

	Point of Care Testing (POCT) Using the i-STAT Analyzer System PRO-POCT-LAB—09	Dept: Point of Care Testing
	Previously known as: PPB-WFBMC-LAB-775-09	Effective Date: 04/1999
		Revised Date: 06/2014
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1) General Procedure Statement:

The Clinical Laboratory at Wake Forest Baptist Medical Center (WFBMC) is responsible for oversight of explicitly identified non-waived laboratory testing. Specific non-waived point-of-care testing sites have been identified and included under the CLIA certificate of the WFBMC Clinical Laboratories for a highly complex lab. Testing policies and procedures must meet all regulatory guidelines established by CLIA and the accreditation standards established by the College of American Pathologists (CAP). This procedure helps to ensure that all i-STAT testing is performed according to manufacturer's recommendations and that each employee follows the same quality control and patient testing procedures. All i-STAT testing should have a documented physician order. The i-STAT should not be used for personal testing. All results are transmitted to the Clinical Laboratory. Results can be traced back to the device, location, and user.

a. **Scope/Purpose:** Non-Waived POCT sites covered by the Clinical Laboratory CLIA certificate shall adhere to processes outlined in this document.

b. **Responsible Department/Party/Parties:**

i. **Procedure owner:** Clinical Laboratory Point-of-Care Testing Manager/Coordinator

ii. **Procedure:** Non-Waived POCT sites covered by the WFBMC Clinical Laboratory CLIA certificate shall adhere to processes outlined in this document.

iii. **Supervision:** The Medical Director for Point-of-Care Testing shall supervise the person(s) performing activities outlined in this document

iv. **Implementation:** Each applicable POCT site manager is responsible for ensuring compliance with processes stated in this document.

2) Definitions

a. **Point-of-Care Testing (POCT)**—defined as tests designed to be used at or near the site where the patient is located, that do not require permanent dedicated space, and that are performed outside the physical facilities of the clinical laboratory.

b. **Non-Waived Tests**—Tests of moderate or high complexity as designated by the FDA

c. **Clinical Laboratory Improvement Amendments (CLIA)**—United States federal regulatory standards that apply to all laboratory testing performed on humans.

d. **College of American Pathologists (CAP)**—Accrediting agency for the WFBH Clinical Laboratory. Point-of-Care sites included on the CLIA certificate of the Clinical Laboratory are accountable to standards set forth by CAP.

e. **Quality Control (QC)**—processes to ensure the test system is performing as expected.

f. **Quality Assurance (QA)**—a system for ensuring a desired level of quality. The POCT program incorporates activities to monitor the quality of processes and the test system.

g. **Quality Improvement (QI)**—activities implemented to improve the quality of processes

h. **Proficiency Testing (PT)**—Unknown samples sent to a lab/test site by a Centers for Medicare and Medicaid Services (CMS)-approved PT program

i. **Technical Limits/Reportable Range:** The range at which the analyzer has been verified to obtain accurate results. Each analyte has a specific reportable range.

j. **Normal (Reference) Range:** The range of values for the average patient population.

- k. **Upload/Download/Docking of device/analyzer:** Refers to the action of connecting the test devices to the WFBMC network to allow transmit of patient results and QC results to the device data manager.
- l. **ADT (Admit/Discharge/Transfer):** Refers to visit-specific demographics for a patient.
- m. **CSN (Contact Serial Number):** Refers to Electronic Health Record encounter—related to account number
- n. **AC:** Part of the CSN that is stored in Wake One. Included in the linear barcode on the patient armband. For example, AC12345678910. AC is NOT included in the document label CSN barcode. For example, 12345678910.
- o. **Electronic Health Record (EHR):** Digital version of a patient’s paper medical chart.
- p. **Erroneous:** Containing error, mistaken, incorrect, wrong
- q. **Analyzer/device:** Refers to handheld test device

3) Procedure:

The i-STAT System is a non-waived testing device that performs critical care blood analysis at the point-of-care. At WFBMC, the i-STAT test system is used by laboratory and non-laboratory personnel to provide critical lab service at or near the patient. Results are electronically posted to the patient’s medical record.. This document serves to define the procedures and guidelines for point-of-care testing using the i-STAT system. The i-STAT System Manual should also be used as a resource for information not specifically covered in this document, such as, use of the i-STAT test system and information about specific i-STAT tests. (Test principles, clinical significance, and interpretation of results).

a. Operator ID Usage Information

Upon satisfactory completion of training for the i-STAT system, each user will be given a user identification number/code. This code is to be entered each time that the i-STAT system is used and is the equivalent of an electronic signature. Each code is assigned exclusively for each testing staff member (operator). It should not be shared with anyone else, as this would be the equivalent of signing another person’s name to work they did not do. The ID codes are considered personal and confidential. This code allows tracing of testing personnel. **Sharing ID codes or using someone else’s code is prohibited.**

b. Safety Precautions/Safety Equipment

i. Safety equipment

- Gloves
 - Gloves should be worn while collecting or analyzing any patient sample
 - Gloves should be worn while performing any function on the i-STAT, including cleaning/ disinfecting, performing quality control (QC), carrying/handling, and downloading the analyzer.
- Safety Shield – (Face or Stand Alone Shield) should be available in each test site.
- WFBMC-approved safety re-sheathable needles
- Appropriate waste containers should be available for disposal of used cartridges or other blood/sample contaminated non-sharp equipment. Follow appropriate WFBMC policies and procedures.
- Germicidal wipes, fresh 10% bleach, or WFBMC-approved disinfectant should be used to decontaminate analyzer between each patient use.

ii. Sterile Environment:

- When the i-STAT system is used in a sterile environment, such as an OR suite, the analyzer and all supporting equipment should be disinfected prior to and after use in the OR suite/sterile area.
- **The i-STAT analyzer and related equipment should never come in contact with a patient.**
- The analyzer **must be disinfected between each patient use.**

iii. Safety Notes:

- When opening liquid QC vials, protect fingers by wrapping gauze or tissue around vial, prior to breaking open.
- **CAUTION:** When using the SCAN function on the i-STAT 1 analyzer, be aware of Laser Radiation—do not stare into beam. Class 2 product. Laser Diode 650nm Maximum Output 1.0mW.
- Follow appropriate WFBMC battery disposal policies.
- If filling the cartridge on a counter top and the counter gets contaminated during sample analysis, decontaminate the counter with a WFBMC-approved disinfectant.

- If the i-STAT analyzer becomes contaminated at the cartridge insert site, it should be labeled as biohazard and removed from use. Return the unit to the Clinical Laboratory POCT Coordinator.
- The i-STAT analyzer must be disinfected with WFBH-approved disinfectant between each patient use.
- Follow WFBMC policies and procedures for cleaning, disinfection, and discard of supplies.
- Treat all blood samples, proficiency test materials, and quality control materials as a biohazard. Use Standard Precautions!
- All sharps should be discarded in WFBMC-approved biohazard sharps containers.

c. **Equipment** The i-STAT System consists of the following primary components:

i. **I-STAT Analyzer:** Analyzers are the handheld i-STAT Portable Clinical Analyzers. WFBMC utilizes the i-STAT 1 (300 series). When a sample-filled cartridge is inserted into an analyzer for analysis, the analyzer automatically controls all functions of the testing cycle including fluid movement within the cartridge, calibration, and continuous quality monitoring. All analyzers that pass the Electronic Simulator test are considered equivalent.

- **Battery Change/Charge**

i-STAT 1 analyzers can operate using (2) 9-volt lithium batteries or a rechargeable battery. Refer to the i-STAT System Manual for additional instructions. When performing testing, confirm adequate battery voltage prior to testing. (A flashing battery icon or low battery message will indicate low battery voltage.) If battery voltage is low, testing may cease in the middle of a patient test.

NOTE: Alkaline batteries should not be used in the i-STAT analyzers. Use only 9V lithium batteries or i-STAT 1 specific rechargeable batteries.

- **Extreme temperature usage**

When using the i-STAT analyzer in an area with extreme temperatures, it may be required to insulate the analyzer between testing samples to keep the analyzer internal temperature stable. If the analyzer gets too hot or too cold, an error code will occur. Storing the analyzer in an insulated cooler may resolve temperature error codes.

ii. **i-STAT Data Management System:** Used to monitor patient results and quality control data.

d. **Supplies & storage requirements**

i. **I-STAT Test Cartridges/Inventory:** A single use disposable cartridge contains micro fabricated sensors, a calibrant solution, fluidics system, and a waste chamber. Sensors for a variety of tests are available. Refer to the i-STAT System Manual for details.

- **Storage:** The main inventory of cartridges will be stored in the Clinical Laboratory.

- Cartridges should be stored at 2° to 8° C (35° to 46°F) and are good through the package expiration date.
- **Do not allow cartridges to freeze.** Cartridges should NOT be stored next to the refrigerator wall. Freezing could occur.
- Follow manufacturer labeling for room temperature storage and expiration dating. (18° to 30°C or 64° to 86°F).
- **Cartridges should not be returned to the refrigerator once they have been at room temperature, and should not be exposed to temperatures above 30°C (86°F).**
- Each cartridge should be marked to indicate the appropriate cartridge-specific room-temperature expiration date. *The staff member that removes cartridges from the refrigerator is responsible for marking the room temperature expiration date.*
- Cartridges should remain in **SEALED** pouches until time of use.
- **Do not use** after the labeled expiration date or erroneous results may be given.
- Cartridges should be allowed to sit at room temperature without any quick heating. Example: DO NOT hold close to the body or put on a warm object for quick heating. Follow manufacturer instructions.

