Basics of Quality Control

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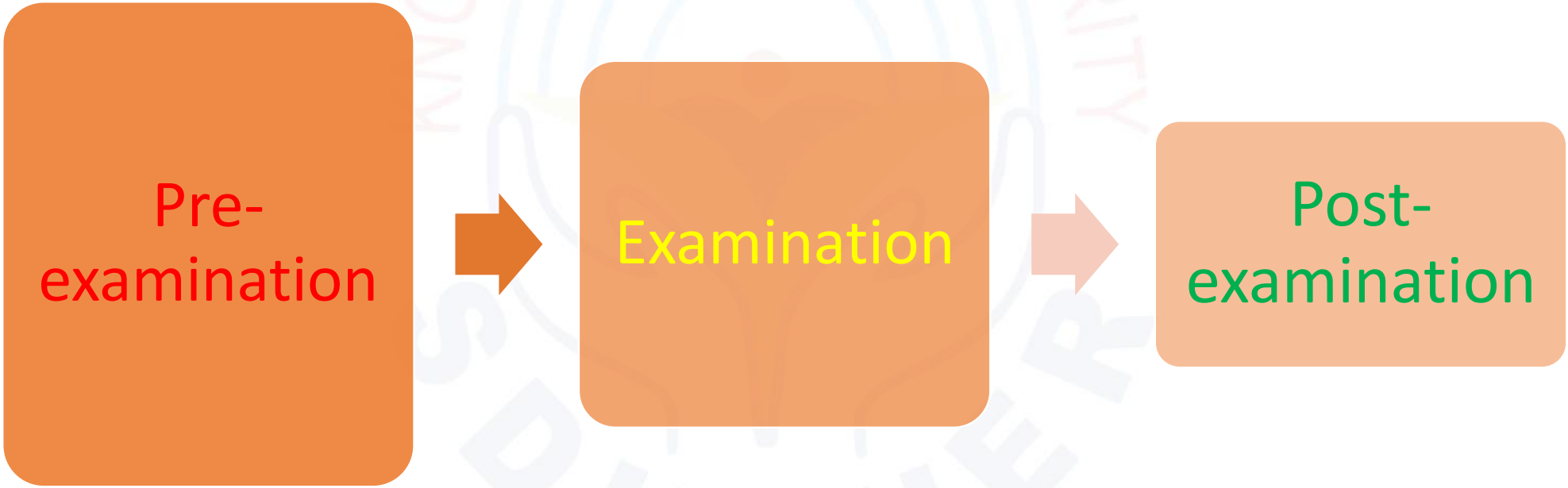
Total Quality management(TQM)

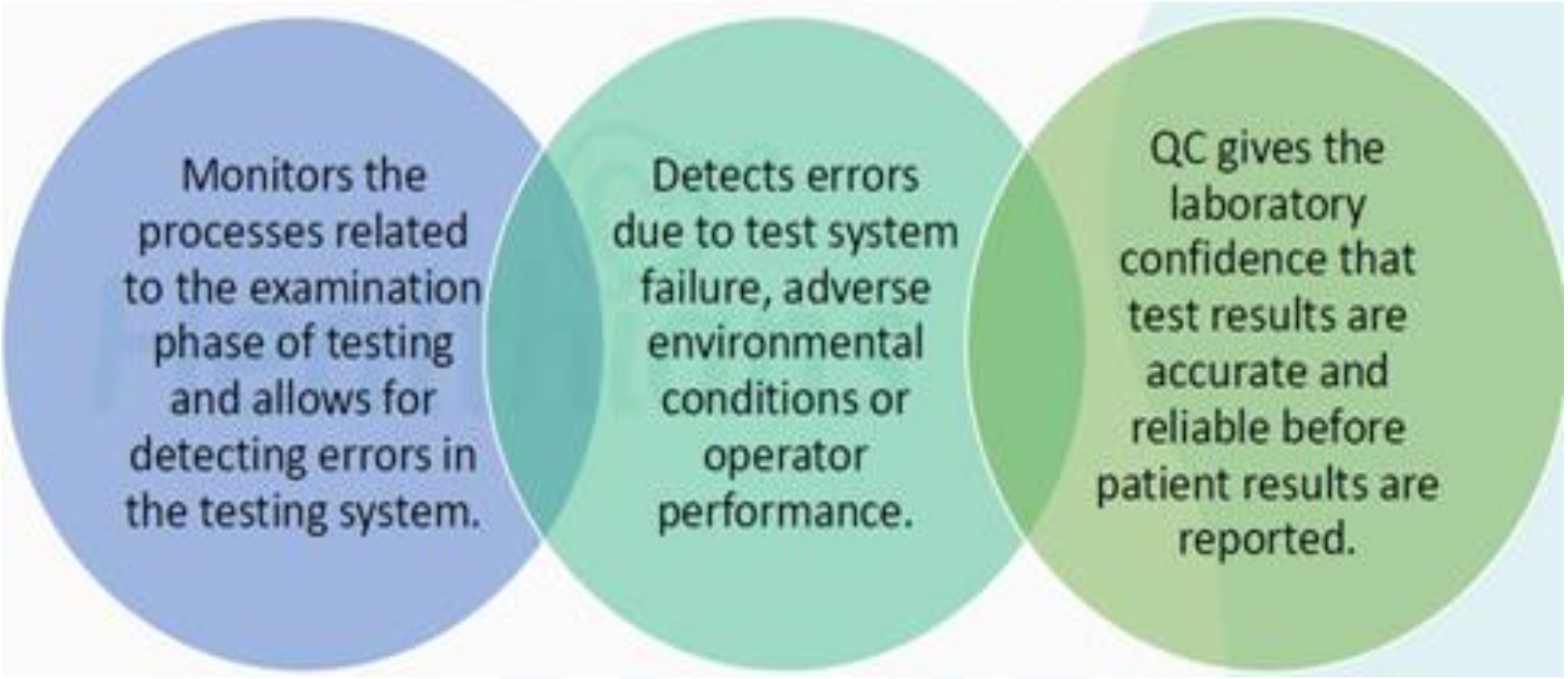


QUALITY CONTROL

- A control is a matrix matched sample composed of one or more constituents with known concentrations
- The constituent concentrations are represented by a range of acceptable values with upper and lower limits
- Controls are used to monitor the precision of the diagnostic testing system

Types

- IQAS & EQAS, Biorad, USA
- IQA- Randox, UK
- India- CMC Vellore, AIIMS, RML


Monitors the processes related to the examination phase of testing and allows for detecting errors in the testing system.
Detects errors due to test system failure, adverse environmental conditions or operator performance.
QC gives the laboratory confidence that test results are accurate and reliable before patient results are reported.

