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Standard Operating Procedure

Title: **TPMG SFO Laboratory Quality Control Policy – Quantitative Assays**	**Procedure Number** SFOSOP-0288 **Revision:** 1

Department: Chemistry Coagulation Hematology Immunohematology Microbiology Point-of-Care Testing Quality System Urinalysis **Area:**	***Approved & Released Standard Operating Procedure***	**Implementation Date:** 07/15/2019

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RWLQCWI-2190 Rev1

Laboratory Quality Control Policy – Quantitative Assays

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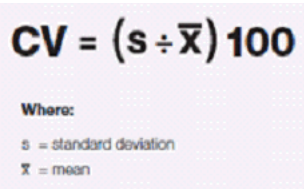
1. **Purpose**	Quality Control (QC) in the clinical laboratory is a system designed to monitor that each test system employed by the laboratory is as accurate and reproducible as initially validated and patient results reported can be used with confidence by the provider for patient care management. QC procedures detect analytical errors, and when used and monitored properly, alert testing personnel (CLS/MLT) to potential analytical problems for which patient test results should not be reported. The region wide Laboratory Quality Control Policy promotes standardized practice across Kaiser Permanente NCAL region and ensures accuracy and precision throughout the analytic phase of testing. The purpose of this policy is to provide better understanding of QC data and to guide testing personnel in making clear and logical decisions about accepting or rejecting patient test results based on predetermined specifications.

2. **Scope**	This policy is applicable only to quantitative tests in the following specialties: Ø Chemistry and Blood Gas Ø Hematology Ø Coagulation This policy is applicable to the following licensed personnel: Ø CLS (Clinical Laboratory Scientists) Ø MLT (Medical Laboratory Technicians) when the test(s) is within scope
3. **Definition of Terms**	**Abnormal Control:** Ø A control product that contains a physiologically high or low concentration of an analyte. **Accuracy:** Ø The closeness of agreement between a measured quantity value and the target value such as accuracy-based reference value or peer group consensus mean. The closeness of measurements to the true value is indicative of accuracy of the assay. **Bias:** Ø Systematic discrepancy between a measurement and the true value. Bias is a measurement of inaccuracy of a test system. A negative or positive bias is an estimate of a systematic measurement error. **Coefficient of Variation (CV):** Ø A measure of the ratio of standard deviation (SD) to the mean. CV is concentration independent and is useful to assess the precision of a test. CV is calculated by dividing the SD by the mean and multiplied by 100. CV is the SD expressed as a percentage of the mean. Ø Formula: 

or

CV = SD / Mean x 100

Coefficient of Variation Ratio (CVR):

- Ø A peer-based estimate of precision. The ratio is obtained by dividing the laboratory monthly CV by the peer group monthly CV.
- Ø Formula:

$$CVR = \frac{\text{Within Laboratory CV}}{\text{Peer Group CV}}$$

Corrective Action:

- Ø Action to eliminate the cause of a detected nonconformity or other undesirable situation. Corrective action is taken to prevent *recurrence*, whereas preventive action is taken to prevent *occurrence*.

Evidence-based QC:

- Ø Evidence-Based QC (EBQC) is a mathematical program used by Sysmex to calculate the control limits of Sysmex hematology QC materials based on the target sigma metrics, bias of the local mean and peer group CV%. EBQC ranges expand the traditional QC ranges beyond ±3SD and do not reflect the precision of the laboratory's Sysmex analyzers.

Individualized Quality Control Plan (IQCP):

- Ø IQCP is a risk-based approach that allows laboratories to examine all possible sources of errors in pre-analytic, analytic and post analytic phases of testing to determine QC frequency for tests qualified for CAP IQCP. It permits reduction of QC frequency.

In Control:

- Ø Indicates that the system is operating within pre-determined specifications.

Instrument:

- Ø An analytical unit that uses samples to perform chemical or physical assays (e.g. Chemistry analyzer, Hematology analyzer).

Laboratory Director:

- Ø The individual who is responsible for the overall operation and administration of the laboratory. This individual is listed on the laboratory's CAP and CLIA certificate. In NCAL KFH labs, it is the Laboratory Medical Director (LMD).

Levey-Jennings Chart:

- Ø A graph that identifies the mean, the working range and other limits for a control sample and shows results of control tests over a period of time.

Lyophilized:

- Ø The characteristic describing the result of the process of vacuum-freeze-drying a liquid material to make its components more stable.

Mean:

- Ø The sum of values divided by the number of values (or average value of control results).
- Ø Formula:

$$\sum x_n / n$$

Where:

Σ = sum

x_n = each value in the data set

n = the number of values in the data set

or

Mean = Sum of Values / Number of Values

Normal Control:

- Ø A control product that contains a physiologically normal concentration of an analyte.

Open Vial Stability:

- Ø The amount of time expressed in hours or days a control product or analyte contained in a control product is considered stable and reliable after the control vial is opened or reconstituted.

Out of Control:

- Ø Indicates that the system is operating outside pre-determined specifications.

Precision:

- Ø The reproducibility of the test.

Preventive Action:

- Ø Action to eliminate the cause of a potential nonconformity or any other undesirable potential situation. Preventive action is taken to prevent

occurrence, whereas corrective action is taken to prevent *recurrence.*

Quality Assessment:

- Ø An overall management plan to assess the integrity of the entire process. Quality assurance is intended to ensure that the right test is carried out on the right specimen, and that the right result and right interpretation is delivered to the right person at the right time.

Quality Control:

- Ø The set of mechanisms, processes, and procedures designed to monitor the measuring system to ensure the results are reliable for the intended clinical use. Quality Control is used to monitor both the accuracy and precision of the assay to provide reliable results.

Quality Control Log:

- Ø A written or computerized listing of successive quality control results.

