I. PRINCIPLE

1. Prothrombin Time (PT) is a coagulation test that is used in monitoring warfarin (Coumadin) therapy. The clotting factors II, VII, IX, and X in the coagulation cascade require activation via Vitamin K to form a blood clot and warfarin acts as an antagonist to Vitamin K, therefore preventing factor activation resulting in a reduced clotting effect.
2. PT is measured and converted to units called International Normalized Ratio (INR). To minimize interlaboratory variability from formula variations in the thromboplastin, the following mathematical formula is used: $(INR = PT\ patient/PT\ normal)^{ISI}$. A target therapeutic INR range is assigned to each patient based on their clinical diagnosis and risk factors. Patients' INR are measured and their warfarin is managed through dosage adjustments to maintain their target INR to prevent unwanted blood clots (low INR), or bleeding (high INR).
3. Coaguchek-XS system calculates a patient's INR by using fresh capillary or non-anticoagulated venous whole blood as opposed to plasma and is often used in an ambulatory setting for point-of-care (POC) results.

II. REAGENTS and EQUIPMENT

CoaguChek-XS system includes: CoaguChek-XS Meter, CoaguChek-XS PT test strips, Code chip, internal control, and single use self retracting Lancets

III. STORAGE and HANDLING

A. CoaguChek-XS Meter

1. CoaguChek-XS must be operated between 15º – 32ºC (59°-89.6°F), and a relative humidity of less than 85%, without condensation.
2. Do not store meter in damp or humid conditions.
3. Do not touch any buttons while a test is in progress.
4. When testing, keep meter level.
5. Do not use the meter near a strong magnetic field such as a microwave oven, as this may interfere with testing.
6. The CoaguChek-XS Meter automatically shuts off after 3 minutes if no buttons have been pushed.

B. Test Strips and Code Chips

1. Test strips must be store between 2º – 30ºC (35.6°-86°F).

2. Storage temperature results will be documented on the temperature log once each day the clinic is operating. Monitoring of all non-clinic day(s) will take place on the first clinic day following the non-clinic day(s) by documenting the thermometer temperature.
3. Test strips must be stored tightly capped in the original vial. Replace the vial cap immediately after removal of a test strip.
4. Test strips must be used within 10 minutes of removal from the vial.
5. Test strips are stable until expiration date on the vial. Do not use after expiration date, discard.
6. Before using a test strip, ensure the code chip matches the code on the vial of test strips.
7. Do not touch or remove a test strip while meter is performing a test.
8. Do not remove or insert a code chip while meter is performing a test.
9. Never open a vial or touch test strips with wet hands.
10. Do not wait more than 15 seconds after sticking fingertip before application of blood.
11. Do not add more blood after test has started.

IV. SET-UP – BATTERIES, TIME and DATE

A. Batteries

1. CoaguChek-XS meter uses four AAA batteries.
2. When meter is turned on, display shows a battery symbol.
3. A fresh battery shows battery symbol with all four segments shaded.
4. Batteries must be replaced when only one segment is shaded in battery symbol.
5. If you store the meter for a period of time, it is recommended to remove the batteries.

B. Changing Batteries

1. Turn CoaguChek-XS meter off by pressing the button with (I) on it.
2. Turn meter over and open battery cover by pressing latch gently inward while lifting.
3. Remove old batteries.
4. Place new batteries in battery compartment following diagram inside compartment.
5. Replace battery cover by snapping it into place.

C. Time and Date

1. Time and date must be set any time they are incorrect.
2. It is important that the time and date is correct as the meter compares current date to the test strip expiration date.
3. When replacing the batteries, insert the new batteries within 1 minute of removing the old ones, to keep the date and time settings. If it takes longer than this, you will need to re-enter the date and time.

D. Setting Time and Date

1. Go to Setup Mode by pressing SET button located on left side of meter.
2. The date format should be flashing in upper right-hand corner.
3. Press SET button until year flashing; press M button to change or correct year; press SET button again to save.
4. Press M button to change month; press SET button to save.
5. Press M button to change day; press SET button to save.
6. Time will flash in upper left-hand corner.
7. Press SET button until hour flashes; press M button to change hour; press SET button to save.
8. Press M button to change minutes; press SET button to save.
9. Turn meter off by pressing (I) button.