Preparing and storing control material

- Carefully adhere to the manufacturer's instructions for reconstituting and storage.
- If in-house control material is used, freeze aliquots and place in the freezer so that a small amount can be thawed and used daily.
- Monitor and maintain freezer temperatures to avoid degradation of the analyte in any frozen control material.
- Use a pipette to deliver the exact amount of required diluent to lyophilized controls that must be reconstituted.

CALIBRATOR

- Calibrators are samples that are used to adjust the recovery values to the standard curve at a point in time based on the reagents, temp., etc. Calibrators "Fine-Tune" or adjust the recovery values to the standard curve.

Calibration is "setting" the analyzer to give correct results

QC is checking to see if the analyzer is producing correct results

QC material

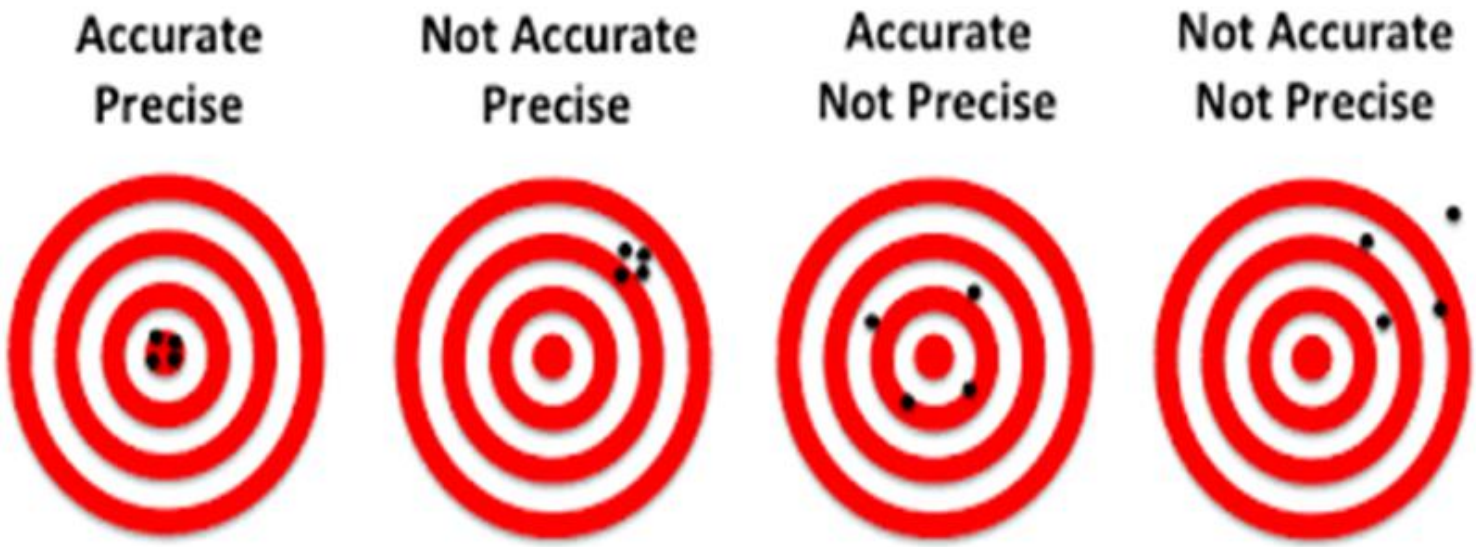
- Preferably Third Party
- Long Shelf-Life and Open Vial Stability
- Clinically Relevant Levels
- Human Based Matrix
- Extensive Assayed Values Provided

ACCURACY

- Accuracy is the trueness of the value measured.
- Accuracy can be checked by
  - By a Reference Method
  - By Peer Group Comparison

PRECISION

- The degree of replication or reproducibility.
- The best estimate of replication uses both SD and CV to describe Precision.



QC STATISTICAL TERMS

- Mean
- Standard Deviation
- Bias
- Coefficient of Variation
- The Standard Deviation Index

MEAN & STANDARD DEVIATION

- Mean is the arithmetic average of a set of data points.

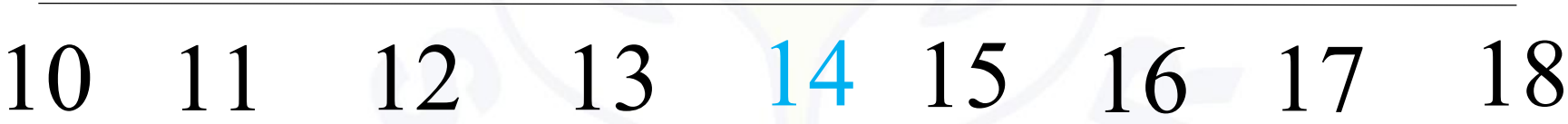
$$\chi = \frac{\text{sum of observations}}{\text{* number of observations}}$$

- Standard Deviation is the degree of dispersion of a set of data from the mean.

How??

Example:

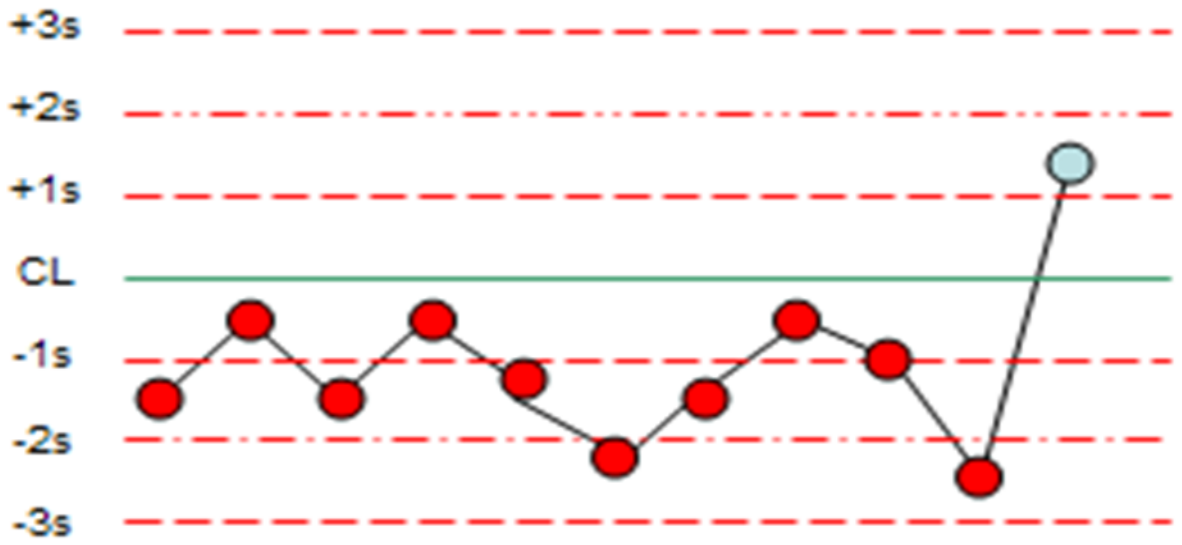
Consider Hb range of 10 gm% (Lower limit) and 18 gm% (Upper limit) for Level II IQC



