(preexamination or preanalytical phase, when a broader sense is necessary) begins when the needle is first inserted into the vein and lasts until the sample enters the measurement system. The CV observed in this phase for the quantity measured is 0.8% (5), which in our example corresponds to a standard deviation, or standard uncertainty, of 2.2 μmol/L.

**Uncertainty of the value assigned to the calibrator.** The manufacturer of the calibrator does not declare the uncertainty of the assigned value. Because the uncertainty of the assigned value of the reference material SRM 909b, to which the calibrator is traceable, expressed as relative standard deviation is 1%, we can (optimistically) assume the same uncertainty for the calibrator. Thus, because the assigned value of calibrator is 301 μmol/L, the standard uncertainty attributable to the calibrator is 3.0 μmol/L.

**Day-to-day imprecision.** The measurement procedure of this example has an heteroscedastic behavior with a day-to-day CV within the measurement range equal to 1.1%. This imprecision applied to the patient’s result (275 μmol/L) corresponds to 6.6 μmol/L, but because there are three influence quantities studied by the reagent manufacturer, the estimated standard uncertainty should be multiplied by 3:

\[ u = \left[3 \times (6.6)^2/18\right]^{0.5} = 11.4 \text{ μmol/L} \]

When the standard uncertainties of every uncertainty component have been estimated, the combined standard uncertainty \(u_c\) attributable to all of these components may be estimated (4, 8):

\[ u_c = (2.2^2 + 3.0^2 + 11.4^2 + 3.0^2)^{0.5} = 12.4 \text{ μmol/L} \]

Finally, we will estimate the expanded uncertainty \(U\) with a confidence level \(1 - \alpha = 0.95\), multiplying the combined standard uncertainty by a coverage factor \(k\) equal to 2 (4, 8):

\[ U = u_c \times k = 12.4 \times 2 = 24.8 \text{ μmol/L} \]

Thus, the complete patient’s result, after rounding the value of the expanded uncertainty as is usually done for the measurement result, will be:

P-Urate; subst. c. (SRM 909b) = (275 ± 25) μmol/L

Keeping all of the above in mind, it seems clear that more effort should be devoted to improve the metrological specificity of the measurement procedures used in clinical laboratories, because in many cases, influence quantities, in spite of being not significant, may be, quantitatively, the more important component of the uncertainty of a patient’s result.

**References**


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**Serendipitous Detection of Umbilical Venous Catheter Displacement by Cardiac Troponin I Measurement**

To the Editor:

The measurement of cardiac troponin I (cTnl) is pivotal in the biochemical diagnosis of myocardial damage in adults and in infants as well (1). cTnl could also be used in other pathologies that may affect the neonatal heart, such as birth asphyxia, primary pulmonary hypertension, sepsis, and multiple organ system failure (2, 3).

A newly born term male suffered a
mild episode of asphyxia at birth (Apgar scores: 3 and 9 at 1st and 5th min, respectively) and needed a short resuscitation course at our Neonatal Intensive Care Unit. Blood tests 30 min after delivery showed metabolic acidosis, an arterial lactate concentration of 4.9 mmol/L, and a cTnI concentration of 0.18 μg/L (Dimension RxL-HM; Dade Behring) (4). The cTnI was below the 99th percentile (0.73 μg/L; Fig. 1) (5). As part of routine care, we positioned an umbilical venous catheter (UVC) and checked the correct position of its tip in the inferior vena cava by chest x-ray. In the next few hours, both clinical and biochemical indices improved, but a marked increase of cTnI (1.03 μg/L) was detected at 80 h despite the infant’s stable clinical conditions and normal electrocardiogram. Echocardiography demonstrated a normal cardiac contractility but, unexpectedly, revealed that the UVC tip had moved through the foramen ovale into the left atrium. The catheter was immediately removed. At 120 h, a marked decrease in the cTnI concentration (0.36 μg/L) was observed, and echocardiographic and electrocardiographic findings were normal. On day 6, the patient was discharged in good clinical condition.

In newborns suffering episodes of asphyxia at birth, we routinely measure cTnI concentrations to detect signs of myocardial injury (3). The management of these cases includes oxygen therapy, cannulation of the umbilical vein, and cardiorespiratory monitoring (2). In the patient described here, despite marked clinical improvement already apparent a few hours after birth, transient myocardial ischemia complicating birth asphyxia was suspected after a nearly sixfold increase in cTnI on the 4th day of life. We confirm previous reports of higher concentrations of cTnI in newborns compared with adults measured on another analyzer (Immuno1; Bayer) (6). However, the well-known standardization problems of cTnI assays (7) hamper the comparison of absolute results from different assays.

The mechanical injury attributable to the UVC tip hitting the endocardium wall during each cardiac cycle could explain the increase in cTnI, a specific and sensitive marker of cardiac injury, and its almost threefold decrease 40 h after removal of the UVC. Increased cTnI has been reported after difficult positioning of intracardiac catheters in adults and, similarly, after atriotomy performed in children undergoing cardiac surgery (8). Our observation suggests that increases in cTnI without clinical explanation in a newborn having an UVC should raise suspicion of accidental intracardiac displacement of the catheter.

How to Improve Total Error Modeling by Accounting for Error Sources Beyond Imprecision and Bias

To the Editor:

Boyd and Bruns (1) have used Monte Carlo simulations to assess glucose meter specifications. This letter suggests that their modeling methods do not account for all possible error types and thus their conclusions may not follow. A more realistic modeling method is reviewed as well as an alternative to modeling.

The error simulation method chosen for glucose by Boyd and Bruns (1) was also used in principle to generate the National Cholesterol Education Program goals for cholesterol analytical performance (2). Boyd and Bruns (1) generate glucose error by adding various levels of assay imprecision to various levels of assay bias. This method is intuitively appealing as a way of simulating