

OREGON HEALTH & SCIENCE UNIVERSITY
Hospitals and Clinics
Point of Care

**Blood Gas, Electrolytes, Glucose, Chloride, iCa, Lactate,
Hemoglobin, and Oxygen Saturation by ABL 825**

Principle

The ABL 825 analyzer is used for measurement of pH, blood gases (pO₂ and pCO₂), electrolytes, metabolites, and hemoglobin status in arterial, venous, and capillary blood samples.

Blood gases and lactate are obtained to determine if the patient is well oxygenated and to determine the acid base status of the patient. The pH determines if the patient is in an acidic or alkali state, the pO₂ refers to the pressure or tension exerted by dissolved O₂ gas in the blood. The pCO₂ is influenced by respiratory causes only. The O₂ measurement indicates how well the tissues are oxygenated. The oxygenation of blood from the lungs and the circulation of the blood from the heart contribute to the amount of pO₂ measured and renal compensation to the acid/base disturbance. The O₂ saturation is calculated as a ratio and shows the percentage of the volume of oxygen carried to the maximum volume which is possible to carry.

Electrolytes help maintain osmotic pressure, regulation of heart and other muscular contraction, oxidation-reduction potential, and participate as catalysts for enzymes. Disturbance of K⁺ homeostasis causes muscle weakness and affects heart rate. Sodium maintains normal distribution of water through osmotic pressure. Ionized calcium is the active form of calcium and is useful in the evaluation of renal function and endocrine disorders.

Hemoglobin is the main chemical substance within red blood cells and is the compound which transports the major portion of oxygen to the tissues. The ABL 825 optical system is designed to measure total hemoglobin, oxygen saturation, and hemoglobin derivatives in human blood.

Abnormal amounts of lactic acid in the blood can be due to severe tissue hypoxia as seen in severe anemia, shock, cardiac decompensation or pulmonary insufficiency. Other types of lactic acid acidosis may be caused by drugs and toxins (ethanol, methanol, biguanides or streptozotocin); by acquired and hereditary defects in enzymes involved in gluconeogenesis; by disorders such as severe acidosis, uremia, liver failure, tumors, and seizure; and during anesthesia.

Specimen Requirements

1. Whole blood collected in a standardized hospital Lithium Heparin syringe. Do not use other heparin solutions.
2. Perform tests immediately.

3. Minimum volume is 195 μ L.

Interferences

Substance	Source	Interference
Halothane	Anesthetic	Unreliable pO ₂ results.
Lipid therapy, protamine sulfate	Treatment	Oximetry measurements. May be necessary to use cleaning program after analysis.
Methylene Blue, HiCN	Medication	Oximetry measurements.
Anions: Br, I, S, ClO ₄	Drugs	Erroneously high Cl results.
Anticoagulants other than heparin	Sampling	Unreliable Na, K, Ca, glucose, or lactate depending on anticoagulant.
Thiocyanate	Degradation from treatment with Nitroprusside or thiosulphate	Erroneously high glucose and lactate.
Glycolic Acid	Ethylene glycol degradation	Erroneously high lactate.
Insufficiency stabilized blood: caustic fluids, high viscosity hydrophobic reactive fluids	Varies	Varies

Analytical Measurement Range (Linearity)

Analyte	AMR	If Value is Outside Linear Range, Report Results as Follows:
pH	6.80-7.80	<6.80 or >7.80
pCO ₂	0.0-100 mmHg	<1.0 or >100
pO ₂	0-500 mmHg	<1.0 or >500
tHb	0.0-25.0 mmol/L	
sO ₂	0.0-100.0%	<1.0
FO ₂ Hb	0-100% 0.0-1.00 fraction	
K ⁺	0.5-15.0 mmol/L	<0.5 or >15.0
Na ⁺⁺	75-170 mmol/L	<75 or >170
Cl ⁻	60-130 mmol/L	<60 or >130
Ionized Ca ⁺⁺	0.20-2.00 mmol/L	<0.20 or >2.00
Lactate	0.0-30.0 mmol/L	<0.1 or >30.0
Glucose	0.0-1000 mg/dL	<1 or >1000