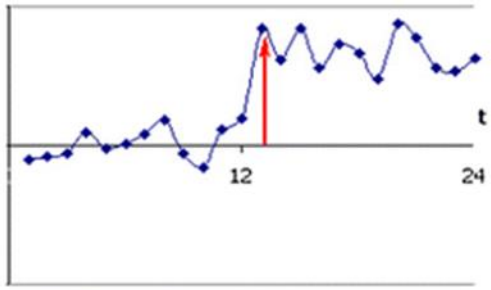
BIAS

- Bias is the shift on either side of the mean. It can be positive bias or negative bias.

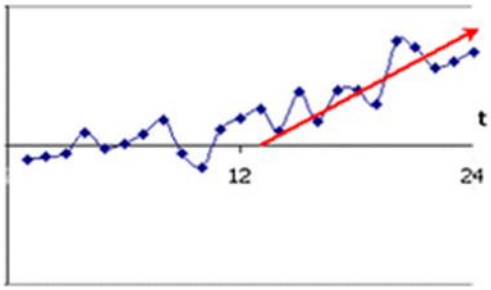
- Bias is a representation of inaccuracy.



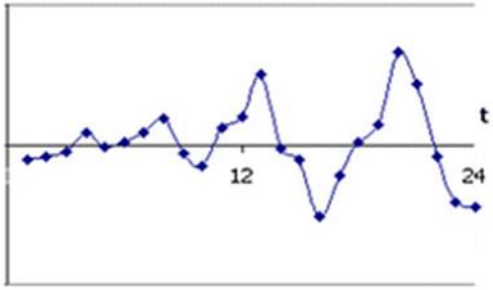
TREND & SHIFT



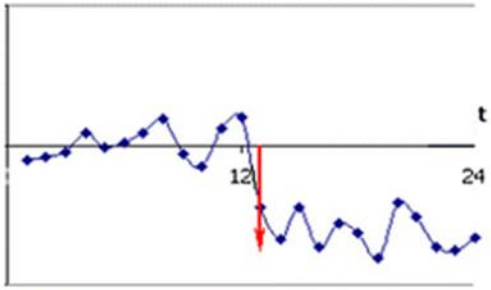
Shift (Upward)



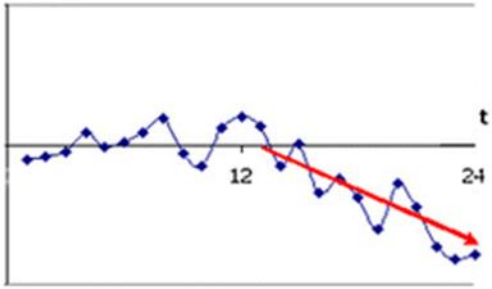
Trend (Upward)



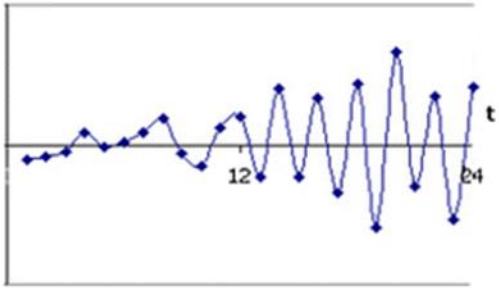
Cycle (T : 8, k : 0)



Shift (Downward)



Trend (Downward)



Systematic (k : 0)

COEFFICIENT OF VARIATION

- The coefficient of variation (CV) is defined as the ratio of the standard deviation to the mean.

- It is a measure of variability (imprecision) and expressed as %

$$CV = \frac{\text{Standard Deviation}}{\text{Mean}}$$

COEFFICIENT OF VARIATION

- The coefficient of variation should be computed only for data measured on scales that have a ratio scale and hence allow relative comparison of two measurements.

- CV measures are often used as quality controls for quantitative laboratory assays.

- It is used to compare -

  Manufacturer claim

  Peer group results

  Proficiency testing results

CV RATIO (CVR)

$$CVR = \frac{\text{Lab's monthly CV}}{\text{Peer group monthly CV}}$$

- Ideally CVR should be ≤ 1.

- It should be noted that CV values are not an ideal index of the certainty of a measurement when the number of replicates varies across samples.

QC Error

Systemic Error	• Poor accuracy • Reproducible • Specific cause
Random Error	• Poor precision • Non-reproducible • No specific cause

Random error

- shows no pattern
- generally does not reflect a failure in some part of the testing system, and is therefore not like to reoccur.
- Random error is only a cause for rejection of the test run if it exceeds +2 SD.