- **Storage:** Testing site inventory will be obtained by testing site personnel from the Clinical Laboratory.
 - The cartridges in the testing sites should be stored at room temperature and kept away from extreme heat and cold.
 - Do not store on computers, above lights or any other warm surface.
 - If cartridges are noted as having been exposed to an unacceptable temperature, the cartridges should be removed from patient use and the POCT Coordinator should be notified for further action.
 - If a user site stores refrigerated cartridges, the refrigerator temperature must be monitored at least daily, 7 days per week, and be maintained 2° to 8°C.
 - Refrigerator temperature logs must be copied and forwarded to the Clinical Laboratory each month.

ii. Blood Collection and Transfer Equipment

- **Capillary Testing**
 - Warming pad, if applicable
 - Alcohol pad
 - Skin puncture lancet. Only auto-disabling, single-use capillary stick devices will be used for collection of capillary samples
 - Capillary tubes and caps. **NOTE: If ionized calcium is to be tested, a balanced heparin capillary tube should be used.**
 - Gauze
 - Bandage
- **Venipuncture Testing for Venous specimens**
 - Venipuncture collection equipment. Refer to the WFBMC Intranet-Go to—Department of Pathology (Internal)-Pathology Lab Handbook-Phlebotomy- General Phlebotomy Procedures
 - Use appropriate collection tube or plain syringe, as indicated in the test specific information listed in the i-STAT System Manual
 - **NOTE: If ionized calcium is to be tested, a balanced heparin blood collection tube should be used or appropriate tube, as referenced in the i-STAT System Manual.**
 - Disposable transfer device, if applicable
- **Arterial Testing**
 - Plastic syringe with no anticoagulant or a WFBMC-approved pre-heparinized blood gas syringe/blood gas collection kit.
 - Cap for syringe.
 - Refer to site-specific blood gas collection policies/procedures for specific details.
 - **NOTE: If ionized calcium is to be tested, a balanced heparin syringe should be used.**

e. Blood Specimens

i. **Required Blood Volume** – 17-95 µL depending on cartridge type. See i-STAT System Manual for specific details.

ii. Suitable Specimens

- Only Fresh whole blood may be used for i-STAT testing.
- Different i-STAT tests require different sample collection techniques and collection devices. Refer to the i-STAT System Manual (Test specific 'Cartridge and Test Information Sheet') for specific details not included in this document.
- Certain samples may be collected in a capillary tube or a plastic syringe without anticoagulant.
 - **Test within 3 minutes of collection.**
- Certain samples may be collected in a sodium or lithium heparinized capillary tube, plastic blood gas syringe, or blood collection tube. Refer to the i-STAT System Manual for specific details regarding timing of testing specimens.
 - **Capillary samples should be tested within 3 minutes, regardless of sample heparinization.**
- **Lactate, ACT, and PTINR samples should be tested immediately after collection with no delay.**

- There are additional considerations when testing lactate, ACT, or PTINR test cartridges. Refer to the i-STAT System Manual test specific 'Cartridge and Test Information Sheet' for additional details.
 - Refer to the i-STAT system Manual for a listing of test-specific acceptable anticoagulants for use with the i-STAT.
 - Sample collection containers must be filled to capacity.
- iii. Unsuitable/Unacceptable Specimens: Specimen Rejection Criteria: Do not perform sample analysis if any of the following circumstances apply.**
- Do not test CSF, pleural, peritoneal, urine, or any other body fluid that is not whole blood.
 - Do not ice samples prior to test analysis.
 - Do not use samples from improperly filled tubes. Tubes/syringes/collection containers must be filled to capacity to ensure correct blood to anticoagulant ratio.
 - Samples with evidence of clotting.
 - Specimens collected in containers with inappropriate anticoagulant for the test being performed.
 - Partially filled sample collection containers.
 - Syringe for pH, pCO₂, pO₂, and ionized calcium testing with air bubbles in the sample.
 - Samples for pH, pCO₂, pO₂, and ionized calcium testing that are not capped immediately after collection.
 - Incompletely filled heparinized collection container for the measurement of ionized calcium.
 - If samples are collected from a line which can NOT be adequately cleared to remove contaminating fluids.

f. Patient Preparation

There are no specific patient preparation procedures, prior to collecting samples for i-STAT testing. However, if samples are collected from an artery, appropriate testing for collateral circulation (Allen's testing) should be performed, prior to arterial puncture. Follow site-specific procedures.

g. Specimen Collection and Considerations

Follow site-specific and WFBMC sample collection policies and procedures. If no site-specific policy/procedure exists, refer to the section below and Clinical Laboratory-Department of Pathology sample collection procedures. (Infinet-Dept. of Pathology Handbook).

- i. Prior to collecting any sample for i-STAT testing, the patient's identity should be verified by the WFBMC identification bracelet.
 - Use (2) identifiers.
 - Verification of patient identification by staff may be completed using the patient's full name and date of birth, and comparing that information to the document label on the paper or electronic chart.
 - Medical record number may also be utilized, if necessary, as a patient identifier.
 - The patient or patient's family should be utilized in the patient identification process, when appropriate. Follow all WFBMC policies and procedures regarding sample identification.
- ii. If the i-STAT testing is performed away from the patient's bedside, the blood sample should be labeled in the presence of the patient. Label with a patient identification sticker, which should, at a minimum, include the patient name and medical record number.
- iii. Ensure correct patient identity throughout entire test process.
- iv. To ensure quality blood gas results and to avoid contamination by air, place an airtight cap on the end of the syringe, immediately after collection. Excess air in the sample should be expelled prior to mixing the sample and prior to capping the sample.
- v. **NEEDLES SHOULD NOT BE RECAPPED!**
- vi. **GLOVE SHOULD BE WORN!!!**
- vii. When using blood gas syringes with liquid heparin, extreme care should be taken to avoid sample dilution/contamination from the liquid heparin.
- viii. **ACT Samples:** Follow all current manufacturer recommendations.
 - Only venous or arterial samples should be used for ACT testing.

- Must be collected in a **plastic** syringe WITHOUT anti-coagulant and tested IMMEDIATELY after collection.
 - A metal needle should not be used during cartridge fill.
 - If sample testing is delayed, results will be adversely affected.
 - i-STAT analyzers are programmed to read kaolin ACT's in the pre-warm mode and Celite ACT's in the non-warm mode.
 - The i-STAT analyzer should not be moved or subjected to any vibration during sample testing. Results may be adversely affected. Keep the analyzer flat and free of movement.
- ix. PTINR Samples** – Follow all current manufacturer recommendations.
- Only capillary or venous samples should be used for PTINR testing.
 - When disinfecting finger stick skin puncture sites, swabs or solutions containing substances other than isopropanol (e.g. chlorhexidine gluconate) are not recommended.
 - The i-STAT PTINR test may report a false prolongation of the prothrombin time (PT) and an elevation of the INR on samples contaminated with chlorhexidine gluconate.
 - The **first drop** of blood from a capillary sample should be used.
 - I-STAT recommends filling cartridge directly from skin puncture.
 - Capillary tubes are NOT recommended for PTINR testing.
 - If a collection container is used for a venous sample, the sample must be collected in a **plastic** syringe without anti-coagulant and tested IMMEDIATELY after collection.
 - Devices used to transfer sample to cartridge must be plastic.
 - Metal needles should not be used when filling an i-STAT cartridge.
 - If sample testing is delayed, results will be adversely affected.
 - The i-STAT analyzer should not be moved or subjected to any vibration during sample testing or results may be adversely affected. Keep the analyzer flat and free of movement.
- x. Ionized calcium** – Follow all current manufacturer recommendations.
- For ionized calcium use balanced or low volume heparin sample collection containers (syringes, capillary tubes, or blood collection tubes).
 - Balanced heparin or 10 IU/mL of sodium or lithium heparin is recommended.
 - Collection containers should be filled to correct sample fill capacity to avoid binding of ionized calcium by heparin.
 - Incomplete filling/under filling of the sample collection container causes higher heparin to blood ratio, which will **falsely decrease ionized calcium results** and may affect other results.
- xi. In-Dwelling Line**
- Back flush line with sufficient amount of blood to remove intravenous solution, heparin, or medications that may contaminate the sample. Recommendation: five to six times the volume of the catheter, connectors, and needle.
 - **Coagulation cartridges:** If blood must be drawn from an indwelling line, possible heparin contamination and specimen dilution should be considered.
 - The line should be flushed with 5mL of saline and the first 5mL of blood or six dead space volumes of the catheter should be discarded.
 - **Accurate results depend on an adequate back flush to eliminate the possibility of sample contamination with IV fluids.**
- Caution should be taken when collecting from lines which have had fluids that could adhere to the sides of the tubing. These lines may be difficult to adequately back flush.*
- xii. Arterial Specimens:**
- Avoid or immediately remove any air drawn into the syringe to maintain anaerobic conditions.
 - Samples should be **capped immediately after collection to avoid air contamination.**
 - Mix blood and anticoagulant by rolling syringe between palms for at least 15 seconds.
 - Roll syringe 5 seconds in one direction.
 - Then roll 5 seconds in the other direction.
 - Then invert for 5 seconds.
 - ENSURE ADEQUATE SAMPLE MIXING

xiii. **Venous Specimens:** Follow current manufacturer recommendations

- **As appropriate per manufacturer's instructions**, if cartridge cannot be filled immediately, collect the sample in a heparinized evacuated blood collection tube. A syringe containing balanced heparin may also be used.
- **Fill collection containers to capacity.**
- Mix blood and anticoagulant by rolling tube/syringe between palms for at least 15 seconds.
- Roll syringe/tube 5 seconds in one direction.
- Then roll 5 seconds in the other direction.
- The invert for 5 seconds.
- **ENSURE ADEQUATE SAMPLE MIXING.**

xiv. **Capillary specimens (finger and heel stick):**

- For **NON-PTINR** samples, **wipe away the first drop of blood**, which contains excess tissue fluid and can increase potassium results and dilute other test results.
- Avoid drawing air into capillary tubes and cap immediately after collection.
- Mix blood and anticoagulant by rolling capillary tube between palms for at least 15 seconds.
- Test samples immediately to avoid clotting (especially in neonates).
- **ALL SAMPLES SHOULD BE WELL MIXED IMMEDIATELY PRIOR TO ANALYSIS TO ENSURE ACCURATE RESULTS.**

h. **Specimen Labeling** – Unless the specimen is analyzed immediately after collection at the patient's side/bedside and then discarded, the specimen should be labeled in the presence of the patient with the following information:

- i. Patient name (first and last)
- ii. Medical Record Number
- iii. Outpatient samples should be labeled with the full name and date of birth (DOB).

i. **Specimen Identification entered into the analyzer**

i. Patient samples are identified in the i-STAT by the patient's Wake One Contact Serial Number (CSN). As applicable, this information should be taken directly from the patient armband on the patient.