Reference Range

Analyte	Age	Arterial	Venous	Capillary
pH	0-2 months	7.30-7.50	7.35-7.45	7.30-7.45
pH	>2 months	7.37-7.44	7.35-7.45	7.37-7.44
pCO ₂ (mmHg)	0-2 months	30-65	30-65	30-69
pCO ₂ (mmHg)	>2 months	32-43	35-50	30-69
pO ₂ (mmHg)	0-2 months	50-75	30-55	40-50
pO ₂ (mmHg)	2mo-40 yrs	83-108	30-55	40-50
pO ₂ (mmHg)	>40 years	72-104	30-55	40-50
O ₂ Sat (%)	0-1 Month	40-90		
	1 Mo – 50 yr	92- 98		
HCO ₃ (mMol/L)	No age limit	21-28	22-28	N/A
Total CO ₂ (mMol/L)	0-150 yrs	22-29	23-29	N/A
Na ⁺ (mMol/L)	No age limit	134-143	134-143	134-143
K ⁺ (mMol/L)	No age limit	3.4-5.0	3.4-5.0	3.4-5.0
Cl ⁻ (mMOL/L)	No age limit	97-108	97-108	97-108
iCa ⁺⁺ , meas. (mMol/L)	No age limit	1.14-1.32	1.14-1.32	1.14-1.32
Lactate	No age Limit	0.5-1.6	0.5-2.2	
Glucose (mg/dL)	0-1 Day	40-60	40-60	40-60
	1 Day-150 yr	60-99	60-99	60-99
Hemoglobin		Male	Female	
	0-6 months	9.5-14.0	9.5-14.0	
	6 mos-1 yr	10.5-13.5	10.5-13.5	
	1-12 yrs	11.5-13.5	11.5-13.5	
	12-18 yrs	13.0-16.0	13.0-16.0	
	18-150 yrs	13.5-17.5	12.2-15.0	

Analyte	Age	Cord Blood Arterial	Cord Blood Venous
pH	Birth	7.17-7.31	7.21-7.37
pCO ₂ (mmHg)	Birth	41-59	33-53
pO ₂ (mmHg)	Birth	10-26	18-38
HCO ₃ (mMol/L)	Birth	20.5-25.5	N/A

Alert Values

Critical alert values are only applicable with the measured results. Temperature corrected results do not contain critical values. Critical values are those results demonstrating such variance from normal as to represent a pathophysiological state with potential of being life threatening unless action is taken quickly. These results must be immediately reported to the care provider and be documented in the test record as to who was contacted, the time of contact, the person making contact, and if relevant, that the results were read back.

Analyte	Age	Arterial	Venous	Capillary
pH	No age limit	$\leq 7.25, \geq 7.55$	N/A	$\leq 7.18, \geq 7.50$
pCO ₂ (mmHg)	No age limit	$\leq 20, \geq 70$	N/A	≥ 80
pO ₂ (mmHg)	No age limit	≤ 50 , no upper limit	N/A	N/A
Na ⁺ (mMol/L)	No age limit	$\leq 120, \geq 160$	$\leq 120, \geq 160$	$\leq 120, \geq 160$
K ⁺ (mMol/L)	No age limit	$\leq 2.5, \geq 6.0$	$\leq 2.5, \geq 6.0$	$\leq 2.5, \geq 6.0$
Hemoglobin	No age limit	<6.6, >18.9	<6.6, >18.9	<6.6, >18.9
Glucose-	Neonate	<40, >300	<40, >300	<40, >300
Glucose	Non-Neonate	<50, >500	<50, >500	<50, >500

Calibration

One and two point calibration can be scheduled or requested manually.

1. Two-point calibration must be scheduled every eight hours.
2. One-point calibration must be:
 - a. Scheduled every thirty minutes.
 - b. Scheduled after each patient sample is run.
 - c. Requested manually before each patient sample is run.
3. To schedule calibrations at a specific interval or after every patient sample, refer to page 6-4 in ABL 800 Operators Manual. Contact POC at 4-5497 with any questions.
4. To manually request one step calibration:
 - a. From the Main Menu, Press Start Programs.
 - b. Press Calibration programs.
 - c. Press one-point calibration.
5. One or two-point calibrations can be requested during instrument troubleshooting.

Quality Control Using the AutoCheck Control Solutions

1. Perform three levels of aqueous Quality Control (QC) every 24 hours of patient testing following the posted QC schedule. At least one level of aqueous control must be run every eight hours of patient testing.

Check AutoCheck Status. Press the *AutoCheck* touch-key on the Replacement Status screen.

2. Next Replacement box shows the next AutoCheck Solution/Lot combination according to the scheduled set-up. If this solution is not in the carousel, the box will be red.
3. Available box shows the presently available AutoCheck+ control solutions, type, lot, and quantity of ampoules in the carousel.
4. Packing list displays the Optimal Packing List screen. List gives the control solution types and the number of ampoules to be packed in the carousel according to the QC schedule.