Quality Control Peer Group:

- Ø A group of labs that uses the same instruments, analytical method, reagent and use the same lot of control material.

Quality Control Material:

- Ø A stable material, liquid or freeze-dried of human, animal or chemical origin that are used to monitor the quality and consistency of the analytical process. A QC sample is designed to simulate a patient sample and is intended for use to monitor the reliability of test system and to alert CLS/MLT when the test system performance is outside the pre-determined specifications. Prepared controls come in either assayed or unassayed forms.
  - o **Assayed Control Material:**
    Assayed control materials generally come with an assay sheet of expected values for analytes assayed by various methods and instrument systems. These assay sheets usually list, for each constituent present, expected mean values and expected ranges. These ranges are provided only as guideline when the laboratory establishes its QC ranges. <u>The manufacturer's ranges should not be used as the laboratory's ranges.</u> The laboratory must establish a valid acceptable range by repetitive analysis that includes previously tested control material.
  - o **Unassayed Control Material:**

Control material that has no assigned analyte values provided by the manufacturer. The laboratory must establish a valid acceptable range by repetitive analysis that includes previously tested control material.

Quality Control Range:

- Ø It is the upper and lower QC limits. QC range is a measure of dispersion which is the difference between the largest and smallest acceptable limits of quantitative characteristic in a given sample. QC range usually represents a ±2SD or ±3SD range unless the range is intentionally expanded.

    - o **Expanded QC Ranges:**
      These are evidence-based QC ranges, inflated QC ranges, manufacturer's ranges where QC ranges are not established based on lab's own data. The QC ranges have limits that are greater than +/- 3 times the true SD.

Random Error:

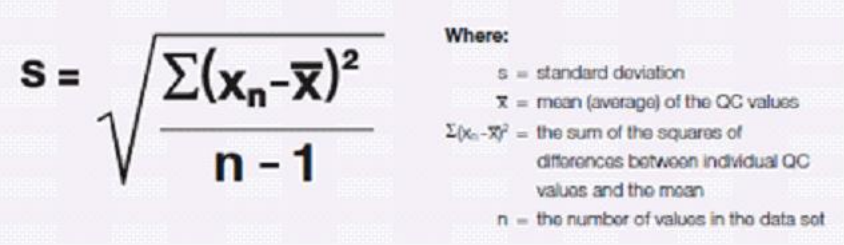
- Ø Any sporadic, non-reproducible and significant deviation from the lab mean that cannot be explained.

Reagent:

- Ø Any substance in a test system other than a solvent or support material that is required for the target analyte to be detected and its value measured in a sample. Examples of reagent are: calibrators, quality controls, etc.)

Standard Deviation (SD):

- Ø The average difference from the mean over time. A statistic which quantifies the dispersion of values around the mean within a specified set of values.
- Ø Formula:



Standard Deviation Index (SDI):

- Ø A peer-based estimate of accuracy

- Ø A statistic that measures the lab's bias relative to consensus group
- Ø Formula:

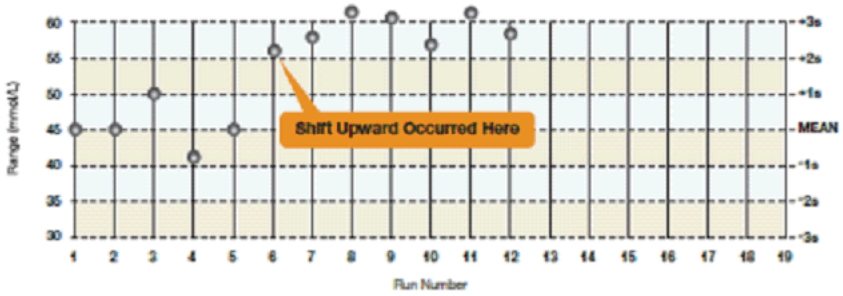
$$SDI = \frac{(X_{Lab} - X_{Group})}{S_{Group}}$$

or

SDI = (Lab Mean – Peer Group Mean) / Peer Group SD

Shift:

- Ø A sudden increase or decrease in control values with at least 7 consecutive points.
- Ø Example:



Stability:

- Ø The stability of a reagent or control as defined by the manufacturer or the laboratory.

Systematic Error:

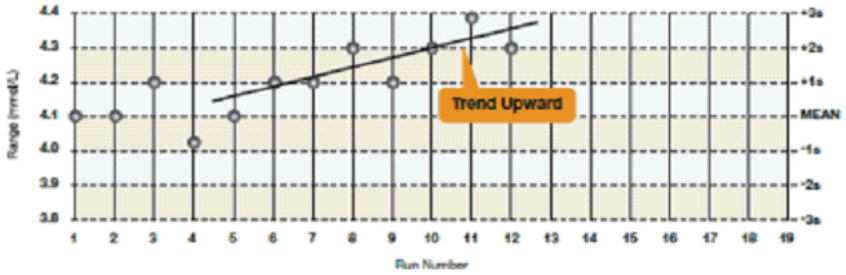
- Ø Are reproducible inaccuracies that are consistently in the same direction. Systematic errors are errors that are traceable to a special cause (e.g. result of instrument mis-calibration).

Testing Personnel:

- Ø Individuals responsible for performing laboratory assays and reporting laboratory results. These personnel are authorized by California Lab Law to perform laboratory tests.

Trend:

- Ø Seven (7) consecutive points with a gradual increase or decrease in control values.
- Ø Example:



Westgard Rules:

- Ø A set of statistical rules used separately or in concert with each other to evaluate QC performance.

Z-Score:

- Ø A statistic that compares each data point to the laboratory mean and SD
- Ø Formula: **Z = (QC result – Lab mean) / Lab SD**

4. **Quality Control Policy Statement**

TPMG SFO Laboratory is committed to complying with California state, federal regulations and CAP quality control requirements.

