity. (Do not use a mechanical mixer) Use immediately.
Storage/Stability	**Frozen**: stable until the expiration date at -20 to -50°C. **Thawed and Unopened**: When stored at 2-8°C and the stopper is not punctured, it will be stable for 30 days for CO2. This product can be used for 7 days when stored on-board the Siemens Dimension Vista at 2- 8°C. **Thawed and Opened**: Once the stopper is punctured, all analytes will be stable for 5 days when stored at 2- 8°C. Store away from light.

6.3 Frequency

Analyze all levels of QC material after every calibration and each day of testing (notated on the QC frequency sheets posted on the instruments).

Refer to the Dimension Vista® QC Schedule in the Laboratory policy Quality Control Program and in the Dimension Vista® Quick Reference Guide.

6.4 Tolerance Limits and Criteria for Acceptable QC

Step	Action
1	Acceptable ranges for QC are programmed into the instrument's Quality Control software system and Unity Real Time, and may be posted near the instrument for use during computer downtime.
2	**Run Rejection Criteria** • Anytime the established parameters are exceeded (if one QC result exceeds 2 SD), the run is considered out of control (failed) and patient results must not be reported. • The technologist must follow the procedure in the Laboratory QC Program to resolve the problem.
3	**Corrective Action**: • All rejected runs must be effectively addressed through corrective action. Steps taken in response to QC failures must be documented. Patient samples in failed analytical runs must be reanalyzed according to the Laboratory QC Program. Supervisors may override rejection of partial or complete runs only with detailed documentation and criteria for overrides that are approved by the Medical Director. Consult corrective action guidelines in Laboratory

Step	Action
	QC Program. Follow corrective action guidelines in the Laboratory QC Program. • Corrective action documentation must follow the Laboratory Quality Control Program.
4	**Review of QC** • QC must be reviewed weekly by the Group Lead or designee and monthly by the Supervisor/Manager or designee. • If the SD and/or CV are greater than established ranges, investigate the cause for the imprecision and document implementation of corrective actions.

6.5 Documentation

- QC tolerance limits are programmed into the instrument and Unity Real Time; it calculates cumulative mean, SD and CV and stores all information for easy retrieval.
- Quality control records are reviewed daily at the bench, weekly by the Group Lead or designee, and monthly by the Supervisor/Manager or designee.
- Refer to complete policies and procedures for QC documentation and for record retention requirements in the Laboratory QC Program.

6.6 Quality Assurance Program

- Each new lot number of reagent or new shipment of the same lot of reagent must be tested with external control materials and previously analyzed samples. Performance of the new lot must be equivalent to the previous lot; utilize published TEA for acceptability criteria.
- Training must be successfully completed and documented prior to performing this test. This procedure must be incorporated into the departmental competency assessment program.
- The laboratory participates in CAP proficiency testing. All proficiency testing materials must be treated in the same manner as patient samples.
- Monthly QC must be presented to the Medical Director or designee for review and signature.
- Monthly QC mean and SD are sent to Bio-Rad Laboratories for peer group comparison.
- Consult the Laboratory QC Program for complete details.

7. EQUIPMENT and SUPPLIES

7.1 Assay Platform

Dimension Vista® System

7.2 Equipment

- Refrigerator capable of sustaining 2–8°C.
- Freezer capable of sustaining range not to exceed -20 to -50°C.
- Centrifuge

7.3 Supplies

- Aliquot Plates
- System Fluids
- Assorted calibrated pipettes (MLA or equivalent) and disposable tips
- Reagent grade water

8. PROCEDURE

CO2 Flex® reagent cartridge Cat. No. K1137 is required to perform this test.

Carbon Dioxide is performed on the Dimension Vista® System after the method is calibrated (see Reference Material in Calibration section) and Quality Controls are acceptable.

NOTE: For all procedures involving specimens, buttoned lab coats, gloves, and face protection are required minimum personal protective equipment. Report all accidents to your supervisor.

8.1	Sample Processing
1.	A sample rack holding tubes or cups is placed on the rack input lane.
2.	The sample shuttle moves the rack to the barcode reader which identifies the rack and samples to the system.
3.	The rack moves into the sample server and to the rack positioner.
4.	At the same time, aliquot plates move from the aliquot loader into position.
5.	The aliquot probe aspirates the sample from the tubes or cups and dispenses it into the wells of the aliquot plates.
6.	After each aspirate-dispense action, the probe is thoroughly rinsed inside and out to prevent sample carryover.
7.	When sample aspiration is completed, the sample server moves the rack back to the sample shuttle, where it is placed on the output lane and can be removed by the operator.

8.2	Specimen Testing
1.	For QC placement and frequency, refer to the Dimension Vista® QC Schedule in the Laboratory QC Program.
2.	Follow the instructions, outlined in the Dimension Vista® Operator's Manual
3.	The instrument reporting system contains error messages to warn the user of specific malfunctions. Results followed by such error messages should be held for follow-up. Refer to the Dimension Vista® system manual "Error messages" section for troubleshooting.