V. CODING (CALIBRATION)

1. CoaguChek-XS meter must be calibrated with code chip:
   a. Before meter is used for first time.
   b. Whenever a new lot number of test strips are used.
   c. Whenever a code chip error is displayed.

NOTE: It is **IMPORTANT** that the code chip matches the code on the vial of test strips. The code chip provides the meter with information such as lot number and expiration date of test strips.

2. Loading Code Chip
   a. Collect CoaguChek-XS meter and the test strips with code chip.
   b. Remove code chip from test strip box.
   c. Turn meter off by pressing power button (designated with (I) on it).
   d. Remove the old code chip by pulling straight out. The code chip is located on the left-hand side of the meter below the SET button.
   e. Insert new code chip with numbers facing upward and snap into place.
   f. Turn meter on to verify 3-digit code on screen matches 3-digit code on vial of test strips.
   g. Leave code chip in meter when not in use to maintain clean electrodes.

VI. ELECTIVE GUIDELINES FOR MANAGING THE COAGUCHEK XS METER

1. Anticoagulation clinics using CoaguChek- XS devices should be validated against their subsidiary laboratory mainframe instrument before being used for patient testing.

   a. Validation study- A validation study should be performed by the Anticoagulation clinics to demonstrate correlation between the CoaguChek-XS meter and the Laboratory instrumentation. The validation should cover low, mid-range, and high INR patient values by using data collected on 20 paired INR samples (CoaguChek-XS and Laboratory mainframe instrument).
      - Collect one sample in a blue 3.2% citrate blood collection tube, and send to the laboratory for the INR.
      - Collect a second sample by finger-stick and perform an INR on the CoaguChek-XS meter.
      - Enter the data from both methods using a software program for method comparisons such as the EP Evaluator. The comparative method is the current method or method being compared to and is entered as the X value (lab instrument). The new method is entered as the Y value (CoaguChek-XS).
   b. Lot number change/new shipment of strips - A Split Sample study should be performed using 3 to 5 samples for testing the INR using the laboratory mainframe instrument and the CoaguChek-XS meter for lot number change/new shipments of Coaguchek-XS strips.
   c. Data from both the validation and lot number change/new shipments are reviewed and signed by the Laboratory Director.
   d. Acceptable results are the recommended standard deviation range per manufacturer as defined by the Clinical laboratory. Results of the compared methods in the validation study and the lot number change/new shipment of strips should correlate within +/- 30%.

2. Communicate with clinicians/staff on reasons for discrepant INR results (CoaguChek XS vs. Lab)
   a. Different lots of reagent, with different ISI and calibrations
   b. Different reagents and device/reagent combinations
   c. Different brands, and even lots, of blood collection tubes
   d. Alternating measurements by different methods (CoaguChek XS vs. Lab)
   e. Incorrect calculation of the INR and/or Mean Normal Protime range calculated with reagent lot number changes.
   f. Specimen type (whole blood vs. platelet poor plasma)

3. Investigate discrepancies
   a. Patient specific findings - patient's current clinical presentation
   b. Pre/Post analytic errors
   c. Method/reagent differences
   d. Lot shifts, Proficiency/ Quality Control performance history

4. Proficiency Samples are offered through College of American Pathologists (CAP) and the American Proficiency Institute (API) quarterly, and are recommended to be performed to ensure quality performance as indicated by a survey report.

VII. QUALITY CONTROL

A. Testing Frequency

1. Roche Diagnostics does not provide liquid external quality control material with this test system.
2. The meter automatically performs a two-level, on-board quality control test on the test strip before it displays each patient test result. "QC" appears in the display. A checkmark appears after the "QC√", if the QC is successful.
3. Internal controls check for accuracy and precision of analytical process.
4. Internal controls on CoaguChek-XS check the following:
   a. Electronic components and functions
   b. Temperature of the test strips while test is in progress. (It is important to have reagents and test strips shipped and stored properly).
   c. Expiration date and lot information on test strip. On-board quality control tests in the same chamber that the patient is analyzed.