- Ø The laboratory Quality Control procedures detect immediate errors that occur due to test system failure, adverse environmental conditions, and operator performance.
- Ø The laboratory Quality Control procedures monitor over time the accuracy and precision of test performance that may be influenced by changes in test system performance and environmental conditions, and variance in operator performance.

5. **Laboratory QC Programs**

A. **Intra-Laboratory QC Program:**

- Ø The **Intra-Laboratory Quality Control Program** uses commercially available control materials or, if applicable (e.g. Coagulation), pooled, pre-analyzed patient specimens to assess the reliability of day-to-day accuracy and precision of testing system.

B. **Inter-Laboratory QC Program:**

- Ø This is provided by QC or instrument manufacturers to compare the laboratory's quality control data with other laboratories using the same quality control material on the identical instrumentation for statistical analysis and comparison to other laboratories. It is highly recommended to enroll in an Inter-Laboratory Quality Control Program.

C. **Individualized Quality Control Plan (IQCP):**

- Ø IQCP is a risk-based approach that allows flexibility in QC frequency for qualified tests. IQCP must include a risk assessment (RA), Quality Control Plan (QCP) and Quality Assessment (QA) as required by CMS and CAP. It provides structure and guidance to perform this evaluation and determine the best QC protocol for a laboratory.

	Ø Only tests that qualify under CAP IQCP are permitted to reduce QC frequency below CLIA minimum requirement via IQCP evaluation process. CAP IQCP Qualifications: o Non-waived and non-pathology tests o Test that has an internal or electronic control o Organism QC for Microbiology media Ø IQCP has been implemented region wide for non-waived point of care tests such as i-Stat and microbiology media QC. Contact the ALAD-LQC and/or Regionwide NCAL-LQC if assistance is needed to determine IQCP qualification or for IQCP development.
6. **Quality Control**	A. **QC Handling and Preparation:** Ø Follow the manufacturer's instructions in handling and preparation. Ø Frozen controls must be completely thawed prior to use. Mix controls by gentle inversion prior to dispensing. Ø If lyophilized, put the date when the control was reconstituted. Some controls may require shorter expiration date than what is originally stated on the label upon opening, thawing or reconstitution. Follow the manufacturer's instructions in determining in-use expiration date. Ø Keep controls tightly capped when not in use. If controls require refrigeration, put the control vials back in the refrigerator as soon as possible after use. Ø Discard expired controls appropriately. Ø NCAL LQC recommends putting the open date, expiration date and CLS/MLT initials on the control vial or tracking log. B. **QC Level Selection:** Ø Refer to each test procedure. A minimum of two levels of control is used in all quantitative assays. Some assays (e.g. beta hCG) have additional control to monitor the accuracy of on-board dilution. Control material should have constituent concentrations at normal and abnormal levels and should be within the reportable range of each assay. C. **QC Frequency:** Ø Follow the regulatory and manufacturer recommendations, whichever is more stringent. For most tests, CLIA and CAP require that QC be tested, at minimum, every 24 hours that testing occurs. QC must also be tested after calibration, after a change in reagents, after test system maintenance and after replacement of a critical part (e.g. lamp, probe, photometer, incubator replacement).

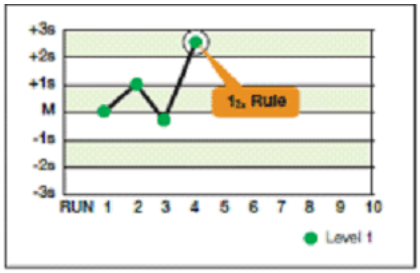
	Ø **Chemistry QC Frequency:** v Routine Chemistry – for most tests, every 24 hours; electrolytes and creatinine, every 8 hours v Osmolality – every 24 hours v Blood Gas – every 8 hours Ø **Hematology QC Frequency:** v Two to three levels of liquid QC every 8 hours Ø **Coagulation QC Frequency:** v Two levels of liquid QC every 8 hours
7. **New QC Lot Validation**	A. **Establishing New Lot Mean:** Ø Approximately 30 days before the current lot of controls expires, establish a target mean by replicate testing. Ø For assayed and unassayed controls of chemistry and coagulation tests, concurrent testing of new lot and current lot of QC materials is required. Collect QC data over an extended period, such as 30 days, so that data reflects variations normally occurring in routine operation. Ø Evaluation should include: v Several bottles of control material v Different calibrations, whenever possible v Several operators v Change of environmental conditions, such as temperature fluctuations Ø For assayed controls, target mean must fall within the manufacturer's range. Assigned values provided by the manufacturer should be used only as guides and not as a replacement for the target values established by the laboratory. Ø Invalid results (obvious outliers, results >3SD, evaluation results from runs where current lot of QC fails, wrong QC vial, and/or deteriorated QC material) should be omitted from the calculations of the mean. B. **Establishing New Lot Range:** Ø Use the laboratory's QC data to calculate the mean, SD and CV. Ø For most tests, a ± 2SD range is acceptable but for Hematology, a ± 3SD range is more appropriate (i.e. instruments for CBC, if lab is using own QC data). Ø QC range that is intentionally expanded beyond ±3SD by the laboratory must be justified and approved by the LMD or manager overseeing the department. <u>Westgard Rules do not apply to inflated QC ranges</u>. Ø QC range that is intentionally inflated by the manufacturer (e.g., Evidence-Based QC of Sysmex analyzers) can be used without additional approval. Follow Sysmex instructions to establish QC ranges. <u>Westgard Rules do not apply to EBQC ranges.</u> Ø In emergency situations, the new lot QC range of a stable method can be estimated. Repeat the new lot control at least 10 times over 5 days to obtain the new

