

Laboratory Quality Control

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Definitions (1)

Quality Control - QC refers to the measures that must be included during each assay run to verify that the test is working properly. ■

Quality Assurance - QA is defined as the overall program that ensures that the final results reported by the laboratory are correct. ■

“The aim of quality control is simply to ensure that the results generated by the test are correct. However, quality assurance is concerned with much more: 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” ■

Definitions (2)

Quality Assessment - quality assessment (also known as proficiency testing) is a means to determine the quality of the results generated by the laboratory. Quality assessment is a challenge to the effectiveness of the QA and QC programs. ■

Quality Assessment may be external or internal, examples of external programs include NEQAS, HKMTA, and Q-probes. ■

Variables that affect the quality of results

The educational background and training of the laboratory personnel .

The condition of the specimens .

The controls used in the test runs .

Reagents .

Equipment .

The interpretation of the results .

The transcription of results .

The reporting of results .

Errors in Measurement

True value - this is an ideal concept which cannot be achieved. ■

Accepted true value - the value approximating the true value, the difference between the two values is negligible. ■

Error - the discrepancy between the result of a measurement and the true (or accepted true value). ■

Sources of Error

Input data required - such as standards used, calibration values, and values of physical constants. ■

Inherent characteristics of the quantity being measured - e.g. CFT and HAI titre. ■

Instruments used - accuracy, repeatability. ■

Observer fallibility - reading errors, blunders, equipment selection, analysis and computation errors. ■

Environment - any external influences affecting the measurement. ■

Theory assumed - validity of mathematical methods and approximations. ■

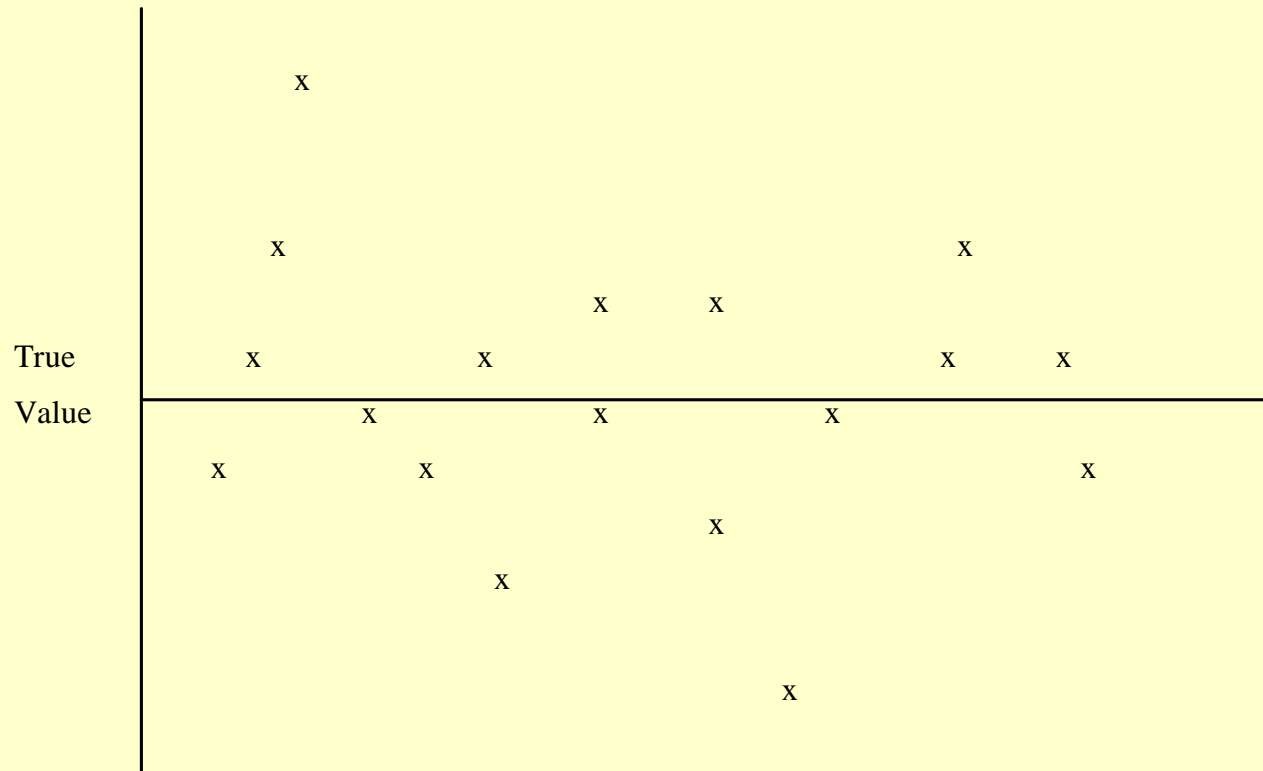
Random Error

An error which varies in an unpredictable manner, in magnitude and sign, when a large number of measurements of the same quantity are made under effectively identical conditions.