Any i-STAT result that has a valid CSN entered in the handheld analyzer will be automatically ordered, billed, and resulted to the permanent electronic health record (EHR). It is crucial that sample identification be entered correctly into the i-STAT handheld analyzer at the time of sample testing.

ii. If the **CSN is not available at the time of i-STAT sample analysis**, alternate means of sample identification should be used. See below:

- **Medical Record/CSN/Patient Registration Number NOT Available:**

- Use the i-STAT generic ID. Current version contains 11 Zeros and an alpha character at the END—for example 00000000000A, 00000000000B, 00000000000C Z-Number. (This is a temporary ID#, specifically used for i-STAT testing).
- Enter the number into the i-STAT as the patient ID number.
- Log the ID used on the patient flow sheet and i-STAT Resolution Requisition.
- Be sure that the ID used is noted on the patient care flow sheet maintained in the user site.
- During your SAME-DAY shift, do NOT use the same generic ID for multiple patient samples.
- Do NOT use the same generic ID for a multiple-patient transport
- Send the properly completed i-STAT RESOLUTION REQUISITION to the Clinical Laboratory as soon as correct patient identity is available.
 - A copy of the results should be attached to the resolution requisition.
 - It is very important to complete an i-STAT Resolution Requisition and send to Clinical Lab.
 - Otherwise, the i-STAT results do not get posted to the patient's electronic health record.
- NOTE: Use the correct CSN for subsequent samples as soon as one is available. The admission CSN must be used for inpatient samples.

iii. **Sample identification during sterile procedures:**

During sterile procedures, the armband on the patient may not be accessible. If the armband is not accessible during a sterile procedure, adhere to the following process.

- Print extra patient armband that matches the armband that is on the patient.
- If the patient has been admitted, the inpatient admission armband must be used.
- The extra armband must be verified against the armband that is on the patient, including
 - Full patient name
 - Date of birth
 - Medical record number
 - CSN
- Verification of the second armband should be documented on the time-out form during time-out procedures.
- This extra armband can be used to scan patient ID into the i-STAT analyzer, **only during sterile procedures.**
- Once the case is completed, the extra armband should be destroyed.

j. **Sample Misidentification**

- i. Immediately call the ICU Blood Gas Lab at extension 6-4832 to alert lab staff that a correction needs to be made to patient results.
- ii. An i-STAT Resolution Requisition should be completed and sent to the Clinical Laboratory immediately.
- iii. The i-STAT analyzer should also be downloaded. This allows laboratory staff to access results.
- iv. Refer to i-STAT appendix, 'i-STAT Misidentification Protocol' for specific details.
- v. It is the responsibility of testing personnel to return i-STAT Resolution Requisitions, as necessary.
- vi. If there are instances when results cannot easily be traced to the correct patient, it will be the responsibility of the point of care contact person in each user site to work with the Clinical Laboratory POCT Coordinator to resolve such issues.

k. **PROCEDURE FOR ANALYSIS**

- ❖ A documented order, submitted by an authorized provider, should exist for any patient i-STAT testing.
- ❖ The order should be traceable to the patient medical record.
 - i. **Cartridge Preparation for use.** All cartridges should equilibrate to room temperature prior to use. Individual cartridges may be used after standing at room temperature for 5 minutes. A box of 24/25 cartridges should stand at room temperature for one hour before use.
 - ii. **Sample testing procedure.**
 - ❖ *Gloves should be worn during entire sample collection and testing process.*
 - ❖ Face shield protection should be available in each test site.
 - ❖ **Analyzer should be programmed, PRIOR TO COLLECTING blood sample. This is extremely important when testing coagulation cartridges (PT/INR, ACT)**
 - Select the desired cartridge and confirm the cartridge is not expired. Check the expiration date.
 - Turn on the analyzer.
 - Select '2-i-STAT Cartridge'.
 - Scan or manually enter operator ID.
 - To scan ID, hold 'Scan' and scan barcode reader over bar-coded operator ID.
 - Confirm that information scanned by the analyzer is correct.
 - **Notify the Clinical Laboratory POCT Coordinator if erroneous data scanning occurs.**
 - If operator ID is manually entered, the ID must be entered twice to ensure accurate entry.
 - Testing personnel should not share ID numbers.
 - Scan or manually enter the patient medical record number.
 - To scan ID hold 'Scan' and scan barcode reader over bar-coded patient armband.

- Confirm that correct information is canded by the analyzer.
- **Notify the Clinical Laboratory POCT Coordinator if erroneous data scanning occurs.**
- If the patient ID is entered manually, the ID must be entered twice to ensure accurate entry.
- **Accurate patient ID should be confirmed throughout entire test process. As applicable, the ID entered into the i-STAT analyzer should come directly from the patient armband.**
- Enter the cartridge lot number by manual entry or by scanning the barcode on the cartridge package.
- Information scanned into the i-STAT 1 analyzer will stay in the analyzer for 15 minutes, until the analyzer turns off.
 - **CAUTION: Laser Radiation—Do not stare into beam. Class 2 product. Laser Diode 650nm Maximum Output 1.0mW.**
- Collect the blood sample
 - *Remove residual air bubbles in the end of the collection container and cap the sample immediately after collection to avoid air contamination and erroneous results.*
- Open the pouch. Remove the cartridge from the pouch and use immediately.
- Place the cartridge on the pouch or other absorbent material.
 - **Avoid touching the contact pads or exerting pressure over the calibrant pack in the center of the cartridge.**
- Samples should be properly mixed immediately prior to testing.
 - If a sample is not properly mixed, results may not be accurate.
 - Hematocrit results are adversely affected by improperly mixed samples.
 - *If the sample is not adequately mixed or the filled cartridge sits for any period of time, inaccurate hematocrit results may be obtained.*
- As applicable, carefully squirt out a few drops of sample to confirm no sample clotting, to remove any residual air in the end of the syringe/capillary, and to facilitate smooth movement of the syringe plunger.
- **Do not test samples that have or have had evidence of clotting.**
- Fill the test cartridge.
 - Direct the syringe, dispensing tip, capillary tube, or finger to the sample well of the test cartridge.
 - Dispense the sample until it reaches the fill mark on the cartridge.
 - **Do not use force to fill the i-STAT cartridges. The cartridges should fill easily by capillary action. If resistance is encountered, stop the fill process and check for a clot in the sample. If force is used while filling the i-STAT cartridges, blood splatter may occur.**
 - Leave a small blood dome at the sample fill well.
 - After the cartridge is properly filled, carefully close the cover over the sample well until it snaps into place.
 - **(Do not press over the sample well.)** Inspect the cartridge to be sure any visible blood has been wiped off. **Do not allow blood to seep into the analyzer.**
- As applicable, recap the sample so integrity is maintained in case of needed repeat testing (not applicable for coagulation tests).
 - **DO NOT** re-cap needles.
- Insert the cartridge into the cartridge door until it clicks into place.
 - 'Cartridge locked' will display on the analyzer screen.
 - **DO NOT** try to remove a cartridge when 'cartridge locked' is displayed. *Damage to the analyzer may occur.*
- Do not move the analyzer during the testing process.
- For analyzers programmed with Operator Test Select, an additional screen will appear. The user should numerically select the desired tests to be performed and press the 'right arrow' soft keypad to move forward to the next screen.

- NOTE: When testing blood gas cartridges, TCO₂ must be selected for display of HCO₃ results.
- NOTE: Cardiopulmonary bypass patient samples: Select CPB hematocrit correction, as necessary. Refer to i-STAT System Manual for detailed information regarding the CPB hematocrit correction.
- Enter additional parameters (if required):
 - Patient temperature can be entered as degrees Centigrade or Fahrenheit. Use the '.' key for a decimal point.
 - The patient temperature only requires entry if a temperature corrected blood gas is desired. **Care should be taken in entering the temperature.** The temperature corrected results are reported in the patient's electronic health record (EHR).
 - ***If an incorrect entry is entered for the patient temperature, an i-STAT Resolution Requisition should be completed and sent to the Clinical Laboratory so results can be corrected in the EHR. A copy of the results should be attached to the i-STAT Resolution Requisition.***
 - FIO₂ can be entered as the number of liters or as a percentage of the oxygen a patient is receiving.
 - Choose the number corresponding to the sample type used when prompted at the Sample Type field. Press ENT.
- Depending on the test performed, after 2 minutes, results will be displayed on the i-STAT analyzer.
 - Results should be evaluated for good sample quality, abnormal and critical values, and suppressed results.
- Document results and report to the appropriate personnel, according to user site specific guidelines.
- Results may be printed. See 'Reporting Results' for procedure.
- Remove the test cartridge at any time after the 'cartridge locked' prompt disappears.
- Discard the used cartridge in a container designated for biohazard materials.
- Once a cartridge is removed, the analyzer is ready to accept another cartridge.
- Download results to the electronic health record as soon as possible.