B. Documentation of QC

1. Internal quality control results must be documented with **each** patient result. If acceptable, patient tests results can be reported.
2. All internal quality control results, in addition to any corrective actions taken to fix unacceptable control results, will be documented as "passed" (√) or "failed" on the patient log in the physician practices or in procedural notes in the Standing Stone anticoagulation software program (CoagClinic) used in the Coumadin Clinics.

3. A "pass" result means that the quality control process met the criteria of acceptability and that patient testing can continue. A "fail" result on the quality control would need remedial action taken prior to patient testing.
4. The lot number of test strips must be documented on a log each clinic day in the Coumadin clinics. The documentation must include the date, test strip lot number, expiration date, and the operator initials. A similar patient log to also include patient name, date of birth (DOB), and results of the internal quality control, will be used in the physician practices for each new lot number of test strips.
5. Internal quality control logs must be retained in accordance with the McLaren Healthcare Record Retention Schedule.
6. Quality control and patient logs will be reviewed for by the appropriate authority for potential problems and completeness of documentation.

VIII. SPECIMEN COLLECTION and HANDLING

1. If using venous blood – samples can be analyzed using CoaguChek-XS meter. Collect sample in a plastic syringe free of anticoagulant. The syringe needle should be 23 gauge or larger. Capillary tubes cannot be glass or contain anticoagulants.
2. If using finger stick – specimens may be applied directly from the patient's finger onto the CoaguChek-XS test strip. It is an option to have the sample collected in CoaguChek-XS capillary tubes/bulbs and subsequently applied to test strip.
3. Blood must be analyzed within 15 seconds of finger stick.
4. Do not use the CoaguChek-XS System for testing patients being treated with any direct thrombin inhibitors. These include Angiomax (bivalurudin), Argatroban, and Dabigatran etexilate (Pradaxa).

****NOTE**: If patient sample is drawn and the CoaguChek-XS system indicates an error- draw a new specimen, using a different finger.

IX. PATIENT PREPARATION

1. Explain the purpose of test and steps of procedure before testing
2. Follow proper universal precaution guidelines when collecting and preparing patient specimens; see individual subsidiary infection control guidelines.

X. SUPPLIES

- CoaguChek-XS Meter
- Test Strips
- Lancets
- Alcohol Pad (70% Isopropyl Alcohol)
- Gauze
- Band-aid

- Proper personal protection, including gloves
- Syringe, needle, tourniquet, capillary tubes, bulb if applicable

XI. TESTING PROCEDURE

1. Place meter on solid horizontal surface or hold horizontally, do not move meter while test is in progress.
2. Remove test strip from container and securely replace lid. The test strip must be used within 10 minutes from removal from vial.
3. Slide test strip into guide in the direction the arrow is pointing until it stops. Meter will turn on.
4. Check time/date and battery level on meter. If time/date or battery level is incorrect or low, fix the problem. Refer to “Set-up Batteries, Date and Time”.
5. **Confirm** that the code number displayed matches the code number on the test strip container, then press “M” button.
6. An hourglass appears while meter warms up, this takes about 30 seconds. When meter is warmed up, a flashing test strip appears and it will start counting down from 180 to 0. Sample must be placed on test strip within this time.
7 Find target area on strip.
8. While meter is counting down, collect and apply sample.
   a. **Finger stick method: DO NOT** wipe away first drop of blood**.** Apply sample to target area on test strip until flashing drop of blood disappears. This must be done within 15 seconds of puncture. (It is OK to pick up meter to patient’s finger and touch edge of test strip, but be sure to keep meter flat and set down after sample is collected).
   b. **Capillary tube method**: Touch CoaguChek-XS capillary tubes to first blood drop after finger stick and allow tube to fill up halfway by capillary action. Hold capillary tube over target area on test strip and expel specimen within 15 seconds of puncture. Avoid air bubbles.
   c. **Venous sample**: EXPEL FIRST FOUR DROPS of blood from syringe or syringe needle. After drops are expelled, immediately place sample on target area of test strip.
9. While placing blood on target area, hold there until flashing drop of blood symbol disappears.
   ****NOTE**: Do not add more sample while test is processing.
1. Place used test strip, lancet, alcohol, gauze and other material in appropriate waste containers
11. Shut meter off by pressing (I) button.