Random errors create a characteristic spread of results for any test method and cannot be accounted for by applying corrections. Random errors are difficult to eliminate but repetition reduces the influences of random errors.

Examples of random errors include errors in pipetting and changes in incubation period. Random errors can be minimized by training, supervision and adherence to standard operating procedures.

Random Errors



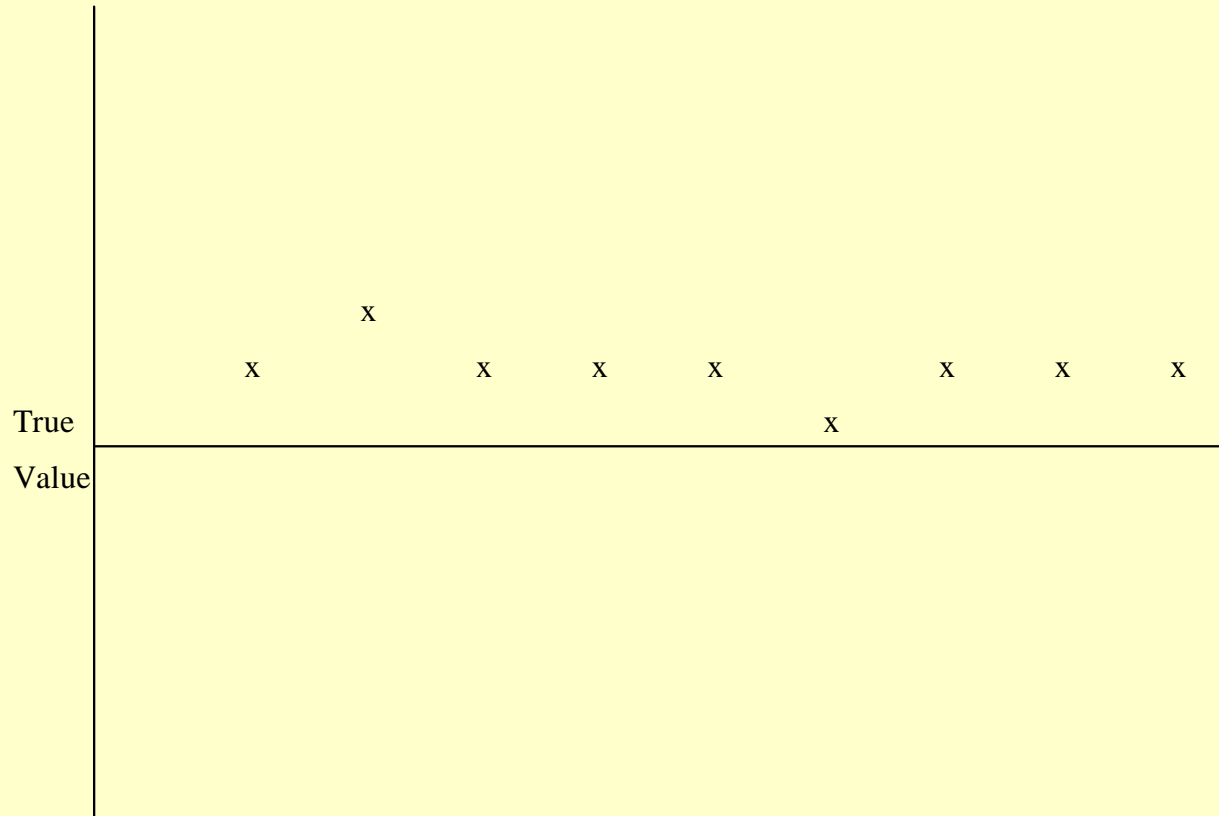
Systematic Error

An error which, in the course of a number of measurements of the same value of a given quantity, remains constant when measurements are made under the same conditions, or varies according to a definite law when conditions change.

Systematic errors create a characteristic bias in the test results and can be accounted for by applying a correction.

Systematic errors may be induced by factors such as variations in incubation temperature, blockage of plate washer, change in the reagent batch or modifications in testing method.

Systematic Errors



Internal Quality Control Program for Serological Testing

An internal quality control program depend on the use of internal quality control (IQC) specimens, Shewhart Control Charts, and the use of statistical methods for interpretation.