I. Alternative Procedures

- i. Should a problem occur with the i-STAT analyzers or cartridges in a user site, the Clinical Laboratory Point of Care Testing section has extra analyzers that can be used.
- ii. If extra analyzers are not available, specimens for ACT, blood gas, whole blood electrolytes, ionized calcium and hematocrit analysis should be collected and submitted to the ICU Blood Gas Lab or OR Blood Gas Lab.
- iii. PTINR samples may be collected by venous sample collection and sent to the Clinical Laboratory for testing. Samples may be delivered or sent via the pneumatic tube system.
- iv. Samples for ACT tests must be tested immediately after collection, so these samples should be hand-delivered to the Clinical Laboratory, as appropriate.
- v. Other Chemistry/Hematology testing may be sent to the Clinical Laboratory, via the pneumatic tube system or via courier.

m. Results

- i. **Calculations:** The i-STAT analyzer contains a microprocessor that performs all calculations required for reporting results. Refer to the i-STAT System Manual for calculated parameters.
- ii. **Reference and Reportable Ranges**
 - **Reference ranges (Normal ranges)**
 - Reference ranges are the normal analyte ranges, as defined by the WFBMC Clinical Laboratory.
 - Test results that fall outside of these ranges exceed the normal value range for a normal population.
 - These results should be handled according to user site specific guidelines or physician orders.

- **Values Outside the Analyzer Reportable Range.**
 - Values outside the reportable range of the i-STAT system have not been documented as being accurate.
 - Such values should be evaluated for accuracy. Consider repeat testing, via an alternate method with a freshly drawn specimen.
 - See below for additional details.
- iii. **Suppressed Results:** There are three conditions under which the i-STAT System will **not** display results.
- **Out of Instrument Range:**
 - Results outside the System's reportable ranges are flagged with a "<" or ">", indicating that the result is below the lower limit or above the upper limit of the reportable range, respectively.
 - If a result is dependent upon another result that is outside of the reportable range of the analyzer, the results will be suppressed and display as <>.
 - See the table of Reportable Ranges.
 - **Action:**
 - If contamination is a possibility, recollect and retest on another cartridge.
 - Otherwise, consider sending specimens to the Clinical Laboratory as outlined in 'Alternative Procedures'.
 - Submit patient credit requests, as necessary.
 - **QC failed parameters: (***-Star Outs)**
 - Individual parameter results, which are not reportable based on internal QC rejection criteria, are flagged with "****".
 - Star out results are not automatically sent to the electronic health record. These results are reviewed by the POCT Coordinator or designee.
 - Only the parameter noted with the flag (***) is affected.
 - Other reported results are not affected by the QC rejection (***) .
 - **Action:**
 - If desired, repeat using a new cartridge.
 - If a parameter still results as "****", consider that an interferent may be present, or there may be a cartridge problem that needs to be investigated.
 - A specimen may be sent to the Clinical Laboratory as outlined in 'Alternative Procedures'.
 - The results that are not suppressed can be used and should be reported in the usual manner.
 - Submit patient credit requests, as necessary.
 - **Instrument/Cartridge problem (Quality Check Code):**
 - Results will not be reported if a test cycle has a problem with the sample, calibrant solution, sensors, mechanical or electrical functions of the analyzer.
 - **Action:**
 - Take the action displayed with the message that identifies the problem, and refer to the i-STAT System Manual-Technical Bulletin-"Analyzer Coded messages" for assistance.
- iv. **Critical Values.**
- Critical results are test results that fall outside high and low critical limits which define the boundaries of life-threatening values for a test.
 - Critical results represent an emergency condition and should be reported immediately to the patient's attending physician, nurse, or mid-level provider. Follow WFBMC policy, regarding critical value notification and documentation.
 - The analyzer will flag potential critical values with bold black arrows.
 - Documentation of notification should be noted in the patient record. Documentation should include:
 - Notifying individual's name/signature
 - Critical result
 - Date

- Time
- Name of the person that is notified of the critical value.
- The author's name should be legible and authenticated. Documentation pertaining to the person that is notified of the critical value should be identifiable for future questions. At a minimum, last name and credentials should be documented. It is preferred that the full name of the provider be documented.
- Results that are verbally reported need to be confirmed by verbal reading back of results.
- *Unexpected critical values should be followed-up with appropriate repeat testing by an alternate means.*

v. i-STAT PT/INR Reflex Testing

INR values equal to or greater than 4.0, as reported by i-STAT, will have a reflex venous PT/INR ordered and sent to the Clinical Laboratory for confirmatory testing.

vi. Unexpected results

- Any result that is obtained and is unexpected or not consistent with patient presentation *should be tested by an alternate method.*
- If contamination is suspected, repeat testing with a freshly collected specimen.
 - Submit patient credit requests, as necessary.
- If analyzer/test system performance is in question, try using a different lot number/box of cartridges and a different analyzer.
- When unexplained discrepant results are noted, the *POCT Coordinator should be notified immediately.*

vii. Result quality may be affected by: (Results are only as good as the sample used!)

- i-STAT **hemoglobin and hematocrit** results may be affected by improper sample mixing, total protein values, and other factors. Refer to the i-STAT System Manual for detailed information.
 - **NOTE: Extreme caution should be exercised if using i-STAT hemoglobin and hematocrit results for transfusion decisions.**
- Drawing a specimen from an arm with an IV
- Stasis (tourniquet left on longer than two minutes before venipuncture)
- Extra muscle activity (fist pumping)
- Icing sample before filling cartridge
- Time delays before filling cartridge
- Using the first drop of a capillary blood sample for **NON-PTINR** testing can give erroneous results
- Exposing the sample to air when measuring pH, pCO₂ or pO₂
- **ACT and PTINR results may be adversely affected by using a metal needle to fill the test cartridge or moving the analyzer during sample testing.** The analyzer should be level with display facing up during testing.
- **PTINR results may be adversely affected if the first drop of blood is Not used.**
- **Hemolysis (alcohol left over puncture site, a traumatic draw, or forceful flow of blood through a needle)**
 - i-STAT tests whole blood. Hemolysis can Not be determined when testing via i-STAT.
 - Hemolysis will **falsely elevate potassium results.**
 - Hemolysis is defined as the destruction of red blood cells, caused by disruption of the cell membrane and resulting in the release of hemoglobin in the sample.
 - To determine the presence of hemolysis, the sample must be spun in a centrifuge and the plasma/serum layer observed for pink to red color.
 - The intensity of red color is proportional to the amount of hemolysis that is present in the sample.
 - **DO NOT report/treat high potassium results, until verified via an alternate method.**
 - The sample should be checked for hemolysis.

viii. Interferences

- Refer to the cartridge and test information sheets in the i-STAT System Manual for a detailed listing of interfering substances. Any time questionable results are obtained on the i-STAT, interferent information should be referenced.
 - **Common interferences:**
 - It has been determined that **Propofol, Thiopental Sodium and Hydroxyurea** can cause interference on the i-STAT test system. Results from patients receiving these drugs should be evaluated with caution. See the i-STAT System Manual-Cartridge and Test Information section for specific details.
 - Increased patient lactate may interfere with certain i-STAT results.
 - Hemodilution of the plasma by more than 20% associated with priming cardiopulmonary bypass pumps, plasma volume expansion or other fluid administration therapies using certain solutions may cause clinically significant error on sodium, chloride, ionized calcium and pH results.
- ix. Reporting results:** Results should be reported to the clinical provider in a timely manner.
- **Transmitting results to the Electronic Health Record:**
 - ❖ i-STAT 1 Analyzers should be downloaded after each patient test.
 - ❖ Test results obtained during procedural cases should be downloaded immediately following completion of the procedure.
 - Place analyzer in the downloader.
 - 'Waiting to Send' and then "Communication in Progress" will display on the analyzer.
 - Results will automatically transmit all unsent results.
 - **Do not move analyzer until message disappears.**
 - If the analyzer display indicates that there are unsent results:
 - Check all plug connections and repeat the download process.
 - If unsuccessful after 3 attempts, contact the Help Desk for assistance.
 - i-STAT handheld analyzers should be downloaded at an alternate site until resolution is made.
 - **Printing results:**

Some i-STAT sites are supplied with portable printers. Refer to the i-STAT System Manual for additional information.

 - Turn the printer on.
 - To print the displayed test record,
 - Align the infrared windows on the analyzer and printer
 - Press the PRT key on the analyzer.
 - **NOTE:** Results printed on thermal paper will fade with time and are not acceptable as a permanent chartable record.
 - Do not move the analyzer while results are printing.
 - Write the patient's name on the result tape, if applicable.
 - **Creatinine results and estimated glomerular filtration rate (GFR) Calculation**
 - Creatinine test results will include an estimated glomerular filtration rate (eGFR), when reported to the electronic health record.
 - The i-STAT analyzer does not report the eGFR. It will be automatically calculated when the creatinine value is entered into the electronic health record.
 - African-American and Non-African American GFR values will be calculated and resulted.
 - eGFR will be calculated using the Isotope Dilution Mass Spectrometry (IDMS) traceable equation:
 - $GFR (mL/min/1.73 m^2) = 175 \times (S_{cr})^{-1.154} \times (Age)^{-0.203} \times (0.742 \text{ if female}) \times (1.212 \text{ if African American})$
 - **Clerical Errors.**
 - If an error is discovered in identifying the patient sample, contact the Clinical Laboratory immediately so that the correct patient information can be entered to the electronic health record.
 - Once the i-STAT analyzer is downloaded, results will automatically populate the electronic health record.

