

Western Pathologist Quality Assurance Association

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Be Aware of 2SD

The goal of a clinical laboratory is to provide physicians, in a timely fashion, with reliable and medically pertinent laboratory results. To reach that goal, clinical laboratories are engaged in a number of quality control (QC) and proficiency testing programs. Quality control samples are analyzed along with patient specimens. These quality control samples are usually obtained from commercial sources and the matrix of these samples mimic the matrix of the patient specimens. If patient's serum samples are analyzed, the control samples are protein based. The analyte concentration of the control sample is known or the concentration is determined and the acceptable limits are set. When the control sample is analyzed, its concentration has to fall within the set quality control limits. Historically, the quality control limits are based on the mean concentration ± 2 standard deviations (SD). If the quality control sample falls outside the ± 2 SD the analysis is rejected and if the QC sample falls within the mean ± 2 SD. the analytical run is accepted. Over the years, the ± 2 SD rules have been modified and expanded.

Quality control programs that the clinical laboratories participate in are internal, external or a combination of both. The internal QC program is run by the laboratory. The laboratory charts or in some other way that is readily accessible and retrievable, organizes control values. The quality control limits and the observed QC values should be accessible to the bench technologists, in order to accept or reject the analytical run. The laboratory's performance is assessed immediately and constantly. The external quality control programs are run either by professional organizations and/or instrument companies or reagent manufacturing companies. All participating laboratories use the same lot of QC materials for their quality control. In turn the laboratories supply QC values on a monthly basis or in some cases the laboratory's QC values are retrieved online from the instruments by the QC program providing organizations. Even though turnaround time of the QC evaluation is returned back to the laboratories within a few days after submission of the QC values, the laboratory's performance is evaluated on a monthly basis. In addition to the regular feedback to the laboratory about the laboratory's QC performance, these programs usually compare the laboratory's performance with peer laboratories.

When the ± 2 SD rule is used, it is assumed that the error distribution is Gaussian. One must be aware then that statistically 5% of all QC values will fall outside the mean and ± 2 SD range. Or, 1 QC value out of 20 will be out of control. The laboratory supervisor or director should be aware of this. When the QC sample exceeds the mean ± 2 SD limits, the laboratory should examine the method/instrument to determine whether the observed value represents the expected random error (1 out of 20) or a problem with the system.

The precision of analyte measurements has improved over the years. The current analytical instruments in clinical laboratories achieve coefficient of variation for some analytes around 1 to 2%. As the imprecision decreases, the +/- 2 SD range decreases and becomes tighter and tighter. For example, a coefficient of variation of 2.0% for serum magnesium measurement is easily obtainable. If the mean magnesium concentration for the QC sample is 1.40 mEq/L, then the standard deviation is 0.028 mEq/L. (%CV=SD/X x 100).

Consequently, the 2SD is less than 0.1 mEq/L, the smallest measurable difference for magnesium. Actually QC sample deviation of 0.1 mEq/L from the mean of 1.4 mEq/L for magnesium measurement represents 3.6 SD. Statistically this should happen only one time per thousand observations. As a general rule, a QC value outside the +/- 3 SD calls for the rejection of the analytical run. Should this analytical run, cited above, be rejected? Not necessarily, however, it should not be ignored either. Laboratory supervisor or director should assess the situation and make an appropriate decision to reject or not to reject the run.

When a laboratory participates in an external QC program, the laboratory receives extensive statistical summaries and the laboratory's QC mean values are compared to the mean values of the participating laboratories. The laboratory's QC values are summarized and reported as SDI (standard deviation interval or index). The SDI is calculated as follows:

$$\text{SDI} = \frac{\text{Lab mean} - \text{Group mean}}{\text{Group standard deviation}}$$

The calculation of the SDI reduces all the data to the same values making it possible to compare the results without reference to the means and standard deviations. The SDI value of +2 indicates that the laboratory's mean value is 2SD above group's mean. A SDI values greater than 2 indicates that laboratory's mean is not in good agreement with the mean value of the participating laboratories'.

As mentioned earlier, the precision of our analytical systems is improving and the standard deviations are decreasing. A small change in the analytical system can readily generate values outside +/- 2 SD's. Are these results then not medically acceptable or reliable? • Not necessarily. When the QC value falls outside +/- 2 SD limits, it is the supervisor's or director's responsibility to determine the reason for the observed discrepancy and to correct it. Beware!