	mean and use the cumulative CV% to estimate the new SD. Formula: v New Lot SD = New Lot Mean x cumulative CV% Ø QC ranges between two identical instruments must be, if not identical, close with each other (i.e. QC Means between 2 identical instruments using the same calibrator/reagent and run by same group of testing personnel are **within 0.5 to 1.0 SD**). C. **Levey-Jennings Chart On-Board the Analyzer:** Ø The mean and SD of the analyzer QC program, when available, must be updated to reflect the current QC range to allow CLS/MLT to use the Levey-Jennings chart to appropriately evaluate QC performance. D. **Cerner Millennium (CM) QC Program, when applicable:** Ø The mean and SD in CM must be updated to reflect the current QC range to allow CLS/MLT to use the Z-Scores to appropriately evaluate QC performance.
8.**QC Rules**	A. **Purpose of Quality Control Rules:** Ø Use QC rules in decision-making based on one or more QC measurements to determine whether the method is performing in a stable (in control) or unstable (out of control) state. Ø Use QC rules to detect a change from stable analytic method (systematic error), such as shift or trend. Ø For test system where manufacturer requires all three levels of quality control values are within acceptable ranges, run is rejected when this criterion is not met. Ø For test system where the additional third quality control material is for monitoring dilution accuracy, undiluted patient results are acceptable when both undiluted quality controls are in range. Diluted patient results are acceptable when all three quality controls (undiluted and diluted controls) are in range. B. **Westgard Rules:** Ø There is no regulatory or accreditation requirement to use all (or any) Westgard Rules, but the laboratory must have rules to indicate when method is out of control and needs attention, including corrective action and patient impact assessment. Ø Westgard Rules can be used only when QC range is established using the laboratory's own data without intentional expansion. Ø Westgard rules do not apply if the lab is using peer group range, evidence-based range, inflated range and manufacturer's range. These ranges are usually wider than the laboratory's range.

NCAL TPMG SFOO Labs Standardized QC Rules:

1_{2s} Rule

- Ø First data point of 20 is outside the ±2 SD limits.
- Ø The second control is in range.
- Ø This rule warns that random or systematic error may be present in the test system, therefore, the relationship between this value and other QC results within the current analytical runs must be examined. If no relationship can be found and no source of error can be identified, a single a control value outside the ±2s limits is an acceptable random error.

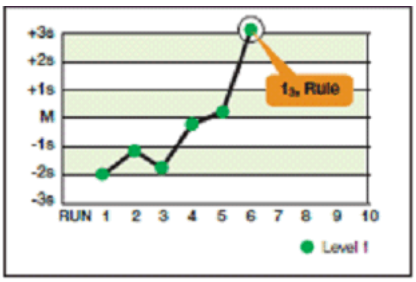


- Ø Actions:
  - ü Review Levey-Jennings Chart for shift and/or trend.
  - ü If none, repeat QC one time only to confirm random error.
  - ü If random error is confirmed, report patient results; otherwise, hold patient results and start troubleshooting (Section 10).

- Ø Monitor:
  - ü Inspect preceding QC data if other rules are violated (i.e. 1_{3s}, 2_{2s}). If so, reject the run.
  - ü Follow Westgard Rule Flowchart (Section 8-C).

1_{3s} Rule

- Ø Data point that is outside ±3 SD violates this rule.
- Ø Could be random error or beginning of a systematic error.



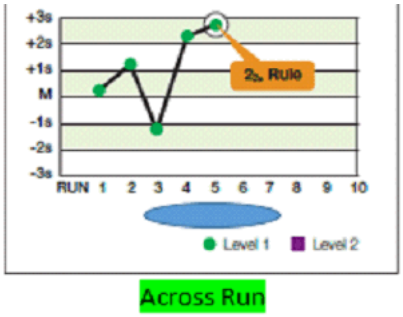
Ø Actions:
- ü Review Levey-Jennings Chart for shift and/or trend.
- ü Investigate and do not report patient results.
- ü Assess the need for patient lookback after QC issue is resolved.

2_{2s} Rule

Ø **<u>2-2s Within Same Run</u>**: 2 of 2s violations from two levels of controls within the same run.

Ø Actions:
- ü Review Levey-Jennings Chart.
- ü Investigate and do not report patient results.
- ü Assess the need for patient lookback after QC issue is resolved.

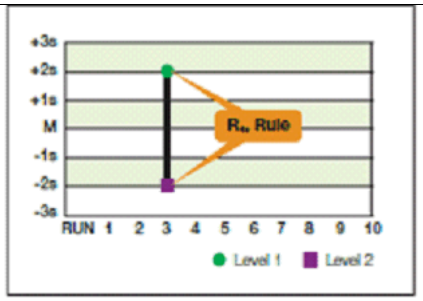
Ø **<u>2-2s Across Run</u>:** 2 of 2s violations from successive runs of the same control



Ø Actions:
- ü Reject the run, do not report patient results.
- ü Investigate, identify cause of out-of-control.
- ü Perform patient lookback (Section 10, Patient Impact Assessment).

$R\text{-}4_s$ Rule

Ø There is at least a difference of 4s between the control values within a single run.



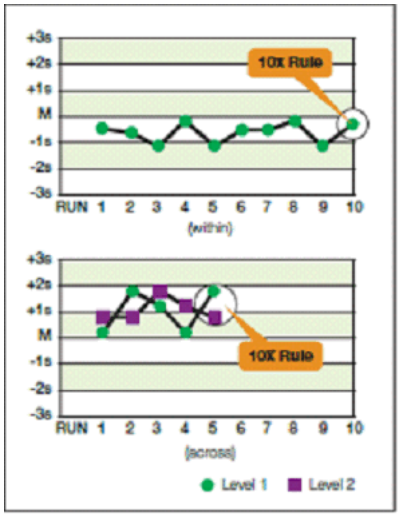
Ø Actions:
- ü This rule identifies a random error.
- ü Repeat the QC.
- ü If random error is confirmed, report patient results; otherwise, hold patient results and start troubleshooting (Section 10).