- It is imperative that incorrectly identified results be corrected immediately.
- An i-STAT Resolution Requisition must be completed and sent to the Clinical Laboratory POCT Coordinator.
- **Comments:** If additional sample/result comments need to be added to i-STAT results, *the testing staff member is responsible for sending an i-STAT Resolution Requisition to the Clinical Laboratory indicating the edits that need to be made to the record.*

4) Review/Revision/Implementation:

a. Review Cycle: Each 2 years

- i. All new policies/procedures/guidelines and those that have major revisions must be reviewed/signed by the CLIA Laboratory Medical Director.
- ii. All reviewed procedures and procedures with minor revisions can be signed by the designated section medical director or section manager.

b. Office of Record: Clinical Laboratory, Section on Point-of-Care Testing

5) Related Policies/Procedures/Guidelines:

- a. Understanding of Responsibilities between Testing Sites and the Clinical Laboratory for Point-of-Care Testing
 - PPB-WFBMC-NCBH-95
- b. Handling of POCT Analyzers when Removed from Service or Returned to Manufacturer for Repair
 - PRO-POCT-LAB-25
- c. Non-Waived Point of Care Testing Quality Management Plan and Quality Control/Quality Assurance Procedures
 - PPB-WFBMC-LAB-775-18
- d. Clinical Laboratory Point-of-Care Testing Competency Assessment for Non-Waived Testing
 - POL-POCT-LAB-24
- e. Department of Pathology, Proficiency Testing Procedure

6) References:

- a. College of American Pathologists (CAP) Lab Accreditation Program Lab General, All Common, and Point of Care Testing checklists, CAP, 325 Waukegan Rd, Northfield, Illinois 60093-2750, Revised April 2014
- b. i-STAT System Manual, i-STAT Corporation, 303 College Road East, Princeton, NJ 08540 Art # 714446-00P Updated May 2014.
- c. National Kidney Disease Education Program web sites; www.nkdep.nih.gov/professionals/gfr_calculators/idms_con.htm and www.nkdep.nih.gov/professionals/gfr_calculators/orig_con.htm

7) Attachments:

- a. Appendix A: Sample Identification Resolution/Request for Credit
- b. Appendix B: Critical Results
- c. Appendix C: Quality Control/Quality Assurance Procedures
- d. Appendix D: i-STAT Misidentification Protocol
- e. Appendix E: i-STAT Cartridge Sign-out Procedure
- f. Appendix F: Reference Ranges and Reportable Ranges

8) Revised/Reviewed Dates and Signatures:

Document Adopted: 4/19/99

Revised:

- 04/09/2000
- 04/23/2001
- 01/21/2002
- 01/2004
- 01/2007 supersedes policy identified as PPB-NCBH-PCS-LAB-775-09—changed numbering to PPB-NCBH-LAB-775-09—PCS deleted in policy ID numbering
- 07/2011 policy identification changed from NCBH to WFBMC—PPB-NCBH-LAB-775-09 changed to PPB-WFBMC-LAB-775-09

- PPB-NCBH-LAB-775-22, "i-STAT Creatinine Testing" adopted 09/2009, revised 12/2009, incorporated into PPB-WFBMC-775-09 07/2011
- 11/2011--updated eGFR calculation—document not re-circulated for all signatures—document signed by Clinical Laboratory Medical Director
- 6/2014—document renumbered from PPB-WFBMC-LAB-775-09 to PRO-POCT-LAB-09
- 6/2014 continued—all existing i-STAT related documents were combined into the one master document, PRO-POCT-LAB-09
- Incorporated documents include:
 - PPB-WFBMC-NCBH-LAB-775-15—i-STAT Quality Control and Assurance As Performed by the Clinical Laboratory
 - PPB-NCBH-LAB-775-17—i-STAT Misidentification Protocol
 - PPB-NCBH-LAB-775-16—i-STAT Supply Sign-out Procedure

Biennial Review: _____ Date: _____

Biennial Review: _____ Date: _____

Modifications/Date/Reviewed/Approved:

PROPOCTLAB09iSTATtesting2014 053014

**Appendix A:
Sample Identification Resolution/Request for Credit
Revision 6/2014**

1. Purpose:

In the event patient results require edit or testing credit, an i-STAT Resolution Requisition should be used to communicate needs with the Clinical Laboratory. Blank resolution requisitions should be located in the user site with i-STAT supplies.

The document can also be accessed from the internal Point-of-Care Testing web site.

Intranet—Departments—Point of Care Testing—Forms and Records

2. Procedure:

- a. Obtain i-STAT Resolution Requisition
- b. Always complete section I
- c. Always include the results that require edit
- d. Complete section II or III, as necessary
- e. **Common LIS credit codes. This list is not all-inclusive**
 - QISTA—Questionable i-STAT results
 - TNTOR—Test not ordered by MD
 - USAT—unsatisfactory specimen

NOTE: It is the responsibility of the testing personnel to request appropriate test credits.

Appendix B

Critical Results

Revision 6/2014

Critical results are test results that fall outside high and low critical limits, which define the boundaries of life-threatening values for a test. Critical results represent an emergency condition and should be reported immediately to the patient's attending physician, nurse, or mid-level provider. Documentation of notification should be noted in the patient record. Documentation should include: notifying individual's initials/signature, the result, date, time, and the name of the person that is notified of the critical value. The author's name should be legible and authenticated. Documentation pertaining to the person that is notified of the critical value should be identifiable for future questions. At a minimum, last name and credentials should be documented. It is preferred that the full name of the provider be documented. Critical values should be properly evaluated with the patient's clinical symptoms and followed-up by necessary laboratory confirmation. Any unexpected result should be repeated on the i-STAT or sent to the laboratory for confirmation.

Critical Results of Tests and Diagnostic Procedures, formerly PPB-NCBH-10, should be followed regarding read back of verbally reported critical values.

Critical value limits defined by the Clinical Laboratory in conjunction with the Medical Directors for i-STAT user sites, are as follows:

Analyte	Adult	Pediatric	Neonate (in NICU)	Comments
Sodium mEq/L or mmol/L	<120 >160	<120 >160	<120 >150	
Potassium mEq/L or mmol/L	<3.0 >6.0	<3.0 >6.0	<3.0 >6.0	Unexpected results >6.0 should be verified by the laboratory. Hemolysis falsely elevates results. For potassium results to be considered critical, they should also fail the normal range defined for the patient's age.
Total CO2 mEq/L or mmol/L	<10 >40	<10 >40	<10 >40	
Ionized Calcium mmol/L	<0.75 >1.40	<0.75 >1.40	<0.80 >1.40	
pH	<7.2 >7.6	<7.15 >7.6	<7.20 >7.45	
pCO2 mm/Hg	<25 >60	<30 >80	<35 >80	
pO2 mm/Hg	<50	<30	<30	ARTERIAL
Glucose mg/dL	<40 >600	<40 >300	<50 >300	
Hemoglobin g/dl	<=6 >=20	<=6 >=20	<=6 >=20	
Hematocrit %PCV	<=18 >=60	<=18 >=60	<=18 >=60	
PT/INR	>= 5 or value not calculated	>= 5 or value not calculated	>= 5 or value not calculated	INR values equal to or greater than 4.0, as reported by i-STAT will have a reflex venous PT/INR ordered and sent to the Clinical Laboratory for confirmatory testing.

Appendix C

Quality Control/Quality Assurance Procedures: (information from PPB-WFBMC-NCBH-LAB-775-15 is included in this appendix)
Revision 6/2014

1) Purpose:

Quality control (QC) checks and quality assurance (QA)/quality improvement (QI) activities are important to ensure the test system is functioning properly and to ensure quality results. I-STAT utilizes an internal simulator (QC) check, each 8 hours of use per cartridge type. The i-STAT analyzer is programmed to automatically perform the internal electronic simulator each 8 hours. External liquid QC is also tested to validate the test cartridges. Various activities, as described below, are used to validate performance of the test system.

2) Procedure:

a. Quality Control Materials

i. Internal Electronic Simulator

ii. External Electronic Simulator

iii. Liquid Quality Controls—performed by the Clinical Laboratory and the test site.

- ❖ Refer to the appropriate package insert and i-STAT System Manual for additional handling information and details.
 - **I-STAT Liquid Tri-Controls** – Used to verify the blood gas, hematocrit, chemistry, and electrolyte sensor performance.
 - Store at 2° to 8°C (35° to 46°F) through package expiration date.
 - Controls may be stored at room temperature (18° to 30°C or 64° to 86°F) for five days.
 - Do not use after expiration date on the box and ampules.
 - Protect fingers with gauze or tissue when opening vial.
 - If oxygen is being tested, QC material should equilibrate to room temperature for 4 hours prior to use. Test samples IMMEDIATELY after opening.
 - **ACT Liquid Controls** – Used to validate performance of i-STAT ACT test cartridges.
 - CAUTION: Handle using standard precautions. This product contains human plasma
 - Store at 2° to 8°C through package expiration date.
 - Equilibrate at room temperature for 45 minutes prior to use.
 - Refer to package insert or i-STAT System Manual for additional reconstitution information. Carefully follow timing instructions.
 - **PTINR liquid Controls** – Used to validate performance of PTINR test cartridges.
 - CAUTION: Handle using standard precautions. This product contains human plasma
 - Store 2° to 8°C through package expiration date.
 - Equilibrate at room temperature for 45 minutes prior to use.
 - Refer to package insert or i-STAT System Manual for additional reconstitution information. Carefully follow timing instructions.
 - **Other Controls**—As i-STAT develops more cartridges, a need may exist for additional quality control materials. Details will be included as an appendix at the end of this document or the QC-specific package insert or the i-STAT System Manual may be referenced for details.

b. **Calibration:** Calibration is automatically performed as part of the test cycle on each cartridge. Operator intervention is not necessary.

c. Daily Procedures Performed by the User Site

i. Analyzer Verification

Internal Electronic Simulator (Daily Quality Control)

- To verify performance, each i-STAT analyzer will automatically perform an **internal electronic simulation** every 8 hours of use for each different cartridge type. The internal electronic simulation is activated when a **filled** test cartridge is inserted into the analyzer. The automatic electronic simulator option is activated/programmed by the POCT Coordinator, via the i-STAT data management system, when an analyzer is placed into service.