Systematic error

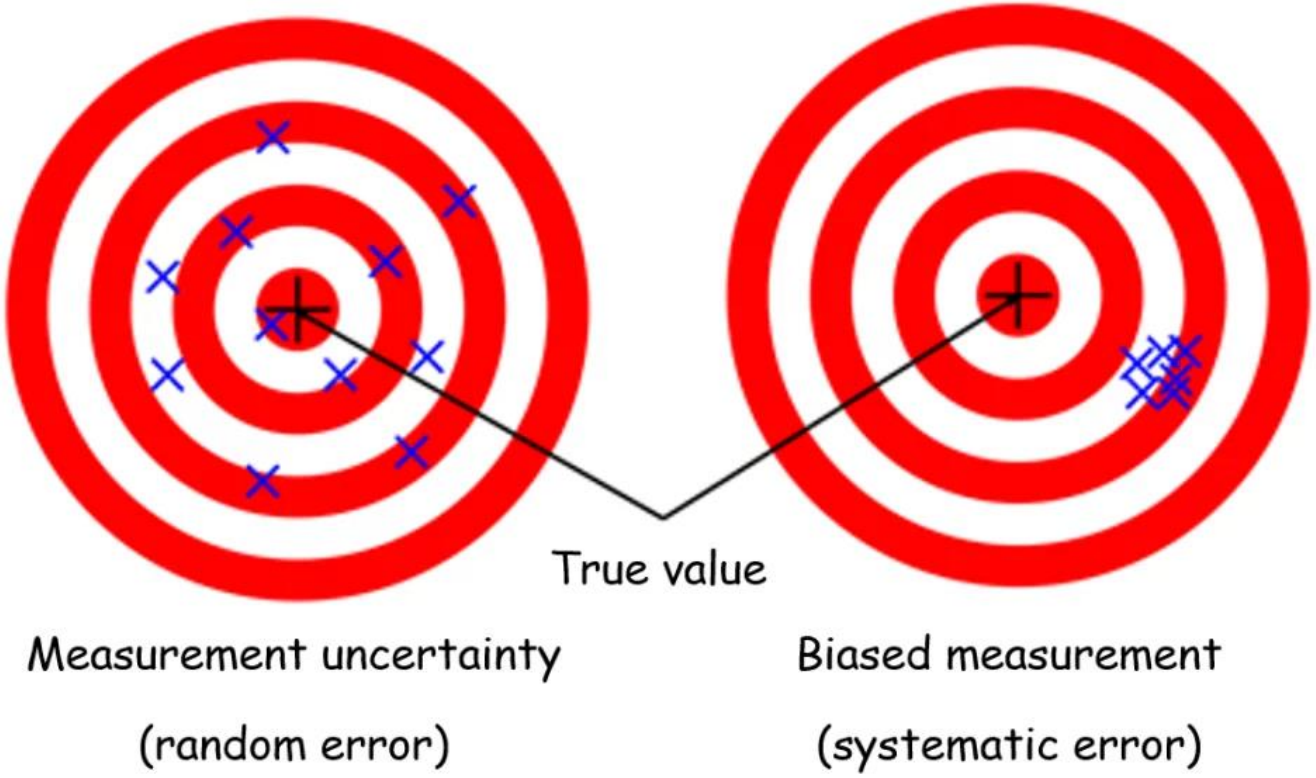
- indicates some failure in the system that can and should be corrected.
- Examples of evidence of systematic error include:
  - Shift—when the control is on the same side of the mean for five consecutive runs;
  - Trend—when the control is moving in one direction, and appears to be heading toward an out-of-control value.

Measurement of Uncertainity

- The QC we run may not totally reflect analytical behavior of patient specimen

- This imprecision is derived from long term IQC calculated as SD or %CV

$$MoU = \pm 1.96 \times \%CV$$


True value
Measurement uncertainty
(random error)
Biased measurement
(systematic error)