Ø Monitor:
- ü Review Levey-Jennings Chart for shift and/or trend.
- ü Inspect preceding QC data if other rules are violated (i.e. 1_3s, 2_2s). If so, reject the run.
- ü Follow Westgard Rule Flowchart (Section 8-C).

10_x Rule

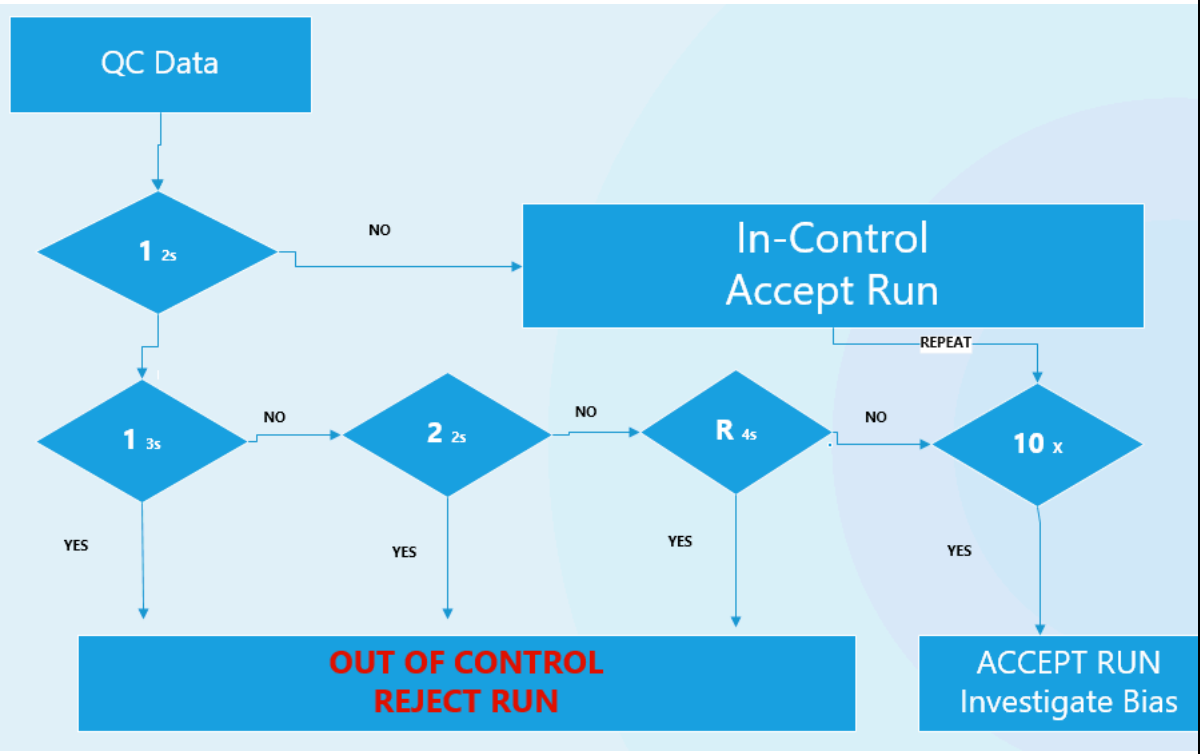
Ø **Within Control Material:** 10 consecutive control measurements within 1 level of control material are on one side of the mean.

Ø **Across Control Material:** 10 consecutive control measurements across 2 levels of control material are on one side of the mean.



Ø Actions:
- ü Review Levey-Jennings Chart.
- ü Patient results can be reported.
- ü Check peer group mean, if available.
- ü Troubleshoot/ recalibrate the instrument.

C. **Westgard Rule Flowchart:**



9. **QC Performance, Recording, Review and Monitoring**

A. **QC Performance:**

Ø Testing Personnel are responsible for performing QC according to instrument and local QC policy requirements.

B. **QC Recording:**

Ø Testing personnel are responsible for ensuring QC records are complete.

- v All QC results regardless of acceptability (even outliers and reasons for out-of-range, e.g. switched QC vials) must be retained electronically or on paper to readily detect a malfunction in the instrument or in the analytic system.
- v QC records must be readily available to the person performing the test.

C. **QC Review:**

Ø Daily

- v Testing personnel at each shift are responsible for ensuring QC has been performed per schedule (i.e. per shift or per day) and results are acceptable prior to patient testing and reporting results.
- v Follow laboratory's protocol in recording outliers, including documentation of troubleshooting and corrective action.
- v Patient results are not reported when controls are not acceptable. Patient results reported since the

last acceptable QC may need to be assessed (Section 8, QC Rules).

- Ø Weekly and Monthly
  - v The Lab Medical Director or delegated section supervisor (TS, TC, GS) is responsible for reviewing and assessing QC results at intervals adequate to assess the performance of analytical process. QC review for each test is documented and may occur electronically or on paper that is readily accessible.
  - v Weekly QC review is performed to check for outliers, appropriate use of Westgard Rules, corrective actions, QC omission, shifts and trends.
  - v Monthly QC review is performed to monitor test accuracy and precision over time. The activities include monitoring changes in CV, mean or SD and maintenance of QC ranges (refer to E, F & G of Section 9).
  - v The review of quality control data for tests that have an IQCP approved by the Lab Medical Director must include an assessment of whether further evaluation of the risk assessment and quality control plan is needed based on problems identified (e.g. trending for repeat QC failures, etc.).