- The simulator is a circuit in the analyzer, when enabled, verifies the electrical measurement of the analyzer and performs the same functions as the external electronic simulator.
- If 8 hours have elapsed since the last electronic simulator test, the analyzer will automatically perform the internal test before the sample is analyzed. 15-20 seconds will be added to the test cycle.
- If the simulator test fails, the FAIL result will be displayed on the analyzer screen, and the sample will not be analyzed.
- **Action for failed electronic simulator:**
 - Repeat the electronic simulation test by inserting another test cartridge or run the external electronic simulator QC device.
 - Analyzers are programmed with “QC Lockout”. Results will not be given to the user, unless the QC/simulator check is acceptable.
 - The i-STAT System Manual should be consulted for assistance.
 - If the analyzer does not pass the external electronic simulator testing, contact the Clinical Laboratory POCT office for assistance.
- **Action for passing electronic simulator:**
 - If the internal electronic simulator passes, patient testing continues and gives results in the standard way.
 - When the internal simulator is run, the PASS message will not be displayed on the analyzer screen. The QC record will appear in the analyzer’s memory and will be transmitted to the i-STAT data manager when the analyzer is downloaded.

External Electronic Simulator (As Needed, Quality Control)

- Test the external electronic simulator in the following circumstances:
 - If the internal QC check fails
 - If the analyzer is dropped
 - If analyzer performance is in question
 - If a quality check code indicates that the simulator should be tested
- Store at room temperature and protect contact pads from contamination by placing the simulator in its protective case.
- **Note:** Do not remove the simulator while “Simulator Locked” is displayed on the analyzer screen. Damage may occur to the analyzer. It is safe to remove the simulator when the ‘Simulator Locked’ message disappears from the display screen.
- **Action for failed electronic simulator:**
 - Repeat the procedure with a different external electronic simulator or contact the Clinical Laboratory POCT office.
 - If FAIL is displayed with the second electronic simulator, do not use the analyzer for patient testing.
 - Return the analyzer to the POCT office.
 - Use another analyzer for patient testing.
- **Action for passing electronic simulator:**
 - If PASS is displayed, the analyzer may be used for patient testing.

ii. QC Documentation

Both the internal and external simulator test results are stored as distinct QC records in the analyzer and will be downloaded into the i-STAT data management system when patient data is transmitted. QC data is reviewed by the POCT Coordinator or designee. Follow-up action is taken as necessary for QC failures.

iii. Cartridge Supply Check (Performed by test sites)

- Room Temperature Cartridges are stored with each device in each user site.
- Inventory should be performed periodically.
- When checking the i-STAT inventory, the cartridge expiration date should also be checked.
- Prior to patient use, verify that cartridges are within manufacturer and/or room temperature expiration dating.
- Follow manufacturer instructions for room temperature storage.
- Using an expired cartridge, could jeopardize patient care.

- The expiration date of each cartridge should be stamped or written on the outside of the cartridge pouch.
- *Always use the oldest date first to avoid loss of cartridges due to expiration.*
- Return any expired cartridges to the POCT Coordinator in the Clinical Laboratory.
- If the room temperature exceeds 30 ° C (86 ° F) for any period of time, quarantine the cartridges and notify the POCT Coordinator. DO NOT USE the cartridges.
- If a user site needs more test cartridges, they may be picked up from the OR Blood Gas Lab.
- DO NOT allow supplies to get critically low.

iv. Verification of Cartridge Storage Conditions

- **Refrigerated Cartridges-Stored in the Clinical Laboratory—(Performed by the Clinical Laboratory)**
 - Periodically and prior to user site release, verify that the cartridges stored in the refrigerator are within the expiration date printed on the boxes.
 - Notify the POCT Coordinator if any expired cartridges are found and pull them from patient issue stock. The cartridges should be labeled as “Do Not Use for Patient Testing”.
 - Daily, verify that the refrigerator did not exceed the limits of 2 to 8 ° C (35 to 46 ° F).
 - Document the temperature in the appropriate temperature log.
 - **Action: If the temperature of the cartridge storage refrigerator is within the range of 2 to 8 ° C,**
 - Dispense cartridges, as required.
 - **Action: If the temperature is outside of 2 to 8 ° C,**
 - Quarantine the cartridges in the storage refrigerator.
 - Notify the POCT Coordinator immediately.
 - DO NOT USE the cartridges from the out-of-control refrigerator for patient testing.
 - I-STAT Tech Support may be contacted for assistance and liquid quality control checks may be performed to verify cartridge performance.
 - Record the temperature failure in the appropriate log, along with the action taken to resolve the problem.
- **Refrigerated Cartridges-Stored in user site refrigerators-(Performed by user site testing personnel)**
 - Prior to patient use, verify that the cartridges stored in the refrigerator are all within the expiration date printed on the boxes.
 - Deliver any expired cartridges to the POCT Coordinator.
 - Daily, verify that the refrigerator did not exceed the limits of 2 to 8 ° C (35 to 46 ° F).
 - Document the temperature on the applicable refrigerator temperature log.
 - **Action: If the temperature of the cartridge storage refrigerator is within the range of 2 to 8 ° C,**
 - use the cartridges as required.
 - **Action: If the temperature is outside of 2 to 8 ° C,**
 - Quarantine the cartridges in the storage refrigerator.
 - Notify the POCT Coordinator immediately.
 - DO NOT USE the cartridges from the out-of-control refrigerator.
 - Adjust the temperature and recheck in one hour.
 - Record the temperature failure on the temperature log, along with the action taken to resolve the problem.

v. Emergency Cartridge Release.

- Do not take cartridges from the refrigerator that are labeled with, “Do Not Use”.
- Complete ‘Emergency Release’ form. Form can be found on the internal Point-of-Care Testing web site.
- All cartridges should be marked with the appropriate room temperature expiration dating when taken from refrigerator.

vi. Analyzer Cleaning and Decontamination

- **The analyzer must be disinfected between each patient use.**
- Anytime an analyzer becomes visibly contaminated with blood, it should be sanitized with an anti-microbial cleaning agent to prevent spread of infection between patients.
- Use a fresh solution of 10% bleach or WFBMC-approved disinfectant.
- **DO NOT ATTEMPT TO CLEAN INSIDE THE CARTRIDGE PORT.** This may damage the probes.
- Return internally contaminated analyzers to the POCT Coordinator.
- Contaminated analyzers should be treated as any other biohazard substance. (i.e. Use Standard Precautions when handling.)
- Follow WFBMC policies and procedures for cleaning, disinfection, and discard of supplies.

d. Liquid Quality Control

Liquid Quality Control (LQC) is used to verify the integrity of the test cartridges. Appropriate liquid controls should be used to test all analytes. Refer to the i-STAT System Manual for the most current list of available liquid controls.

i. New Cartridge Shipments: LQC checks verify the acceptable integrity of the i-STAT cartridges when they are received from the manufacturer. LQC should be tested on each lot number of each cartridge type received. The Clinical Laboratory will perform quality control checks on each new shipment of i-STAT cartridges that are received by the Clinical Laboratory.

- The quality control checks will be performed, prior to release of cartridges to the user sites. If a particular shipment of cartridges fails to pass the quality control check, they will not be released for patient use.
- In addition, i-STAT cartridges are shipped refrigerated with a temperature indicator to monitor temperature during transit. The record of receipt is checked and documented.
 - Complete the 'i-STAT Cartridge Receipt Check' form. Blank forms can be located on the internal Point-of-Care Testing web site.
 - If all windows are white or if only the "A/1" or "B/1" windows have changed color, then transit temperatures were satisfactory.
 - If any or all of the "C/3 or D/4" windows have changed color:
 - Quarantine the suspect cartons.
 - Notify the POCT Coordinator immediately, who in turn, will contact I-STAT Tech Support for assistance.
 - DO NOT USE the cartridges from the suspect cartons.
 - Record the out of control event on the 'i-STAT Cartridge Receipt Form'.

ii. Questionable Cartridge or Analyzer Performance: If cartridge or analyzer performance is in doubt then LQC checks may also be performed.

iii. Monthly: Each month test sites will perform LQC checks.

iv. General Information for Testing Liquid Quality Control

- ❖ **The analyzer should be programmed to test quality control. Refer to i-STAT System Manual for instructions.**
 - Use appropriate liquid controls that test all parameters on the test cartridges.
 - Follow manufacturer recommendations regarding QC performance and handling.
 - Refer to the i-STAT System Manual for additional information.
 - Random cartridges should be selected for quality control performance.
 - QC ampules for non-pO₂ and non-hematocrit cartridges may be used once they have reached room temperature. (approximately 30 minutes)
 - For best results, ampules, cartridges, and analyzers should be at room temperature.
 - QC material for pO₂ and hematocrit should equilibrate to room temperature for 4 hours prior to use.
 - For blood gas and electrolyte QC, immediately before use, shake the ampule vigorously for 5 to 10 seconds to equilibrate the liquid and gas phases.
 - To shake, hold the ampule at the tip and bottom with forefinger and thumb to minimize increasing the temperature of the solution.
 - If necessary, tap the tip of the ampule to send solution back into the bottom section of the ampule.