XII. DOCUMENTATION of PATIENT RESULTS

1. In the physician practices, document the PT/INR result on a patient test log and in the Patient Electronic Medical Record (EMR) according to each subsidiary guideline. The information on the patient log will include the date, patient name, DOB, lot number of test strips and expiration date, internal QC result, and the signature of the operator (with credentials).
2. All Coumadin clinic patient visits will be documented in the Standing Stone anticoagulation software, Coagclinic. The information will include, but not limited to; date, time, initials of the operator, patient name, patient ID, INR results, internal quality control result and progress notes including resulting dosing and follow-up appointment date.
3. The CoaguChek-XS meter automatically stores up to 300 test results and their dates and time in its memory. When viewing results in memory, results can be changed between INR and Protime seconds by pressing the Set button on the meter side. This allows the user to toggle between Protime seconds and INR.

****NOTE**: All test results stored in memory are not accompanied by the required two patient identifiers and should not be used for reporting previous performed patient INR results.

XIII. INTERPRETATION:

Normal Range INR= 0.9-1.1
Critical Call result**:** = INR's ≥ 5.0
Reportable Range = INR 0.8 – 8.0
Therapeutic Range= 2.0-3.0
Mechanical Heart Valve Range= 2.5-3.5

XIV. EXPECTED VALUES

1. Any patient whose INR is ≥ 5.0, will be confirmed from a repeat INR using a different finger.
2. Any patient whose INR results are "out of the reportable range" (INR 0.8-8.0), will display an error message. Refer to the error codes for reference in troubleshooting, or contact Roche Diagnostics at 1-800-428-4674.
3. If a patient's INR results using the CoaguChek-XS system are ≤0.8 or ≥8.0, do not report the results. Send the patient to a laboratory for a STAT confirmatory venous draw.
4. Physicians will be notified of critical values on confirmatory venous draws within 4 hours by the performing laboratory.
5. Confirmatory testing with a venous draw should be performed anytime the pharmacist or provider has concerns regarding the patient's INR trends or if clinically warranted.
6. Physician practices and clinics will follow the subsidiary Hospitals Critical Values Requiring Notification Policy for guidelines in the absence of specific medical-staff-approved policies.
7. All physician and providers recognize the INR differences between POC devices and laboratory instrumentation with INR's >4.0. All clinical decisions will fall within the scope of the out-patient clinic in collaboration with the patient's physician and/or Director of the clinic.

XV. ERROR MESSAGES

1. Error: **Test Strip** – May occur when test strip inserted while meter turned on. May also occur if test strip not removed after performing test, or if meter timed out after strip inserted. May also mean test strip unusable or not a CoaguChek-XS PT test strip. Solution: Remove test strip and replace with new CoaguChek-XS PT test strip.
2. Error: **Meter Temperature** – Occurs when meter is too warm or cold to give correct measurements. Solution: Turn meter off and store at temperatures between 15^{o} – 32^{o}C for about 30 minutes.
3. Error: **Battery** – Battery level low. Solution: Replace batteries.
4. Error: **Test Strip Guide Cover** – Test strip guide cover is not closed. Solution: Close test strip guide cover by snapping into place.
5. Error: **Code Chip** – Code chip is missing, damaged, or improperly inserted. Solution: Check proper insertion of code chip. If code chip is damaged, call the Roche Diagnostics Technical Service Center at 1-800-428-4674.

6. Error: **Test Strip Expired (Error 3)** – Test strips are beyond expiration date. Solution: Ensure meter's date and time is correct. If correct, turn meter off and replace new code chip from new in-date test strips.
7. Error: **Test Strip Unusable (Error 4)** – Test strip is unusable. Solution: Turn meter off, remove test strip, reinsert. If message still reads unusable, replace with new test strip.