D. **Shift, Trend and Bias:**

- Ø Shift
  - v It is a shift when QC values move suddenly upward or downward from the mean and remain for at least 7 consecutive points.
  - v Action:
    - ü Check if new reagent or QC materials are used.
    - ü Check reagent and control lot number.
    - ü Check reagent and control expiration date.
    - ü Check for instrument issues such as missed instrument maintenance, change in internal temperatures, or dirty cuvettes.
    - ü Check the calibrator used at the time of calibration.
    - ü Observe for any shift in QC value due to calibration.
    - ü Recalibrate the analyte and see if the shift is corrected by calibration.
    - ü When QC shifted upon reagent lot change, perform patient comparison (n=20 with high and low values) to confirm that QC shift is limited to control material and that patient results are not impacted.
      - o **Note:**
        For tests that can tolerate result shift when reagent lot change (such as BNP), it is acceptable to adjust QC ranges. For tests that cannot tolerate result shift upon lot change (such as

Troponin), the reagent will need to be rejected.

- Ø Trend
  - v It is a trend when QC values gradually move up or down from the mean and continue moving the same direction for at least 7 consecutive points.
  - v Action:
    - ü Check for failing calibration.
    - ü Check for reagent (calibrator, testing reagent, substrate, wash buffer) expiration date or deterioration.
    - ü Check package insert for control stability and handling instructions
    - ü Open a new bottle of control material.
    - ü If necessary, calibrate a new lot of reagent.

E. **QC Monitoring:**

- Ø QC Statistics
  - v For numeric QC data, calculate CV, Mean and SD monthly to define and monitor bias and analytic imprecision.
  - v Monthly Mean, SD and CV% are tracked for long term performance of the test system.

F. **Peer Group QC Comparison:**

- Ø Use QC provider or instrument manufacturer aggregated QC data to perform results comparability assessment across peer laboratories.
  - v Use peer group data (SDI & CVR) to assess accuracy/bias and precision for tests with inflated QC ranges, manufacturer's QC ranges, and Sysmex Evidence-based QC ranges.
  - v Use the peer group data to verify the stability of in-house method against peers.

<u>Peer Group Comparison Guideline:</u>

SDI	Acceptable	Acceptable to Marginal	Marginal	Unacceptable
1.25 or less (target = 0)	√			
1.26 – 1.49		√ #1		
1.50 – 1.99			√#2	
2.0 and above				√#3

CVR	Better than Peer Group	Imprecision Alert	Imprecision	Unacceptable
< 1.0	√			
> 1.0 – 1.5		√ #1		
>1.5 – 2.0			√#2	
> 2.0				√#3

Actions:
#1: Some investigation of the test system may be required
#2: Investigation of the test system is recommended
#3: Investigation and remedial action are required

Note:
Comparison with the peer does not remove the requirement for daily, weekly and monthly in-house QC review.

G. **QC Range Adjustment**
- Ø Testing personnel are NOT authorized to adjust the QC mean or SD.
- Ø QC range does not need to be adjusted monthly.
- Ø QC range established under Section 7 (New QC Lot Validation) needs to be verified over time of stable performance (e.g. two to three months). This is to confirm the range is not too narrow or too wide. Cumulative data and peer group data can be used as a guide to fine tune the QC range.
- Ø When indicated, investigate the possible cause(s) of the QC change prior to any adjustment. Any change in accuracy, such as shift or trend, will reflect a change in the mean value of the control. Adjusting the mean without investigating the cause of the QC change will only mask the problem and error in analytical process may not be detected.
- Ø QC mean may be adjusted only after confirming that shift is due to matrix of the control material. (Refer to "Shift" under D of Section 9)
- Ø SD may need to be adjusted when there are no QC data points fall between 1 and 2 SD and -1 and -2 SD for a period of time.
- Ø QC range adjustment must be approved by the LMD or manager or designee overseeing the department.

10. **QC Failure Workup**

A. **General Troubleshooting Approach:**
- Ø QC Material
  - ü Correct material, lot number, level?
  - ü Correctly prepared?
  - ü Levels not interchanged?
  - ü Not expired?

- ü Analyzed within known stability period after preparation?
- ü Correctly stored?

Ø Reagents
- ü Correct material, lot number?
- ü Correctly prepared?
- ü Correctly loaded and used?
- ü Not expired?
- ü Correctly stored?

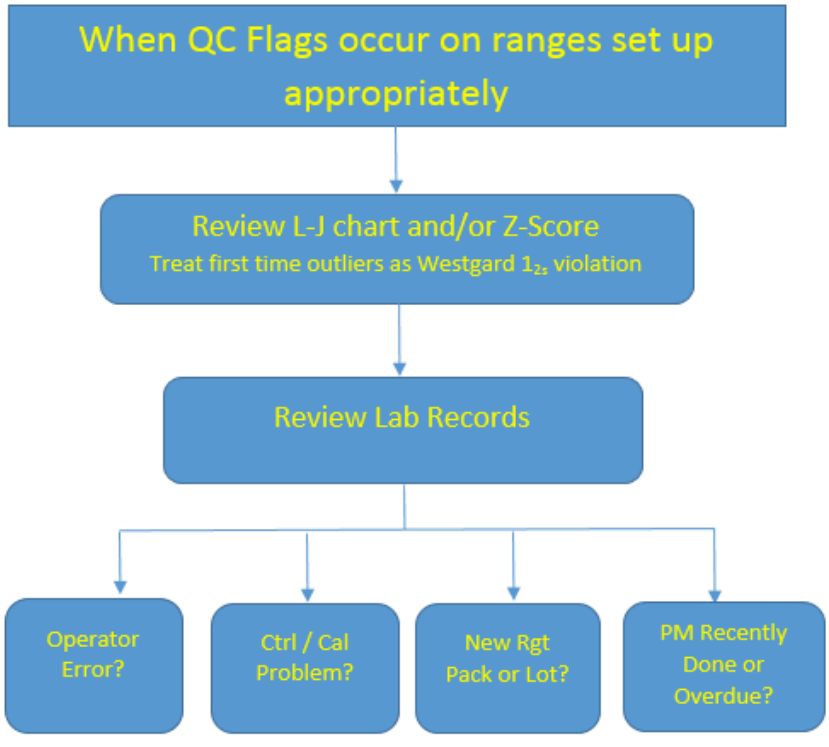
Ø Calibrator
- ü Correct material, lot number?
- ü Correctly prepared, used and stored after use?
- ü Correct number and order?
- ü Correct calculations and settings?
- ü Not expired?