Internal Quality Control Specimens

IQC specimens comprises either (1) in-house patient sera (single or pooled clinical samples), or (2) international serum standards with values within each clinically significant ranges.

Shewhart Control Charts

A Shewhart Control Chart depend on the use of IQC specimens and is developed in the following manner:-

Put up the IQC specimen for at least 20 or more assay runs and record down the O.D./cut-off value or antibody titre (whichever is applicable).

Calculate the mean and standard deviations (s.d.)

Make a plot with the assay run on the x-axis, and O.D./cut-off or antibody titre on the y axis.

Draw the following lines across the y-axis: mean, -3, -2, -2, 1, 2, and 3 s.d.

Plot the O.D./cut-off obtained for the IQC specimen for subsequent assay runs

Major events such as changes in the batch no. of the kit and instruments used should be recorded on the chart.

Westgard rules

The formulation of Westgard rules were based on statistical methods. Westgard rules are commonly used to analyse data in Shewhart control charts.

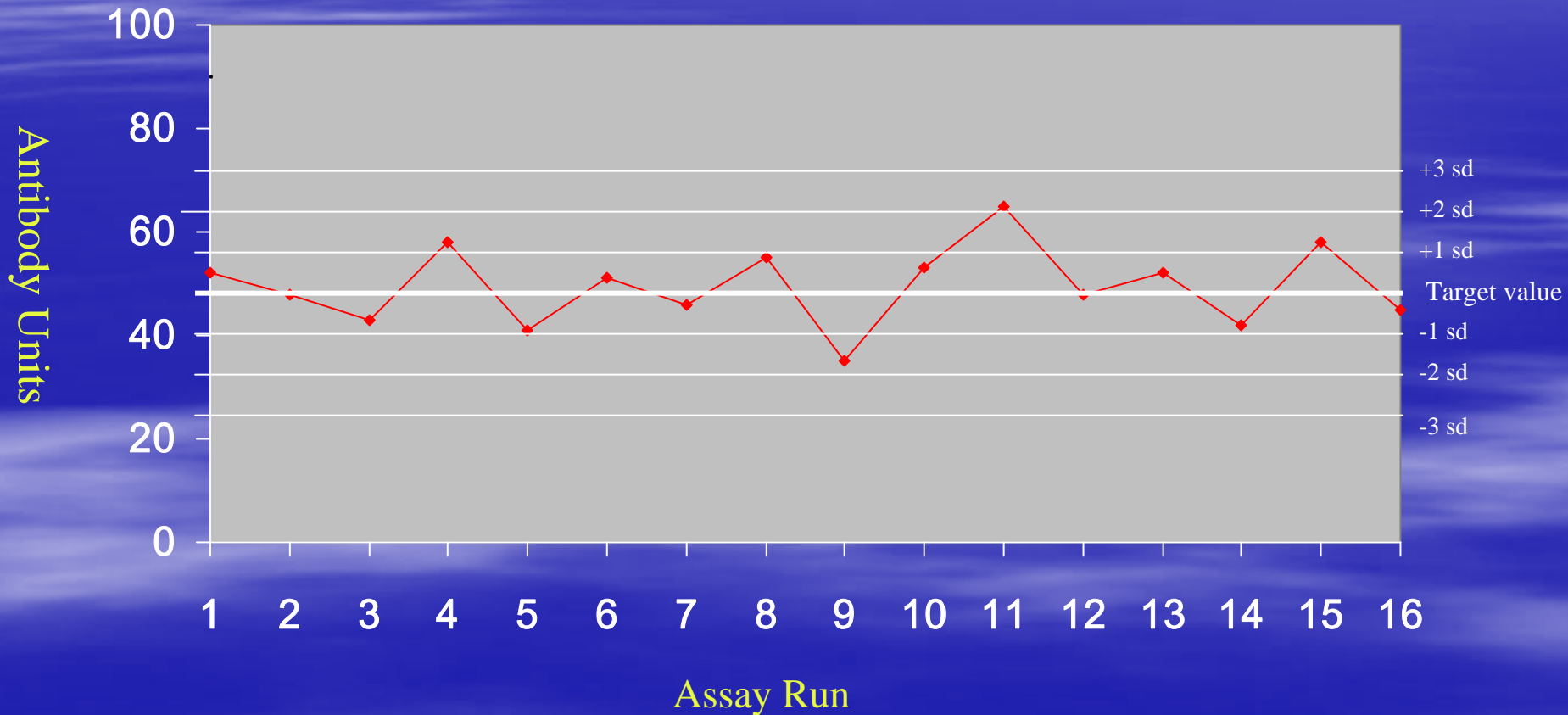
Westgard rules are used to define specific performance limits for a particular assay and can be use to detect both random and systematic errors.