After a packed carousel is placed in the AutoCheck module and scanned, the following message will appear that "Packing List Confirmed." If the Carousel has not been packed according to the list, the message will be "Carousel Not Packed According to Schedule."

Scheduled AutoCheck Measurements

A scheduled AutoCheck measurement will start on time provided no calibrations are pending. If a calibration is pending, calibration will be run first.

1. A QUALITY CONTROL RESULT screen appears when the QC test is complete.
2. If QC test passes, the result is marked by OK.
3. If the QC test fails, the parameter which failed will be RED and marked with an ↑ or a ↓. An explanation of the failure will be printed in the lower left-hand corner of the QC results printout. Repeat the failed QC.
4. If repeat QC test fails, do not perform patient testing. Consult ABL 800 Series Manual Chapter 11 and the troubleshooting flow sheet. For further assistance, call Radiometer Technical Support at 1-800-800-7005.

Manual QC Run

1. Press Control/Status.
2. Press AutoCheck Program.
3. Select QC level by using the up and down arrow and Select/Deselect buttons.
4. Press Run Selected.

QC Data Management

Monthly

1. Save calibration, activity, patient log, and QC logs to a memory stick or CD at the end of each month and e-mail QC data log file and WDC file to POC Coordinator.
2. To Export Data Logs:
 - a. Insert a Memory stick into the USB Port or a CD into the CD/RW drive.
 - b. Press **Export Data Logs** on the **Disk Functions** screens.
 - c. Activate the check touch-keys beside the data logs that are to be exported.
 - Patient logs ✓
 - Quality control log ✓
 - Calibration log ✓
 - Activity log ✓
 - d. Activate the calendar icon in the Date interval box to choose dates.
 - e. Type date (first day of month) in the From box and confirm with ENTER.
 - f. Type date (last day of month) in the To box and confirm with ENTER.
 - g. Press the **Back** touch key to return to Export Data logs screen.
 - h. Activate the drive icon in the Destination box.
 - i. Choose the appropriate destination location.
 - j. Press the **Open/Close** touch key to select the destination directory.
 - k. Press the **Back** touch key to return to Export Data logs screen.
 - l. Press **Start**.
 - m. When done exporting, e-mail QC log files to POC Coordinator.
3. To Create a WDC Report to send to Radiometer:
 - a. Insert a Memory stick into the USB Port or a CD into the CD/RW drive.
 - b. Press the **WDC Report** on the **Disk Functions** screens.
 - c. In the Export WDC data box, set the dates (From and To as noted above) for the month using the Up/Down touch-keys.
 - d. Press the Store Info key to continue.
 - e. Press continue.
 - f. Wait until the Disk Function screen appears before removing the CD or memory stick with the WDC report.
 - g. E-mail the WDC report to the POC Coordinator. Radiometer can identify your data from the serial number in the files. Do not open the files before e-mailing.
 - h. Data will be analyzed by Radiometer and reports made available online to the POC Coordinator for review. POC coordinator will notify users of any QC issues.

Procedure

1. Verify the overall status of the analyzer. The color signal, status, and action are summarized as follows:

Color	Status	Corrective Action
Green	Analyzer okay to use.	None.
Yellow	Error and/or reminder.	Verify which touch keys are yellow and perform troubleshooting as advised. Refer to Chapter 12, Troubleshooting in Operator's Manual
Red	Critical error. Analyzer cannot perform measurement.	Do not use analyzer. Verify which touch keys are red and perform troubleshooting as advised. Refer to Chapter 12, Troubleshooting in Operator's Manual.

2. If READY light is green, mix the sample well by rolling the syringe between palms.
3. Lift the syringe inlet flap and an INSTRUCTIONAL screen appears.
4. Place the syringe tip up into the inlet.
5. Press the ALL 195 μ L touch key to select the blood mode. The ALL 195 μ L mode requires a 195 μ L sample, performs all tests, and aspirates a maximum of 245 μ L of sample.
6. Press the START touch key to aspirate.
7. If the instrument is programmed to run the same tests with each sample, proceed to step 11.
8. If the instrument is not pre-programmed, the SELECTED PARAMETERS screen appears during analysis once the START touch key is pressed. The screen displays all parameters available for testing.
9. Test parameters have a ✓ touch-key that allows it to be selected or deselected. All parameters will be measured but only selected (✓) parameter results will be printed.
10. Each parameter touch-key contains a small round light indicator which indicates the status of the parameter. The following table describes how the light indicator relates to the parameter status:

Color of Light Indicator	Status of Parameter
Green	Parameter status okay.
Yellow	Error associated with test parameter. Refer to Calibration or QC result messages for details.
Red	Serious error associated with that test parameter. Parameter cannot be measured and the result is displayed with a “?” or “...”. Refer to SYSTEMS MESSAGES for details.