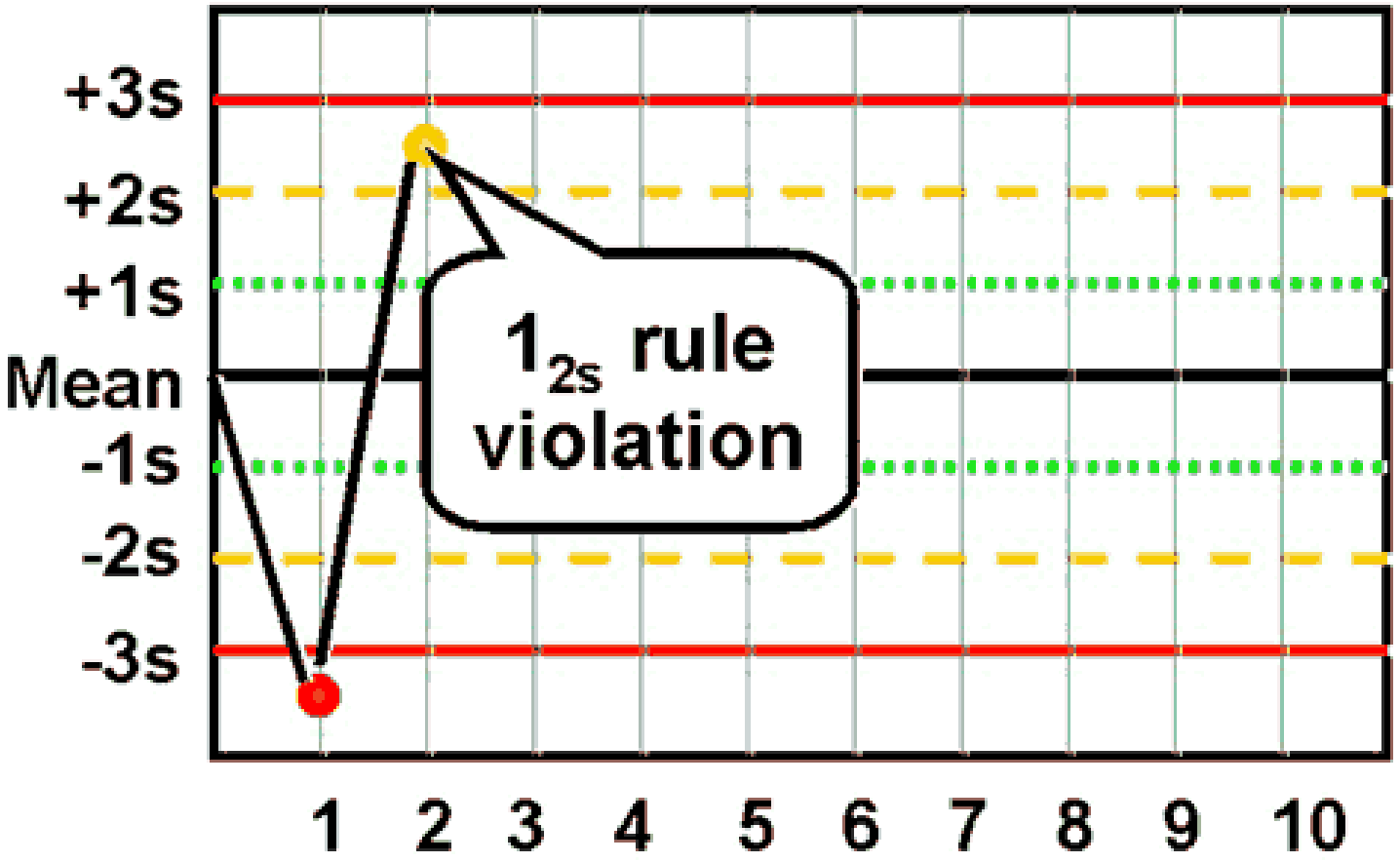
WESTGARD RULES

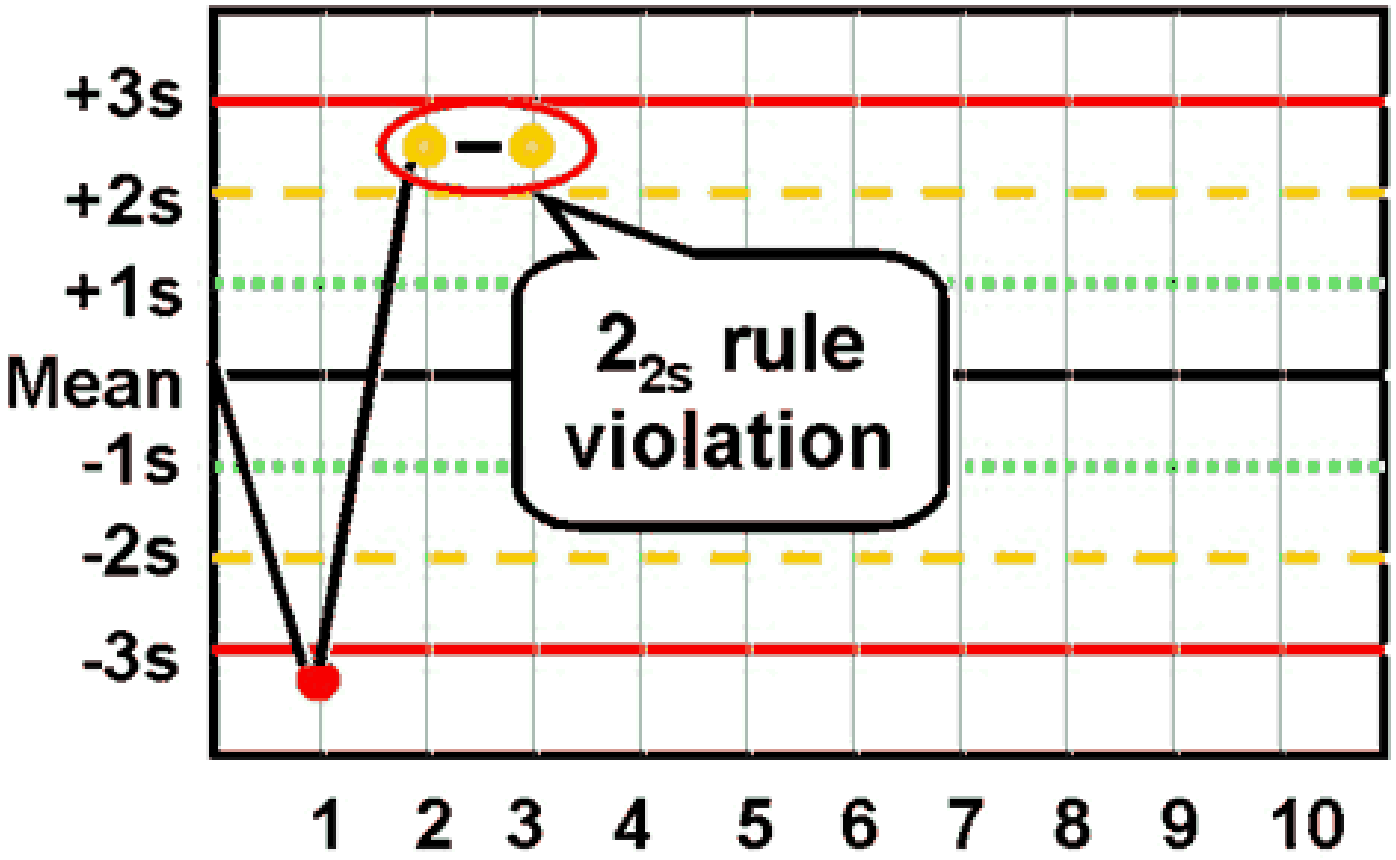
Used for monitoring Internal QC performance.

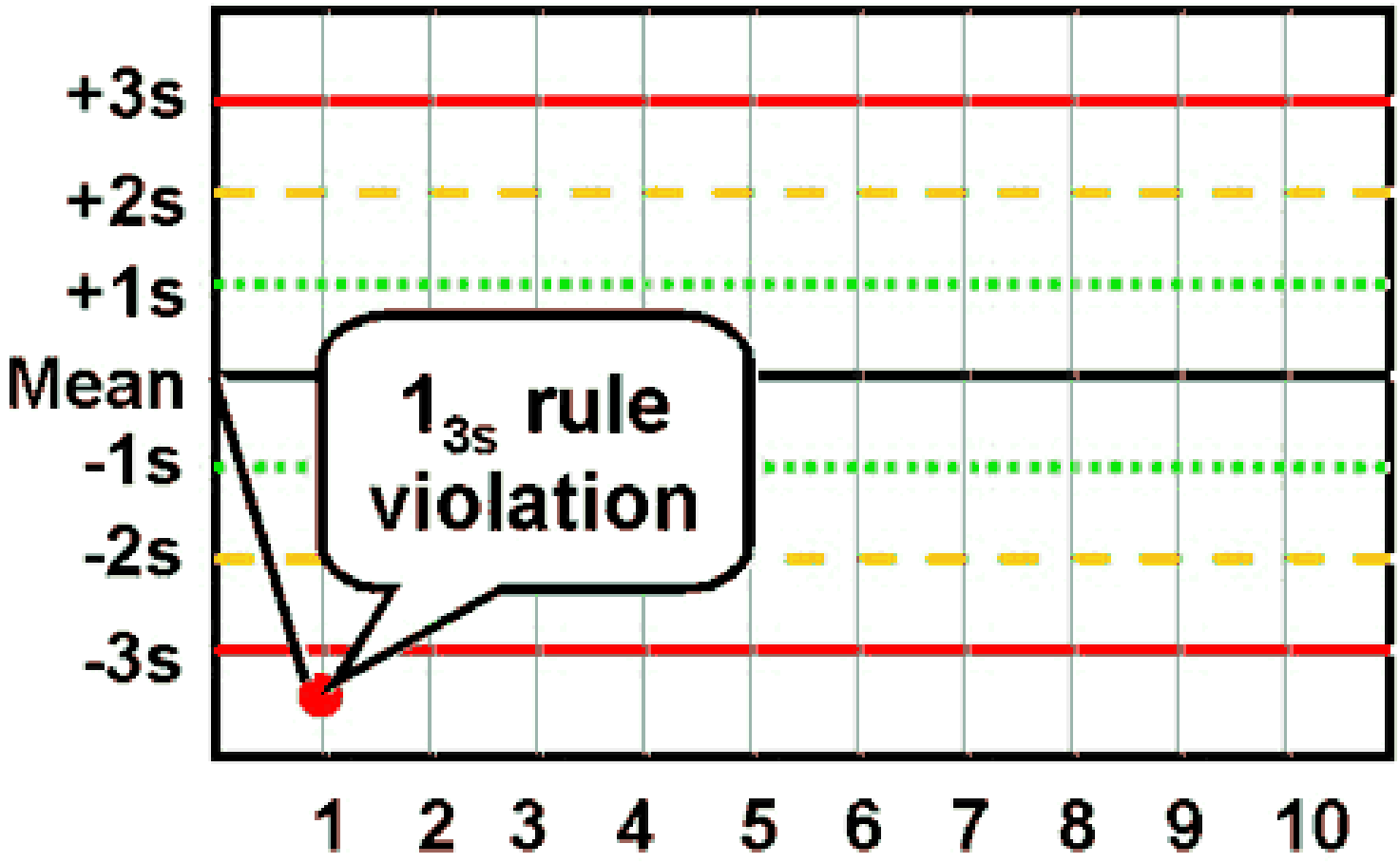
Multi-rule combination for decision making