- Protect fingers with gauze, tissue or glove to snap off the tip of the ampule neck.
- Aspirate the liquid QC material into a pipette, capillary or syringe. Aspirate from the bottom of the ampule. Do not contaminate the sample with air.
- Immediately transfer the solution into a cartridge.
- Immediately seal the cartridge and insert it into an analyzer.
- It is important not to expose the solution to room air since this will alter the results.
- Compare the results obtained against the package insert values. Use the expected values published in the package inserts to verify the integrity of the cartridges.
- Check that the lot number of the control ampule matches the lot # on the package insert. The software version (CLEW) listed on the QC range insert should also match the version that is installed in the I-STAT analyzer.
- Results should be transmitted to the i-STAT data management system.
 - Action: If all results are within the expected ranges,
 - Use the cartridges as needed.
 - Action: If any results are outside the published expected ranges:
 - Repeat the QC check and if the failure continues:
 - DO NOT USE cartridges from the suspect lot
 - Quarantine the suspect lot.
 - Notify the POCT office immediately.
 - Document action taken to resolve the problem.

e. Quality Assurance Review-Performed by the POCT Coordinator or Designee

- i. Check the "Unsent Result Log" on the I-STAT data management system for any results that did not get sent to the electronic health record. Results should be evaluated for the following circumstances:
 - The results should be evaluated for proper identification.
 - The results are checked to determine if ID modification is necessary- e.g.: generic ID number, or patient misidentification.
 - "****" (star out) results are evaluated for necessary reporting and will be documented on the "Star-Out Log"
 - As applicable, a pending log is checked and resolved for any results that did not successfully post to the EHR.
- ii. I-STAT Resolution Requisitions are reviewed for necessary action.
- iii. Confirm that each user site transmitted results.
- iv. Electronic simulator results are reviewed, using the i-STAT data management system.
 - When an electronic simulator is noted as 'FAILED', the electronic simulator results are printed or other electronic documentation is made as to the action that was taken, as applicable.
- v. Cartridge usage and error rate is monitored.
- vi. Quality check codes are reviewed
 - Quality check codes are monitored, via the i-STAT data management system, to check for trends in cartridge or analyzer performance.
 - If there are recurrent and unexplained quality check codes, I-STAT Technical Support may be contacted for resolution of the problem.
- vii. Quality Assurance (QA) reports are monitored for results that are outside of pre-defined limits (out of instrument range or critical values).
 - Results that report as "Out of Instrument Range" are also reviewed for validity.
 - Any result that could indicate inaccurate patient results or poor operator technique is investigated accordingly and appropriate action taken, as necessary.
- viii. When problems are noted, communication is sent immediately to user sites in the form of memos/e-mail documentation and is posted for user review.
- ix. As necessary, quality assurance (QA) reports are sent to user site supervisors or managers for follow-up of problematic issues.

f. Troubleshooting:

- i. See the i-STAT Technical Bulletin "Analyzer Coded Messages" for troubleshooting information.
- ii. The i-STAT ceramic cartridge may be used to correct certain error codes. Refer to i-STAT Technical Bulletin, 'Analyzer Coded Messages', for specific details.
- iii. For technical assistance with the i-STAT system, contact the designated super user for the testing site; call the POCT Coordinator at extension 3-4136 or 3-4137; contact the Clinical Laboratory at 6-2610, or call i-STAT technical service at 1-800-366-8020.

g. Proficiency Testing:

Non-waived Point-of-Care Testing sites at WFBMC participate in a CMS-approved proficiency testing program. Users should follow instructions provided with the survey samples. Current accrediting and regulatory standards are followed. The proficiency samples are rotated among different users. There is no communication between the Clinical Laboratory and POCT sites, regarding specific result values, until after the proficiency provider submission deadline. If proficiency survey sample results fail, the problem is investigated and resolved as necessary. Example, re-training, instrument performance evaluation or survey sample handling. Follow-up and corrective actions are documented. Samples will be handled as follows:

- i. All PT samples in the kit should be tested on the Same Day.
- ii. One staff member should test All samples that come in the survey kit. (referenced as PT event)
- iii. Testing of PT events should be rotated among testing personnel each calendar year, as available.
- iv. A goal, but Not a requirement, is to follow this rule, At least one PT event-- per year-- per staff member when possible. Managers will keep track of personnel testing PT to make sure that one person is not always performing the PT.
- v. One analyzer should be used to test All samples that come in a survey kit. (referenced as PT event)
- vi. A PT event should be handled as would a patient sample, so analyzer selection should be as if it were a patient sample in the workflow. The analyzer used for proficiency testing is not assigned. The analyzer used is at the discretion of the testing staff member, when this is the workflow for patient samples.

h. Employee Certification/Training/Competency:

Employee training documentation is completed upon training on the i-STAT system. Each user of the i-STAT system should be trained prior to using the device for patient testing and should maintain updated competency records. Competency is assessed annually. Current regulatory standards will be followed. Any user that fails to meet the competency requirements will need to be re-educated for use of the system. The Clinical Laboratory Point of Care Testing Coordinator and user site manager maintains training and competency records.

Appendix D

I-STAT Misidentification Protocol (formerly PPB-NCBH-LAB-775-17)

Revision: 6/2014

1) Purpose:

A patient-specific Contact Serial Number (CSN) is used to identify patient samples in the I-STAT analyzer. Sample identity should be confirmed and verified throughout the entire testing and result reporting process. If a patient sample is identified by the incorrect CSN, the results could post and bill to the incorrect patient. This could result in inappropriate treatment of a patient. Extreme care should be taken in entering the patient's identification number into the I-STAT analyzer. If a sample misidentification is recognized, the following procedures should be followed. Patient sample misidentification will be reported to Risk Management.

2) Procedure:

a. User Site

- i. Call ICU Blood Gas Lab at extension 6-4832.
- ii. Tell the lab staff member that you have misidentified a sample in the I-STAT analyzer and need the results flagged as being misidentified.
- iii. Download the analyzer.
- iv. Fill out an i-STAT Resolution Requisition. Complete all requested information. **Include a copy of the results which need to be corrected!**
- v. Send the resolution requisition to the ICU Blood Gas Lab-pneumatic tube station 54 or fax to 716-6586.
- vi. Ensure that result printouts or other documentation in the user site are corrected.
 - **It is the responsibility of the staff member who creates a sample misidentification to ensure site specific documentation and notification of appropriate personnel is completed.**

b. Laboratory

- i. **An ICU Blood Gas Lab staff member should review and initial each i-STAT Resolution Requisition that is received in the lab.**
- ii. When a call or an I-STAT Resolution Requisition is received, regarding a sample misidentification,
 - Obtain the patient identifier that was entered into the I-STAT analyzer.
 - Verify the results, which need to be replaced.
 - **Refer to the results indicated on the I-STAT Resolution Requisition.**
 - **Do not make corrections to results not indicated on the resolution requisition.**
 - Immediately, **replace the results** with the appropriate sample misidentification code or comment!
 - Obtain the assigned accession number.
 - **NOTE:** Multiple accession numbers may be assigned. Ensure all results are flagged/replaced with the appropriate sample misidentification comment.
 - Replace the results in the electronic health record with an appropriate code or comment.
 - Document the name of the person who contacted the lab and the time contacted.
 - **If the incorrectly entered patient identifier belongs to a patient outside of the site that created the misidentification, then the charge nurse of that patient care area should be notified. Notification should be documented in the electronic health record.**
 - As appropriate, test results should be resultated on the correct patient's electronic health record.
 - Appropriate credit for tests should be issued to the misidentified patient.
 - Sample misidentification issues will be reported to Risk Management.
 - The site manager is responsible for follow-up action regarding these occurrences.

Test/ Cartridge	LIS/Test Code	Tests in battery, if multiple test results
ACT-Celite	Battery=ZACT Test=ZACTC	Tests in battery: ZACTC ZCOM-- auto-answer comment POC (point of care testing)
ACT-Kaolin	Battery=ZACTB Test=ZACTK	Tests in battery: ZACTK ZCOM-- auto-answer comment POC (point of care testing)
Creatinine	ZCRTB	Tests in battery: ZCRT ZGFRW ZGFRB Includes LIS generated calculations for estimated GFR. ZGFRW-for NON-African American patient ZGFRB for African American patient
G3 Blood gas	ZG3	Tests in battery: ZSAMP--sample type ZPH ZPCO2 ZPO2 ZHCO3 ZBE ZBD ZSO2 ZFIO2 ZTEMP ZTPH--temp corrected pH ZTPCO2--temp corrected pCO2 ZTPO2--temp corrected pO2 ZTCO2--Total CO2 ZCOM--auto-answer comment POC (point of care testing)
CG4 Blood gas + Lactate	ZCG4 ZG3 + ZLACB	Tests in ZLACB battery: ZSAMP ZLAC ZCOM-- auto-answer comment POC (point of care testing) ZLACB includes LIS generated calculation to append normal range to lactate value-based on sample type entered into i-STAT
EG7 Blood gas + sodium + potassium + ionized calcium + hemoglobin + hematocrit	ZG7	Tests in ZG7 battery: ZG3 + ZNA + ZK + ZICA + ZHB + ZHCT
Glucose	ZGLU	
Chloride	ZCL	
Blood Urea Nitrogen	ZUN	
PT/INR	ZPTB	Tests in ZPTB battery: ZSAMP-sample type ZINR--INR value ZCOM--auto-answer POC ZDEV--helps Sunquest determine whether or not to append DHP address to result ZLOC--auto-answer address if testing performed at DHP ZTECH--tech code of testing personnel--hidden from clinician

Appendix E (formerly PPB-LAB-775-16)
i-STAT Cartridge Sign Out Procedure
Revised 6/2014

1) Purpose

The Clinical Laboratory maintains i-STAT supplies for specifically identified Point of Care Testing (POCT) i-STAT user sites. The Clinical Laboratory receives the cartridges from the manufacturer and performs Quality Control (QC) checks, prior to release for patient use. Each user site is responsible for obtaining i-STAT cartridges and supplies from the Clinical Laboratory. This procedure serves as a guide for Clinical Laboratory staff and i-STAT user sites, regarding appropriate means of issuing and obtaining i-STAT supplies.