11. Once parameters have been selected, press ASPIRATE to continue analysis.
12. The PATIENT IDENTIFICATION screen appears next. Enter the following:
 - a. Patient medical record number.
 - b. Time specimen was collected.
 - c. Operator ID number.
 - d. Patient temperature, if not 37°C.
13. Remove the syringe and close the inlet flap when instrument beeps or message on screen says “Remove Sample.”
14. The PATIENT RESULT screen appears automatically when the analyzer completes the test along with a PATIENT RESULT printout.

Results Reporting

1. Examine the PATIENT RESULT screen for results that are flagged.
2. The following table explains the flags that may appear next to a parameter result:

Flag	Explanation
?	Error arising from previous QC, calibration, or analyzer functioning problems. Do not report the result.
↑	Result outside the upper reference range limit but not a critical result.
↑↑	Result is a high critical result but still within the instrument’s measuring range.
↑↑↑	Result falls outside the upper instrument measuring range limit. Do not report the result.
↓	Result outside the lower reference range limit but not a critical result.
↓↓	Result is a low critical result but still within the instrument’s measuring range.
↓↓↓	Result falls outside the lower instrument measuring range limit. Do not report the result.

3. The PATIENT RESULT MESSAGE screen also provides an explanation of flags or errors associated with a patient result. Press NOTES to enter a note associated with a particular patient result.
4. Refer to Operator's Manual, Chapter 12, Troubleshooting, for a detailed description and possible corrective actions related to messages.
5. Patient results are recorded in patient chart.
6. Report all critical results to provider.

Reagents

1. Calibration Solution 1:
 - a. No preparation needed.
 - b. Unopened containers are stable at 2-25°C until expiration date on container or stable 25-32°C for 2 months.
 - c. Opened containers are stable at 2-25°C for 8 weeks or at 25-32°C for 4 weeks.
2. Calibration Solution 2:
 - a. No preparation needed.
 - b. Unopened containers are stable at 2-25°C until expiration date on container or stable at 25-32°C for 2 months.
 - c. Opened containers are stable at 2-25°C for 15 weeks or at 25-32°C for 8 weeks.
3. tHb Calibration Solution:
 - a. No preparation needed.
 - b. Unopened containers are stable at 2-25°C until expiration date on container or stable at 25-32°C for 2 months.
 - c. Open containers must be used immediately.
4. Rinse Solution:
 - a. No preparation needed.
 - b. Unopened containers are stable at 2-32°C until expiration date on container.
 - c. Opened containers are stable at 2-32°C for 1 month.
5. Cleaning solution:
 - a. No preparation needed.
 - b. Unopened containers are stable at 2-25°C until expiration date on container or at 25-32°C for 6 months.
 - c. Opened containers are stable at 2-32°C for 6 months.

6. Gas 1 and Gas 2:
 - a. Stable at 2-32°C until expiration date.
 - b. Store gas cylinders with adequate ventilation. Avoid contact with oil and grease.
 - c. Do not store or use near heat or open flame. Exposure to temperatures above 52°C may cause contents to vent or cause bursting.
 - d. Not for inhalation. Avoid breathing gas mixtures.

7. Radiometer Qualicheck Quality Control:
 - a. Four levels of quality control in color-coded ampules.
 - b. Unopened ampules are stable at room temperature until expiration date.
 - c. Opened ampoules must be tested immediately.
 - d. If storage temperature is above or below room temperature (18-32°C), allow ampule to sit at room temperature for 40 minutes.

References

1. Broughton, J.O., Jr.: Understanding Blood Gases, Article #456.
2. ABL 825 Operator Manual. Radiometer Medical A/S, Denmark, August 2005
3. ABL 825 Reference Manual. Radiometer Medical A/S, Denmark, December 2004.
4. Kotaska K, et al. Re-evaluation of cord blood arterial and venous reference ranges for pH, pO₂, pCO₂ according to spontaneous or cesarean delivery. J Clin Lab Anal. 2010;24:300-304.
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6. Tietz, Norbert, W. "The Textbook of Clinical Chemistry," WB Saunders Company, Philadelphia, 1986, pp 1191-1220.