8.2	Specimen Testing
4.	Follow protocol in Section 10.5 "Repeat criteria and resulting" for samples with results above or below the Analytical Measurement Range (AMR). Investigate any failed delta result and repeat, if necessary.
5.	Append the appropriate English text code qualifier messages to any samples requiring a comment regarding sample quality and/or any other pertinent factors.

Test Conditions	
Sample Volume:	1.9 µL
Reagent Volume:	38 µL
Reaction Time:	1.9 minutes
Test Temperature:	37° C
Wavelength:	405 & 700 nm
Type of measurement:	Bichromatic rate

NOTE: In the event that the test system becomes inoperable, notify supervision or designee for further direction. Patient specimens must be stored in a manner that maintains the integrity of the specimen.

9. CALCULATIONS

The instrument automatically calculates the concentration of carbon dioxide in mmol/L.

10. REPORTING RESULTS AND REPEAT CRITERIA

10.1 Interpretation of Data

None required

10.2 Rounding

No rounding is necessary. Instrument reports results as a whole number.

10.3 Units of Measure

mmol/L

10.4 Clinically Reportable Range (CRR)

1 – 90 mmol/L

10.5 Review Patient Data

Each result is reviewed for error messages. Refer to the Dimension Vista system manual "Error messages" section for troubleshooting. Resolve any problems noted before issuing patient reports.

10.6 Repeat Criteria and Resulting

All repeats must replicate the original result within the total allowable error (TEa) of the assay. Refer to TEa listing for specific information.

Values that fall below or within the AMR or CRR may be reported without repeat. Values that exceed the upper ranges must be repeated.

IF the result is …	THEN…
< 1 mmol/L	Assure there is sufficient sample devoid of bubbles, cellular debris, and/or fibrin clots. Report as: < 1 mmol/L
> 45 mmol/L	**Manual Dilution**: Using the primary tube, make the smallest dilution possible to bring the raw data within the AMR. Maximum allowable dilution: x 2 **Diluent**: Reagent grade water Enter dilution factor as a whole number. Re-assay. Readout is corrected for dilution.
> 90 mmol/L	If the recommended dilution does not give results within the clinically reportable range, report as: "> 90 mmol/L-REP" Bring to the attention of Tech in Charge (TIC) or Group Lead to check for integrity issues prior to release of results.

Message	Code
Verified by repeat analysis	Append –REP to the result.

11. EXPECTED VALUES

11.1 Reference Ranges

Age	Female / Male
Adult (>18 years):	21 – 32 mmol/L
Pediatric:	
2 – 18 years	21 - 32
13 - 23 months	16 - 25
6 – 12 months	14 - 23
1 – 5 months	13 - 23
7 – 30 days	13 - 22
0 – 6 days	13 - 21

11.2 Critical Values

< 10 mmol/L

11.3 Standard Required Messages

None established

12. CLINICAL SIGNIFICANCE

Increase in serum CO_2 content for the most part reflects increase in serum bicarbonate concentration rather than dissolved CO_2 gas (which accounts for only a small fraction of the total). Increased serum bicarbonate is seen in compensated respiratory acidosis and in metabolic alkalosis. Diuretics (thiazides, ethacrynic acid, furosemide, mercurials), corticosteroids (in long term use), and laxatives (when abused) may cause increased bicarbonate.
Decrease in blood CO_2 is seen in metabolic acidosis and compensated respiratory alkalosis. Substances causing metabolic acidosis include ammonium chloride, acetazolamide, ethylene glycol, methanol, paraldehyde, and phenformin. Salicylate poisoning is characterized by early respiratory alkalosis followed by metabolic acidosis with attendant decreased bicarbonate.

13. PROCEDURE NOTES

- **FDA Status:** FDA Approved/cleared
- **Validated Test Modifications:** None

The instrument reporting system contains error messages to warn the operator of specific malfunctions. Any report slip containing such error messages should be held for follow-up. Refer to your Dimension Vista Operator's Guide.

The expected maximum observed standard deviations for repeatability using n = 5 replicates at the following carbon dioxide concentrations are:

CO2 Concentration	Acceptable S.D. Maximum
11 mmol/L	2 mmol/L
23 mmol/L	3 mmol/L

14. LIMITATIONS OF METHOD

14.1 Analytical Measurement Range (AMR)

1 – 45 mmol/L

14.2 Precision

Material	Mean mmol/L	Standard Deviation (%CV)	
		Repeatability	Within-Lab
Multiqual Control			
Level 1	12	0.4 (2.9)	0.6 (4.6)
Level 2	25	0.6 (2.4)	1.1 (4.5)

14.3 Interfering Substances

Turbidity at 3000 mg/dL decreases CO2 results by 35% at CO2 concentration of 28 mmol/L.