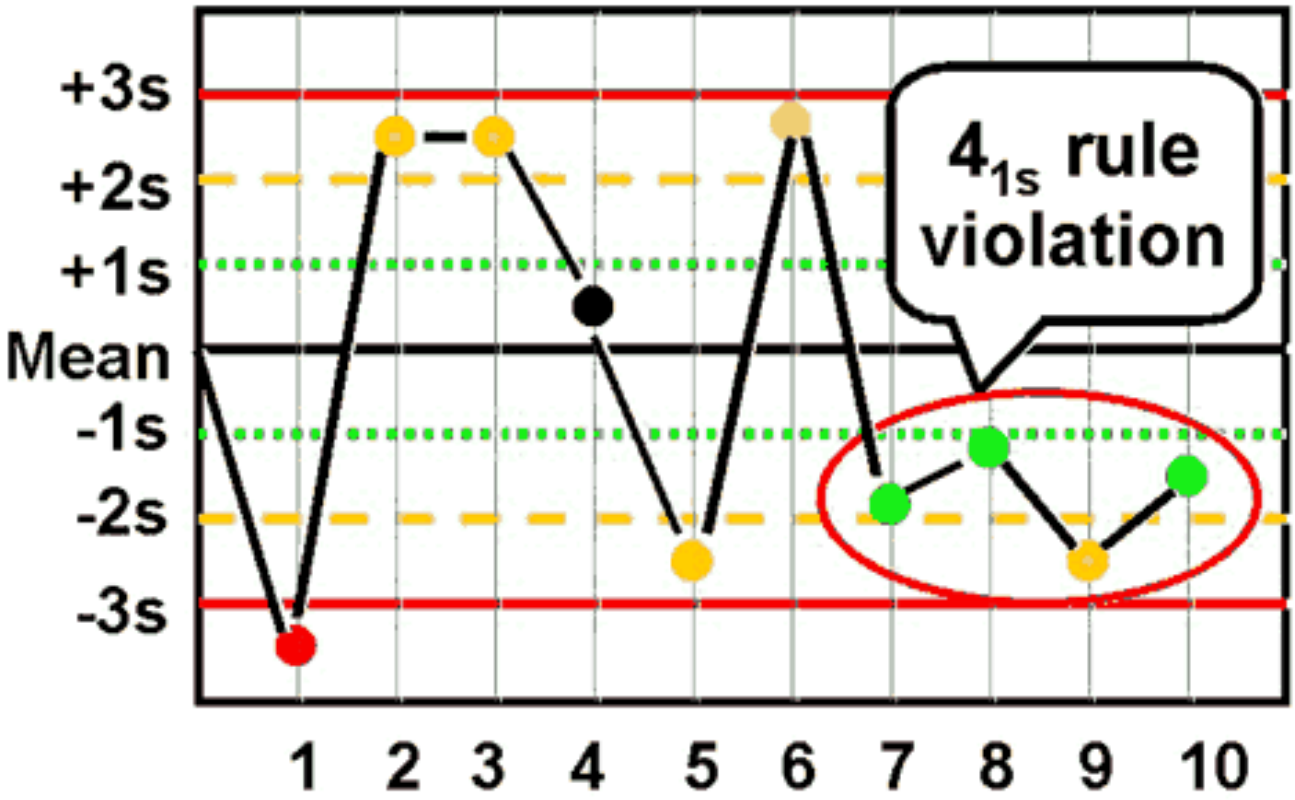
- Increase Sensitivity to Error Detection
- Decrease False Rejections

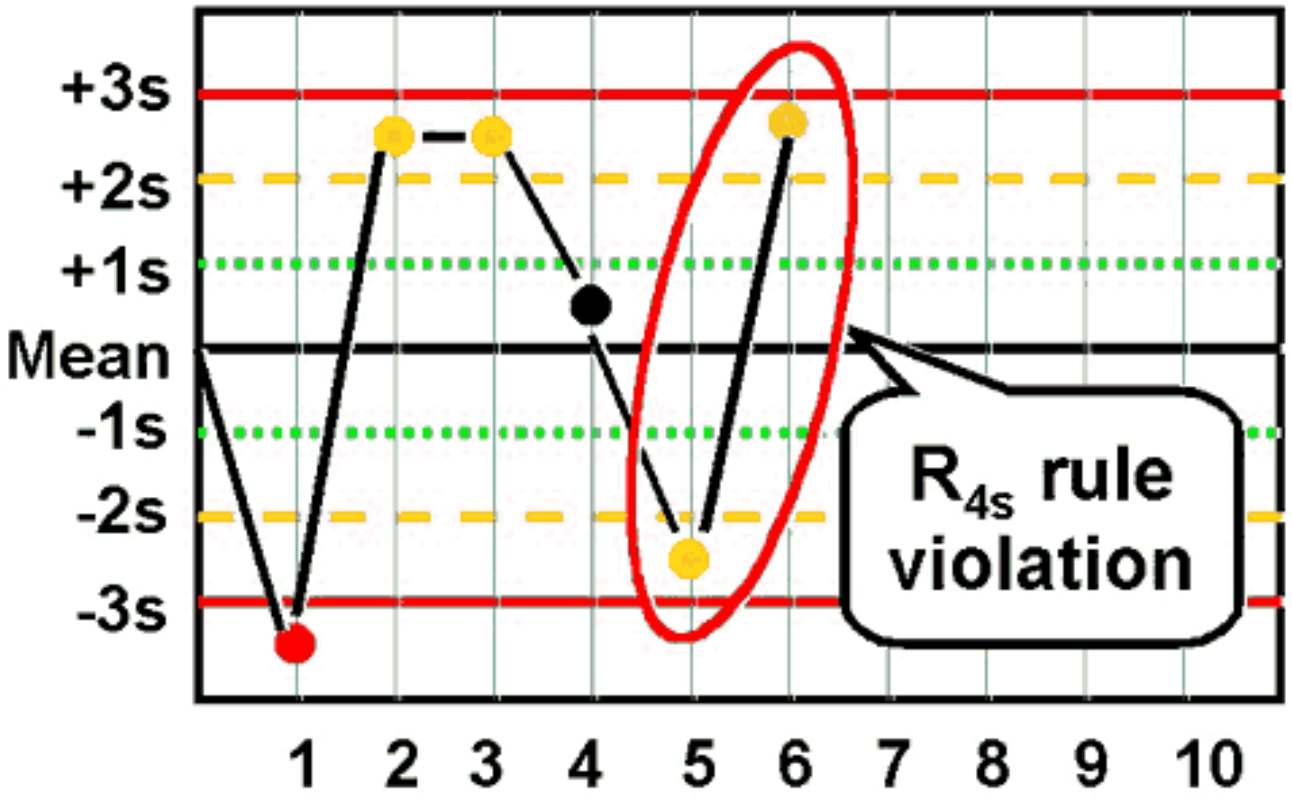
Rule	Criteria
1_{2S}	One measurement exceeds 2 standard deviations either above or below the mean of the reference range.
1_{3S}	One measurement exceeds 3 standard deviations either above or below the mean of the reference range.
2_{2S}	2 consecutive measurements exceed 2 standard deviations of the reference range, and on the same side of the mean.
R_{4S}	Two measurements in the same run have a 4 standard deviation difference (such as one exceeding 2 standard deviations above the mean, and another exceeding 2 standard deviations below the mean).
4_{1S}	4 consecutive measurements exceed 1 standard deviation on the same side of the mean.
$10_{\bar{X}}$	10 consecutive measurements are on the same side of the mean.