Ø Analyzer
- ü Correct and timely maintenance?
- ü Any recent changes?
- ü Materials within stated on-board stability?
- ü Visual inspection for problems?

Ø Environment
- ü Proper water system, acceptable water quality?
- ü Temperature and humidity at proper levels

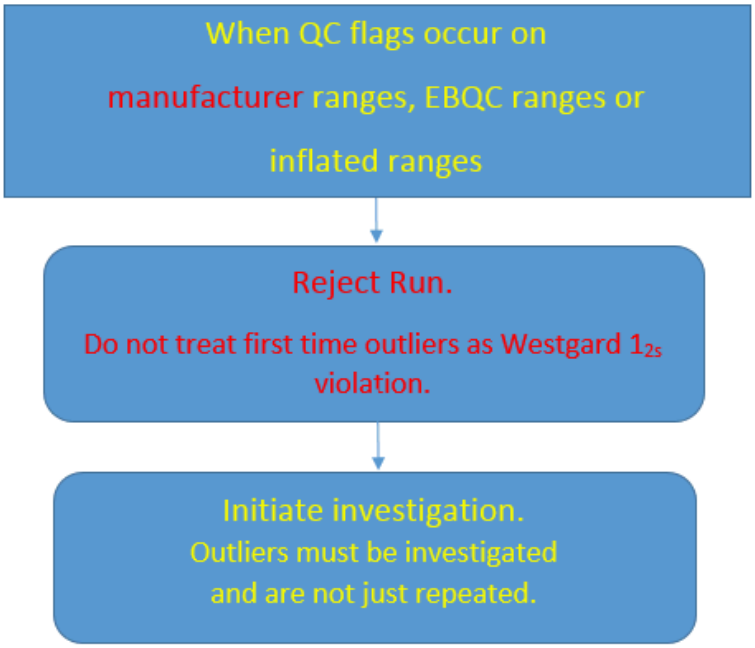
B. **QC Failure Workup:**

v Applicable to QC ranges that are established based on lab's own data.



C. QC Failure Workup for Tests with Expanded QC Ranges:

- Ø Expanded QC ranges are not based on lab's own data. Westgard rules do not apply:
  - v Manufacturer's QC ranges – values provided with assayed controls.
  - v Inflated QC ranges – calculated SDs are expanded to widen QC ranges.
  - v Evidence-based QC ranges – QC limits of Sysmex analyzer are calculated based on predetermined sigma values and peer group CV%.
- Ø For inflated and evidence-based QC ranges, the QC ranges have limits that are greater than +/- 3 times the true SD.
- Ø When QC is out of range, runs are rejected, and investigation is initiated.



11. **Patient Impact Assessment**

A. **Criteria for Patient Lookback**

- Ø Missed QC
- Ø QC failure requiring instrument service or maintenance
- Ø 2_2s rule violation, in cases where the cause cannot be resolved with new QC/CAL material. For 2-2s where the cause is identified, the investigation will be reviewed and it will be in the judgment of the Supervisor, ALAD, or Medical Director to determine if a patient lookback is indicated.

B. **Patient Lookback (Analytical Error Due to Reagent or Instrument Problem)**

- Ø Must be performed in a timely manner by testing personnel as part of the QC corrective action, within the same day when possible.

	Ø Lookback is performed **after** the problem is corrected or issue is resolved. v Depending on the root cause of the QC outlier, spot check or repeat all patients since the last acceptable run. v When QC failure was corrected, repeat all patients since the last acceptable run. v Consult with Clinically Acceptable Limits and Lab Medical Director to determine if patient lookback results are acceptable and error correction (ECR) is indicated. v Retesting of patient samples may be performed on the second analyzer with confirmed accuracy. C. **Patient Lookback (Missed QC on Previously Reported Patient Results)** Ø Retest preserved or stable patient samples, if available. Ø If patient samples are no longer available, re-evaluate results by: v Comparison of patient population means between the run in-question to historical patient means. v Evaluation of deltas across selected patients. Selected patients should have the low-high end of AMR and/or medical decision points. v Correlation with either clinical findings or prior results to see if there are consistent biases (i.e. all results higher or lower currently than previously) for the test in question. v Consult with Clinically Acceptable Limits and Lab Medical Director to determine if patient lookback results are acceptable and error correction (ECR) is indicated.
12. **Appendix**	**Clinically Acceptable Limits** Ø The clinically acceptable limits are acceptance criteria for patient comparison/lookback studies to determine the need to perform error correction when troubleshooting the analyzer. Ø Clinical acceptable limits are not used to evaluate reagent lot acceptability. Ø The routine Chemistry limits are based on the recommendations of Regional Laboratory Chemistry Technical Team (Dr. Dlott, 6/8/05). **Appendix A: <u>Clinically Acceptable Limits for Chemistry Tests</u>** **Routine Chemistry:**