2) Procedure

Each user site should designate someone to maintain adequate i-STAT supplies. When a user site needs supplies, they can be obtained from the OR Blood Gas Lab, first floor, Clinical Sciences Building, between the hours of 07:00am and 07:00pm, Monday thru Friday.

❖ **CARTRIDGES CANNOT BE SENT THROUGH THE PNEUMATIC TUBE!**

a. Cartridge Sign-out and Handling

- i. The oldest expiration dated cartridges should be issued first.
- ii. The cartridges are kept refrigerated, per manufacturer's instructions, in the Clinical Laboratory.
- iii. The cartridges should be at room temperature prior to patient use. An individual cartridge is ready to use after sitting at room temperature for 5 minutes. A full box of 24/25 cartridges should sit at room temperature for 1 hour prior to patient use.
- iv. Once cartridges are removed from the refrigerator, an appropriate room temperature expiration date should be noted on each individual cartridge.

❖ **NOTE:** Room temperature expiration dating should never exceed manufacturer refrigerated expiration dating

- Creatinine cartridges—14 DAY room temperature expiration date
 - PT/INR—14 DAY room temperature expiration date
 - ACT-Celite—14 DAY room temperature expiration date
 - ACT-Kaolin—14 DAY room temperature expiration date
 - Chem 8—14 DAY room temperature expiration date
 - G3—2 Month room temperature expiration date
 - CG4—2 Month room temperature expiration date
 - EG7—2 Month room temperature expiration date
 - Other cartridges—Refer to i-STAT System Manual
- v. Each box of cartridges that is removed from the refrigerator should have the:
 - Receipt date
 - Date/time out of the refrigerator
 - Room temperature expiration date
 - Initials of issuing staff member
 - vi. Do not issue cartridges that are marked "NEW LOT NUMBER or DO NOT USE".
 - vii. When cartridges are issued, they should be logged in the i-STAT Cartridge Sign-out book maintained in the OR Blood Gas Lab. There is a sheet for each cartridge type and each user site. The following information should be documented on the sign out log sheet.
 - Date
 - User site
 - Cartridge type
 - Lot number
 - Box number(s) of cartridges issued
 - Quantity Issued

- Room temperature expiration date or refrigerated expiration date, if cartridges will be stored refrigerated at the user site
- How cartridges are issued--room temperature or refrigerated
- Name of person issuing the cartridges

viii. User sites should only be given the amount of cartridges that will be used before the room temperature expiration date.

ix. It is the responsibility of the testing personnel to ensure an adequate supply of I-STAT cartridges are maintained.

x. Testing site personnel are responsible for cartridge pick-up from the OR Blood Gas Lab. (M-F 7am-7 pm.)

xi. User Site Refrigerated Cartridge Sign-Out

Specifically identified sites may stock I-STAT cartridges in site-specific refrigerators.

- If a site stocks refrigerated cartridges, the refrigerator temperature must be monitored daily and documented by the i-STAT testing personnel.
- The refrigerator must be maintained within i-STAT's current recommended temperature range. Refer to cartridge packaging for correct refrigerated storage temperature range.
- Each box of 24/25 cartridges should be labeled with the receipt date and date issued to the user site along with the initials of the Clinical Laboratory personnel who issues the cartridges.
- The cartridges should be taken directly from the Clinical Laboratory refrigerator to the user site refrigerator, so the cartridges do not warm to room temperature.

xii. Cartridges close to expiration:

User sites may come to the OR Lab and swap cartridges that are close to expiration.

- The Point of Care Testing Coordinator or designee should be notified so the cartridges can be given to a site that will use them prior to the expiration date.

xii. Emergency Cartridge Release

In instances when cartridges are needed outside normal operation time of the OR Blood Gas Lab, sites may come to the laboratory and complete the emergency cartridge release form. This form must be completed for any cartridges taken from the Clinical Laboratory that were not issued by a Clinical Lab staff member. Instructions are included on the form.

The form can be found on the internal Point-of-Care Testing web site, under Forms and Records.

b. Other I-STAT Supplies

The Clinical Laboratory also issues the following supplies for the I-STAT system:

- Thermal printer paper for the I-STAT printers

c. Replacement Analyzers/Printers

- i-STAT sites should deliver faulty analyzers or printers to the main Clinical Laboratory.
- As appropriate, laboratory personnel may issue a replacement device. The serial number (located on the back of the device) should be documented.
- Extra devices are located in the Clinical Laboratory Point of Care Testing office.
- Clinical Laboratory staff should document the following for the POCT Coordinator:
 - Label the faulty device with "DO NOT USE"
 - Note the user site that returned the device
 - Leave the faulty device for the POCT Coordinator
 - Leave a note documenting the replacement device serial number that was issued to the user site.

Appendix F

Reference Ranges and Reportable Ranges

Revision: 06/2014

Reference (normal) range means the range of test values expected from 95% of fasting individuals presumed to be healthy. (Taken from the normal ranges established by the Clinical Laboratory at Wake Forest Baptist Medical Center and from the i-STAT System Manual.)

Reportable range means the range of test values throughout which the i-STAT results have been shown to be valid. The following table contains the Reference Ranges and Reportable Ranges applicable to the i-STAT. Reference the i-STAT System Manual for information not listed in this document.

ANALYTE	UNIT	REFERENCE RANGE	REPORTABLE RANGE
Sodium	mEq/L or mmol/L	18y 135-145	100-180
		2y 136-143	
		0 133-142	
Potassium	mEq/L or mmol/L	18y 3.5-5.0	2.0-9.0
		9y 3.5-5.5	
		5y 3.5-5.0	
		1y 3.5-5.5	
		3m 4.0-6.5	
		1m 4.5-7.5	
		7d 4.5-7.0	
Chloride	mEq/L or mmol/L	8y 95-106	65-140
		7d 95-110	
		0d 90-105	
BUN	mg/dL	18y 8-24	3-140
		16y 14-32	
		1y 5-15	
		0d 8-28	
Glucose (serum/plasma)	mg/dL	18y 70-110	20-700
		1m 60-110	
		14d 50-110	
		7d 50-90	
		0d 45-90	
PT/INR	INR	0.8-1.2 (venous and capillary whole blood) –recommended by i-STAT. WFBMC normal range may differ	0.9-6.0

ANALYTE	UNIT	REFERENCE RANGE	REPORTABLE RANGE
ACT (Activated Clotting Time) (Kaolin Activated)	Seconds	Kaolin activated-Prewarm Non-heparinized 74-137	50-1000
ACT (Activated Clotting Time) (Celite Activated)	Seconds	Celite activated NON-Warm Non-Heparinized 84-139	50-1000
Creatinine	mg/dL	18y 0.5-1.5	0.2-20.0
		10y 0.5-1.0	
		4y 0.4-0.9	
		1y 0.3-0.8	
		3m 0.3-0.7	
		1m 0.3-0.9	
		14d 0.4-1.1	
		7d 0.3-1.2	
		0d 0.5-1.5	
Ionized Calcium	mmol/L	1.00-1.30	0.25-2.50
PH		7.350-7.450	6.50-8.20
pCO2	mm/Hg	35-45	5-130
PO2	mm/Hg	80-100(art)	5-800
Hematocrit	%PCV	18y 42-52	10-75
MALE		12y 37-49	
		6y 35-45	
		2y 34-40	
		6m 33-39	
		3m 29-41	
		2m 28-42	
		1m 31-55	
		14d 39-63	
		7d 42-66	
		1d 45-67	
		0d 42-60	
Hematocrit	%PCV	18y 37-47	
FEMALE		12y 36-46	

ANALYTE	UNIT	REFERENCE RANGE	REPORTABLE RANGE
		6y 35-45	
		2y 34-40	
Hematocrit Female		6m 33-39	
		3m -0d same as male	
HCO ₃	mmol/L	22-26	1-85
TCO ₂	mEq/L or mmol/L	22-30	5-50
BE	mmol/L	(-2)-(+2)	(-30)-(+30)
Anion Gap	mEq/L or mmol/L	10-20 Per i-STAT cartridge and test information sheet Art. 714182- 00T	(-10)-(+99)
SO ₂ O ₂ Saturation	%	>95	0-100
Hemoglobin	g/dL	18y 14-18	3.4-25.5
MALE		12y 13-16	
		6y 11.5-15.5	
		2y 11.5-13.5	
		6m 10.5-13.5	
		3m 9.5-13.5	
		2m 9-14	
		1m 10-18	
		14D 12.5-20.5	
		7d 13.5-21.5	
		1d 14.5-22.5	
		0d 13.5-19.5	
Hemoglobin	g/dL	18y 12-16	3.4-25.5
FEMALE		12y 12-16	

ANALYTE	UNIT	REFERENCE RANGE	REPORTABLE RANGE
		6y 11.5-15.5	
		2y-7d same as male	
		1d 14.5-22.5	
		0d 13.5-19.5	
Lactate	mmol/L	Arterial: 0.36-1.25 Venous: 0.90-1.70	0.30-20.0