HIL Interference:
The CO2 method was evaluated for interference according to CLSI/NCCLS EP7-A2. Bias, defined as the difference between the control sample (does not contain interferent) and the test sample (contains interferent), is shown in the table below. Bias exceeding 10% is considered "interference".

Substance tested	Substance Concentration	CO2 mmol/L	Bias %
Hemoglobin (hemolysate)	1000 mg/dL	30	<10
Bilirubin (unconjugated)	60 mg/dL	31	<10
Bilirubin (conjugated)	60 mg/dL	31	<10
Lipemia Intralipid®	1000 mg/dL 3000 mg/dL	28	<10 -35

14.4 Clinical Sensitivity/Specificity/Predictive Values

Not available

15. SAFETY

Refer to your local and corporate safety manuals and Safety Data Sheet (SDS) for detailed information on safety practices and procedures and a complete description of hazards.

CHEM 3 CAL may cause an allergic skin reaction.
Wear protective gloves/protective clothing/eye protection/face protection. Contaminated work clothing should not be allowed out of the workplace. IF ON SKIN: Wash with plenty of soap and water. If skin irritation or rash occurs: Get medical advice/attention

16. RELATED DOCUMENTS

1. Dimension Vista® Clinical Chemistry System Operator's Manual
2. Dimension Vista® Calibration/Verification Procedure
3. Dimension Vista® Cal Accept Guidelines
4. Dimension Vista® Calibration summary
5. Dimension Vista® Sample Processing, Startup and Maintenance procedure
6. Laboratory Quality Control Program
7. QC Schedule for Siemens Dimension Vista®
8. Laboratory Safety Manual
9. Safety Data Sheets (SDS)
10. Dimension Vista® Limits Chart (AG.F200)
11. Quest Diagnostics Records Management Procedure
12. Dimension Vista® System Error Messages Chart
13. Centrifuge Use, Maintenance and Functions Checks (Lab policy)
14. Specimen Acceptability Requirements (Lab policy)
15. Repeat Testing Requirement (Lab policy)
16. Current Allowable Total Error Specifications at http://questnet1.qdx.com/Business_Groups/Medical/qc/docs/qc_bpt_tea.xls
17. Current package insert CO2 Flex® Reagent Cartridge K1137

17. REFERENCES

1. Ghoshal, Amit K. and Soldin, Steven J., Evaluation of the Dade Behring Dimension® RxL: Integrated chemistry system-pediatric reference ranges. Clinica Chimica Acta 2003; 331:144.
2. Package Insert, CO2 Flex® Reagent Cartridge K1137, Siemens Healthcare Diagnostics Inc., 04/29/2013.
3. Package Insert, CHEM 3 CAL, Siemens Healthcare Diagnostics Inc., 9/2019.
4. Package Insert, Liquid Assayed Multiqual® Chemistry Controls, Bio-Rad Laboratories, 05/2017.

18. REVISION HISTORY

Version	Date	Section	Reason	Reviser	Approval
000	2/5/14		Update owner	L Barrett	R SanLuis
000	2/5/14	5	Change in Calibrator, update information	A Chini	R SanLuis
000	2/5/14	16	Update titles	L Barrett	R SanLuis
000	2/5/14	17	Update calibrator package insert	A Chini	R SanLuis
000	2/5/14	Footer	Version # leading zero's dropped due to new EDCS in use as of 10/7/13.	L Barrett	R SanLuis
1	2/22/18	Header	Add WAH	L Barrett	R SanLuis
1	2/22/18	3.2	Specify anticoagulant	L Barrett	R SanLuis
1	2/22/18	4,5,6	Remove individual section labeling instructions and add general one	L Barrett	R SanLuis
1	2/22/18	6.1, 6.2	Update QC material and storage	L Barrett	R SanLuis
1	2/22/18	6.4, 6.6	Replace LIS with Unity Real Time	L Barrett	R SanLuis
1	2/22/18	7.2	Change freezer upper limit to -50C	L Barrett	R SanLuis
1	2/22/18	10.5	Move patient review from section 6	L Barrett	R SanLuis
1	2/22/18	10.6	Remove repeat value below AMR/CRR	L Barrett	R SanLuis
1	2/22/18	15	Update to new standard wording; add warning for calibrator	L Barrett	R SanLuis
1	2/22/18	17	Update QC product and PI dates	L Barrett	R SanLuis
2	12/26/19	Header	Change WAH to WOMC	L Barrett	R SanLuis
2	12/26/19	7.3	Add reagent grade water	L Barrett	R SanLuis
2	12/26/19	10.6	Specify water type for manual dilution; updated instruction if above CRR	L Barrett	R SanLuis
2	12/26/19	16	Updated SOP titles	L Barrett	R SanLuis
2	12/26/19	17	Updated insert dates	L Barrett	R SanLuis

19. ADDENDA

None