There are six commonly used Westgard rules of which three are warning rules and the other three mandatory rules.

The violation of warning rules should trigger a review of test procedures, reagent performance and equipment calibration.

The violation of mandatory rules should result in the rejection of the results obtained with patients' serum samples in that assay.

Shewhart Chart



VZV IgG ELISA: Target Value = 49 U/ml

Warning rules

Warning 1_{2SD} : It is violated if the IQC value exceeds the mean by $\pm 2SD$. It is an event likely to occur normally in less than 5% of cases. ▪

Warning 2_{2SD} : It detects systematic errors and is violated when two consecutive IQC values exceed the mean on the same side of the mean by $\pm 2SD$. ▪

Warning 4_{1SD} : It is violated if four consecutive IQC values exceed the same limit (mean $\pm 1SD$) and this may indicate the need to perform instrument maintenance or reagent calibration. ▪

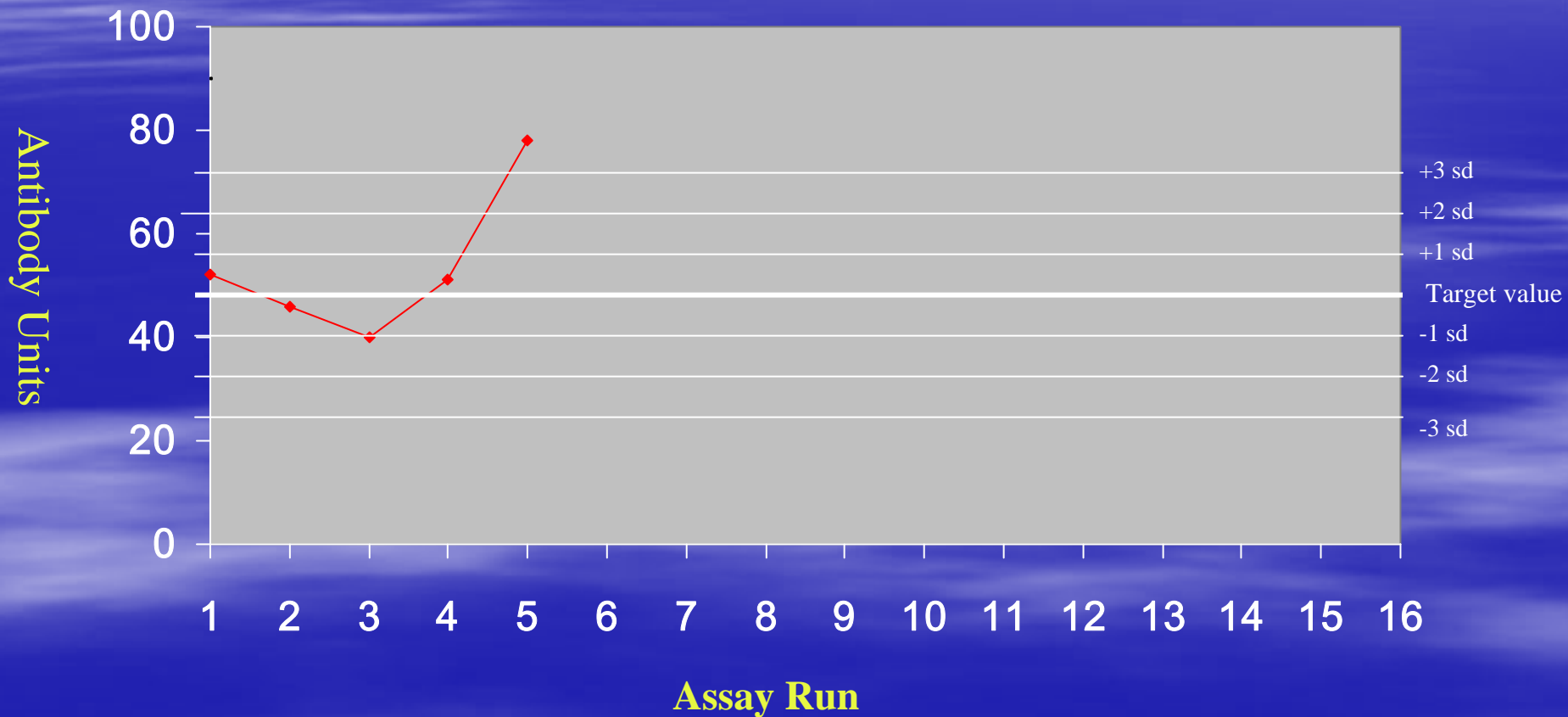
Mandatory Rules

Mandatory 1_{3SD} : It is violated when the IQC value exceeds the mean by $\pm 3SD$. The assay run is regarded as out of control.