8. Error: **Time Exceeded (Error 000)** – Blood not applied to test strip within 3 minutes. Solution: Turn meter off, remove test strip. Repeat test using same test strip, but new drop of blood from different finger. If blood was added to reagent test strip, discard test strip and repeat tes
9. Error: **Blood Application (Error 5)** – Error occurred while applying blood to test strip. Solution: Turn meter off and remove test strip, repeat test using new test strip and new sample from different finger.
10. Error: **Test Strip Interference (Error 6)** – Test strip removed or touched during test. Solution: do not touch or remove test strip during tests, repeat test using new strip and a new sample from a different finger. May see "ERROR 6" with patients under treatment on warfarin in combination with antibiotics and/or chemotherapeutics (i.e. INR>8.0).
11. Error: **Quality Control Failure (QC error)** – Test strip quality control failed, test strip unusable. Solution: Turn meter off, remove test strip, repeat test using new strip and new sample from a different finger.
12. Error: **Measurement Error (Error 7)** – Measurement error due to blood sample. Meter was unable to detect a clot. Solution: Do not remove or touch test strip during testing. Apply blood within 15 seconds of finger stick. Sometimes error message occurs in patients with long coagulation times (INR >8.0). Repeat the test. If message appears again, result must be checked using alternative method. If using capillary tubes, make sure they are CoaguChek-XS capillary tubes.
13. Error: **Internal Error (Error 8 or 9)** – Occurred during internal diagnostic tests. Solution: Turn meter off, remove batteries, and wait at least 1 minute. Reinsert batteries, reset the date and time. Repeat test, if same error message occurs, meter has a defect and may need to be replaced. Call the Roche Diagnostics Technical Service Center at 1-800-428-4674.

XVI. MAINTENANCE

1. Clean the meter with each patient testing. Clean/disinfect the CoaguChek-XS meter housing for a contact time of > 1 minute. Let dry for 10 minutes before performing testing.
2. 70% isopropyl alcohol (70% isopropyl alcohol pad) is used to clean the meter between patient testing. Roche does not recommend using 10% bleach for cleaning or disinfecting the CoaguChek-XS meter. Frequent use with 10% bleach may leave a residue within the system due to evaporation. This will result in conductive connections of the electrical contacts.
3. Turn meter off during cleaning procedures.
4. Always wipe meter with lint-free tissue.

Cleaning the test strip guide

1. Clean test strip guide by opening cover. Use thumbnail to open test strip guide cover by pressing front edge upward. Clean cover.

2. Holding meter upright with the test strip guide facing down. Clean test strip guide with cotton swab or pad using 70% isopropyl alcohol. Be sure the swab is only damp, not soaking wet, to ensure excess fluid does not enter the meter.
3. Leave test strip guide cover off for 10 minutes to dry.
4. Close cover by snapping it into place.

XVII. LIMITATIONS OF THE PROCEDURE

1. The blood sample must be at least 8 µL. Low sample volume will cause an error message to appear on the meter.
2. The CoaguChek-XS System uses only fresh capillary or non-anticoagulated venous whole blood. Plasma or serum cannot be used.
3. Use only plastic syringes without anticoagulants or additives. Do not use glass tubes or syringes.
4. Never add more blood to test strip after test has begun or perform another test using the same finger stick.
5. When a patient is on intravenous infusion therapy, do not collect sample from arm receiving the infusion line.
6. No significant effect on test results was seen with:
   a. Bilirubin up to 30 mg/dL
   b. Lipemic samples containing up to 500 mg/dL of triglycerides
   c. Hemolysis up to 1000 mg/dL
   d. Hematocrit ranges between 25-55%
   e. Heparin concentrations up to 0.8 U/mL
   f. Clopidogrel up to 20 mg/dL
   g. Fondaparinux up to 5 mg/L
   h. Low molecular weight heparins (LMWH) up to 2 IU anti-factor Xa activity/Ml

NOTE: The presence of anti-phospholipid antibodies (APAs) such as Lupus antibodies (LA) can potentially lead to prolonged clotting times, i.e., elevated INR values. A comparison to an APA-insensitive laboratory method is recommended if the presence of APAs is known or suspected.

XVIII. REFERENCE:

CoaguChek- XS System User Manual, Roche Diagnostics, 2011

8/16: Updated Expected Values section
1/18 Validation/Memory/Confirmation testing
4/18 Acceptable range for validation and lot change/new shipment of strips should correlate within +/- 30%
2/19 Do not use 10% bleach for cleaning