	TEST	Clinically Acceptable Limit
1	Albumin	± 10%
2	Alk-P	± 10%
3	ALT	± 10%
4	Amylase	± 10%
5	AST	± 10%
6	Bili-T	± 0.2 mg/dl or 10%
7	BUN	± 2 mg/dl or 10%
8	Calcium, total	± 0.3 mg/dl Or 5%
9	CK	± 10%
10	CL	± 5%
11	Cholesterol	± 10%
12	CO2	± 10%
13	Creatinine	± 0.1 mg/dl or 10%
14	Fructosamine	± 10%
15	GGT	± 10%
16	Glucose	± 5 mg/dl or 5%
17	HDL-C	± 10%
18	Iron	± 10%
19	K	± 0.3 mmol/L or 5%
20	Lactate	± 0.2 mmol/L or 10%
21	LDH	± 10%
22	LDL-C	± 10%
23	Lipase	± 20%
24	Mg	± 10%
25	NA	± 2 mmol/L (serum) or 5% (urine)
26	Phosphorus	± 0.3 mg/dl or 5%
27	Total Protein	± 10%
28	Triglycerides	± 10%
29	UIBC(TIBC)	± 10%
30	Uric acid	± 10%
31	CK-MB	± 5%
32	Troponin I	± 5%

TDMs:

	TEST	Clinically Acceptable Limit
33	Carbamazephine	± 10%
34	Digoxin	0.1 mmol/L or 10%
35	Gentamicin	± 10%
36	Lithium	0.1 mmol/L or 10%
37	Phenobarbital	± 10%
38	Phenytoin	± 10%
39	Theophylline	± 10%
40	Tobramycin	± 10%
41	Valproic Acid	± 10%

Appendix B: Clinically Acceptable Limits for Coagulation Tests

TEST	Clinically Acceptable Limit
PT	± 5%
APTT	± 5%
Fibrinogen	± 7 %

Appendix C: Hematology Duplicate Manual Cell Count Acceptance Criteria

# of Cells Counted (Manual)	Duplicated Counts Agree By	Or Within +/- (whichever is larger)
<5	50%	2
6 to 10	30%	3
11 to 20	25%	5
21 to 30	20%	6
>30	15%	

Appendix D: Hematology Duplicate Automated Cell Count Acceptance Criteria

Automated Count	Duplicated Counts Agree By	Or Within +/- (whichever is larger)
WBC	± 0.5	5%
RBC	± 0.2	2%
HGB	± 0.4	2%
HCT		2%
PLT (0 - 30K)	± 5K	
PLT (30K - 70K)	± 10K	
PLT (71K - 150K)	± 20K	
PLT (151K - 600K)	± 25K	
PLT (>601K)	± 50K	
PMN	6	
LYMPH	6	
MONO	6	
EOS	3	
BASO	3	

Appendix E: Recommended Approach to Manage QC Performance

- ü QC ranges that are appropriately established.
- ü QC is monitored for its long-term performance.
- ü Comprehensive knowledge of the test system/analyzer, reagents, and control materials.
- ü Some tests are more sensitive to changes in reagent lot, control lot, and environmental conditions.
- ü Testing personnel performs troubleshooting in a timely manner and corrective action is documented according to the laboratory policy.
- ü Supervisors ensure technical issues are resolved and normalcy is returned.

Appendix F: QC Do's and Don'ts

	DO's	DON'Ts
	ü Do review L-J Chart or z-score whenever QC is out.	X Do not blindly repeat QC multiple times until the control passes.
	ü Do Perform initial assessment.	X Do not repeat QC without initial assessment.
	ü Do repeat control after investigation and corrective actions are taken to confirm resolution.	X Do not change range to fit the QC data without patient assessment.
	ü Do document what you did to correct the problem.	

13. **References**

1. CLIA Regulations CFR 493.1256; Control Procedures
2. Statistical Quality Control for Quantitative Measurement Procedures, Approved Guideline: Principles and Definitions – 4th Edition, C24, Wayne, PA, Clinical and Laboratory Standards Institutes, 2016
3. CAP All Common Checklist; Chemistry and Toxicology Checklist, August 21, 2017
4. 2018 Focus on Compliance, Quality Control: Getting It Right, D. Robert Dufour, Gregory Gagnon, March 21, 2018
5. Basic Lessons in laboratory Quality Control, Greg Cooper, BioRad Laboratories, Quality Systems Division, 2008
6. Basic QC Practices 4th Edition, James O. Westgard QC Inc., 2016
7. Basic Quality Control: QC 101, The Permanente Medical Group, Northern California Laboratory Quality and Compliance, Shiu-Land Kwong, July 19, 2018

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Associated Documents:

External Documents

Associated Quality System Documents - None

Document Revision History:

Revision: 1	**Date Created:** 04/12/2019 **Date of Last Revision:** 07/15/2019	**Last Approval Date:** 07/15/2019

Document Author: Maureen R Fitzgibbons/CA/KAIPERM	

Reason for Change:

Revision:	Sec/Para Changed	Change Made:	Date
1	N/A	Initial Issue of Document	04/12/2019
2.	11.A and B	A. **Criteria for Patient Lookback** Missed QC QC failure requiring instrument service or maintenance Ø 2_2s rule violation, in cases where the cause cannot be resolved with new QC/CAL material. For 2-2s where the cause is identified, the investigation will be reviewed and it will be in the judgment of the Supervisor, ALAD, or Medical Director to determine if a patient lookback is indicated. B. **Patient Lookback (Analytical Error Due to Reagent or Instrument Problem)** Ø Must be performed in a timely manner by testing personnel as part of the QC corrective action, within the same day when possible. Ø Lookback is performed **after** the problem is corrected or issue is resolved. v Depending on the root cause of the QC outlier, spot check or repeat all patients since the last acceptable run. v When QC failure was corrected, repeat all patients since the last acceptable run. v Consult with Clinically Acceptable Limits and Lab Medical Director to determine if patient lookback results are acceptable and error correction (ECR) is indicated. v Retesting of patient samples may be performed on the second analyzer with confirmed accuracy. Westgard Rule Flowchart is replaced with new chart.	07/15/2019
	8.C		

Approvals:

Name: Elizabeth M Hosfield/CA/KAIPERM
Title: Chief of Pathology; CLIA Director

Jul 15, 2019 12:22:09 PM PDT - Approved by: Elizabeth M Hosfield/CA/KAIPERM