Mandatory R_{4SD} : It is only applied when the IQC is tested in duplicate. This rule is violated when the difference in SD between the duplicates exceeds $4SD$.

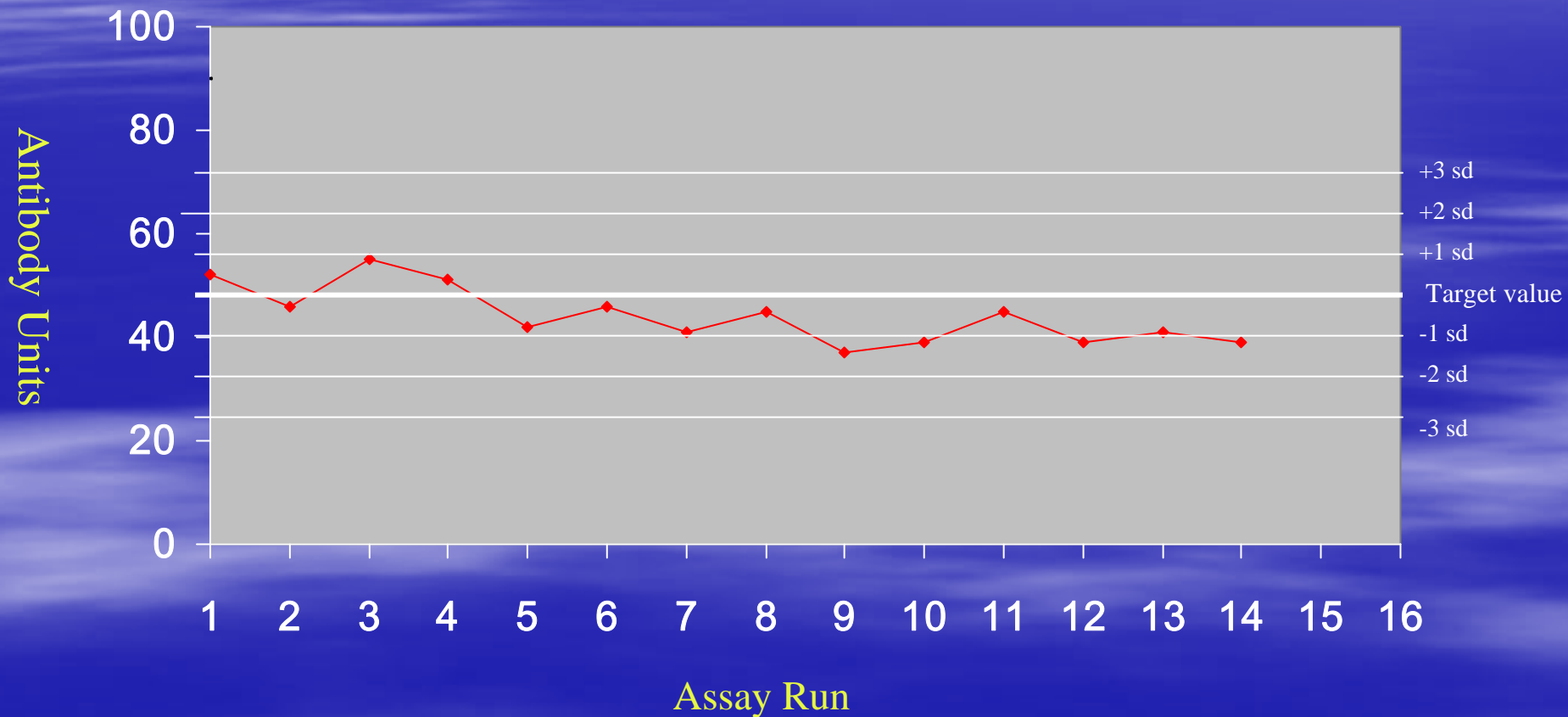
Mandatory $10x$: This rule is violated when the last 10 consecutive IQC values are on the same side of the mean or target value.

Westgard Rules: 1 3SD



VZV IgG ELISA: Target Value = 49 U/ml

Westgard Rules: 10X



VZV IgG ELISA: Target Value = 49 U/ml

Follow-up action in the event of a violation

There are three options as to the action to be taken in the event of a violation of a Westgard rule:

Accept the test run in its entirety - this usually applies when only a warning rule is violated.

Reject the whole test run - this applies only when a mandatory rule is violated.

Enlarge the grey zone and thus re-test range for that particular assay run - this option can be considered in the event of a violation of either a warning or mandatory rule.