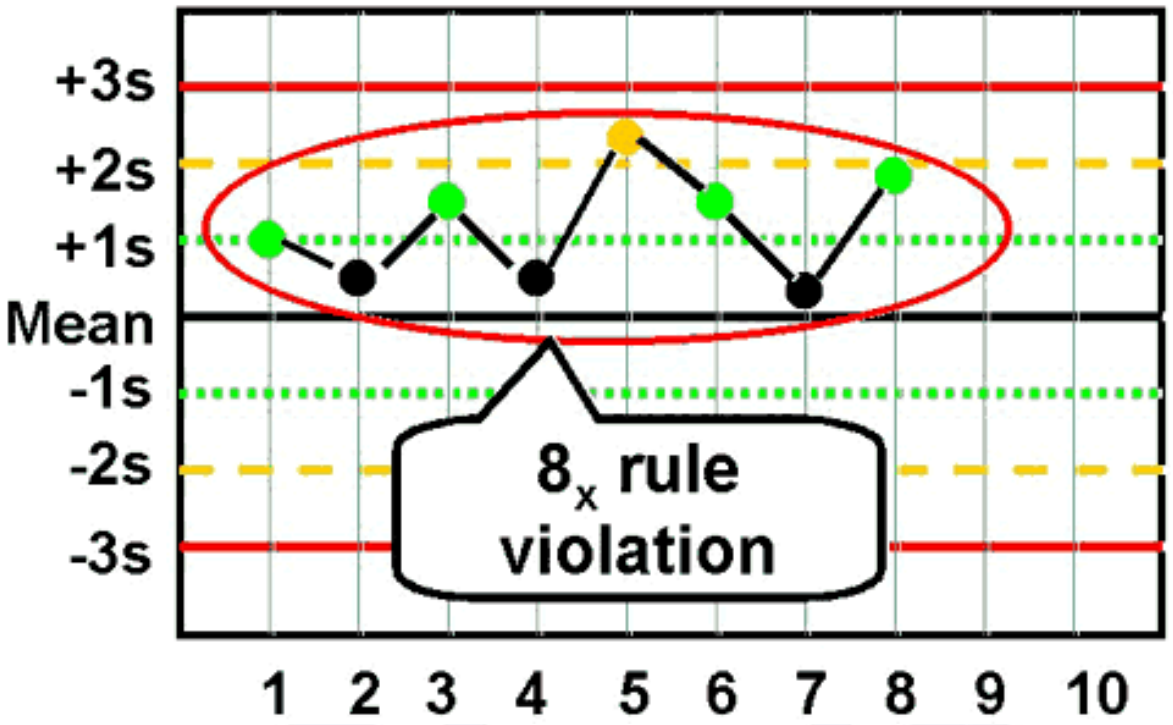

+3s
+2s
+1s
Mean
-1s
-2s
-3s
1 2 3 4 5 6 7 8 9 10
1 2s rule violation


+3s
+2s
+1s
Mean
-1s
-2s
-3s
1 2 3 4 5 6 7 8 9 10
2 2s rule violation

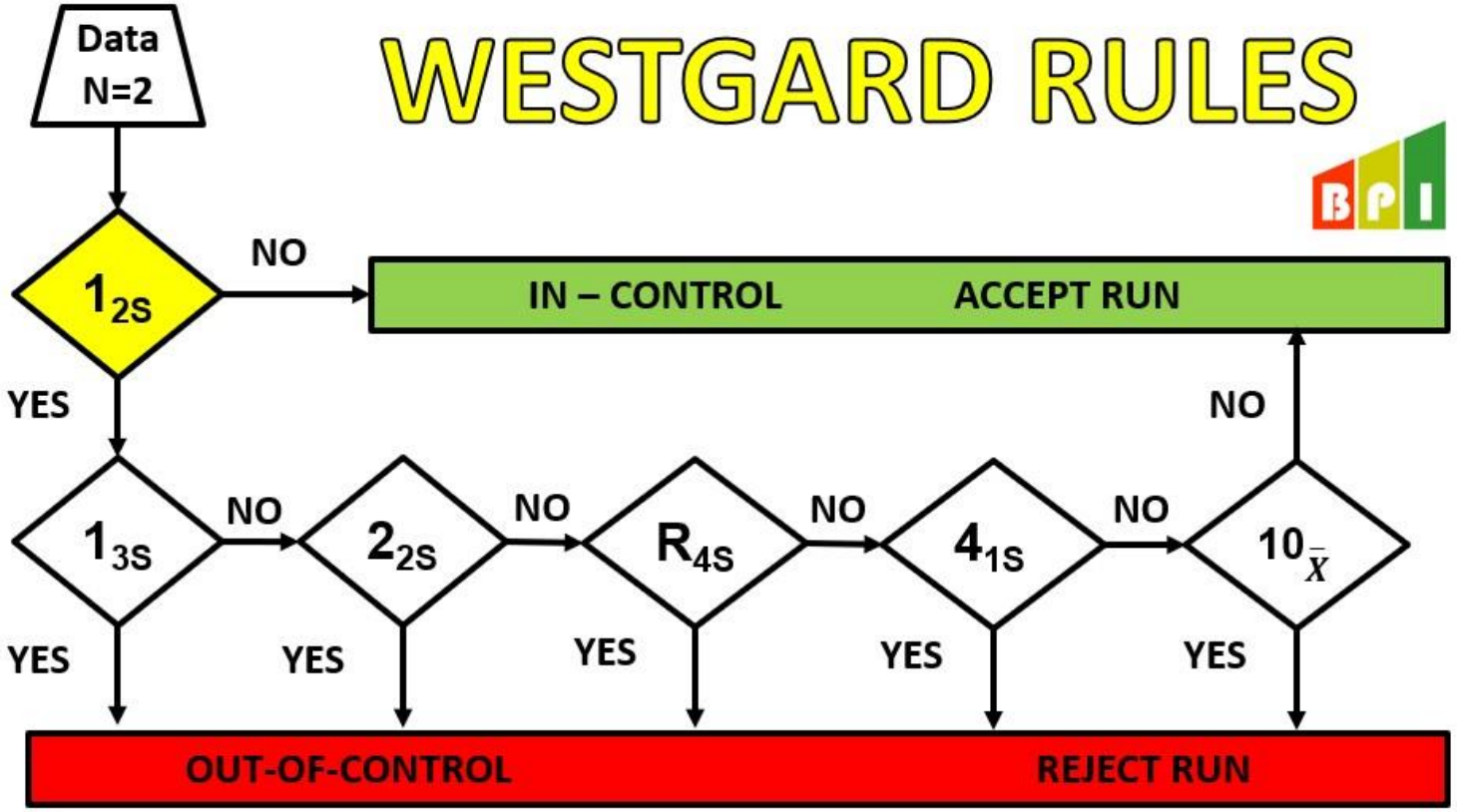

+3s
+2s
+1s
Mean
-1s
-2s
-3s
1 3s rule violation
1 2 3 4 5 6 7 8 9 10


+3s
+2s
+1s
Mean
-1s
-2s
-3s
1
2
3
4
5
6
7
8
9
10
4 1s rule violation


+3s
+2s
+1s
Mean
-1s
-2s
-3s
1
2
3
4
5
6
7
8
9
10
R4s rule violation


+3s
+2s
+1s
Mean
-1s
-2s
-3s
8x rule violation
1 2 3 4 5 6 7 8 9 10

WESTGARD RULES - ACTION NEEDED



Troubleshoot of QC failure

- If the test is performed on multiple instruments check to see if the other instruments have the same problem.

- For QC failures seen on multiple instruments look for things that are common to all, such as calibrator, QC material and/or reagents.

- For QC failures seen on just one instrument then the cause may be related to that instrument. Check the maintenance status and condition of the instrument parts. Resolve the problem internally or call for service.

Review points of failure

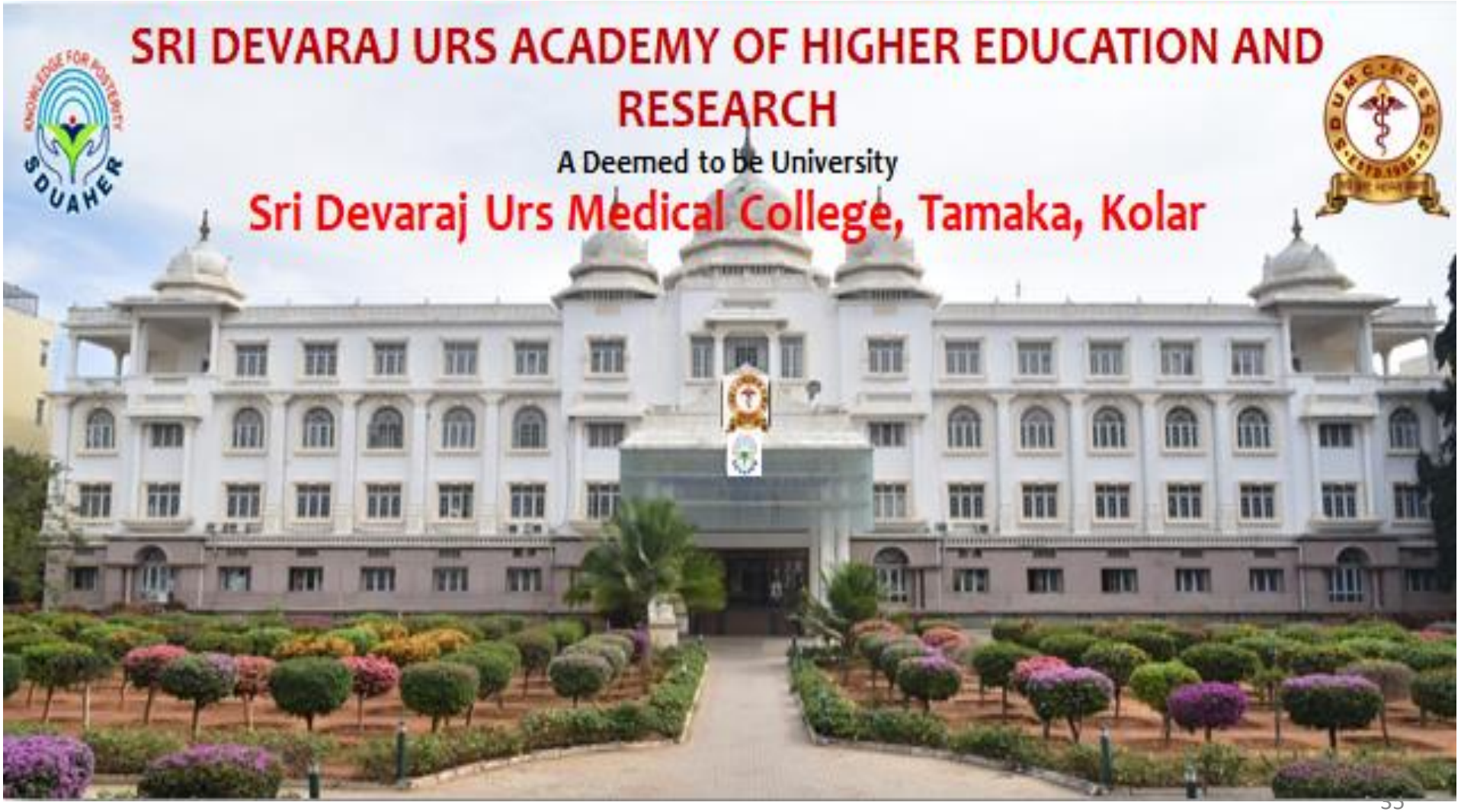
- Instrument repair / Preventive maintenance done recently
- If any shifting of instrument was done recently
- Check to see if temperature and humidity of environment are within defined acceptable range.

Built in QC

- Built-in controls are those that are integrated into the design of a test system such as a test kit device

- Most built-in controls monitor only a portion of the examination phase, and they vary from one test to another as to what is being monitored

- Even though these built-in controls give some degree of confidence, they do not monitor for all conditions that could affect test results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Thank you