Reduction in Hospital Readmission Rates for Hyperbilirubinemia Is Associated with Use of Transcutaneous Bilirubin Measurements

The use of transcutaneous bilirubin (TcB) measurements would seem to represent an opportunity to decrease the use of laboratory total serum bilirubin (TSB) testing because the former would serve as a surrogate for the latter. Many authors of previous studies have concluded that TcB measurements are useful and can serve as a reliable index for estimating TSB concentrations (1–4), even in darkly pigmented neonates (5). Although the use of TcB measurements might represent, correspondingly, an opportunity to decrease expenses by decreasing laboratory TSB measurements, such a consequence would be dependent on several factors, including the cost of personnel and reagents for performing the TcB measurements and the number of TcB measurements performed. In addition, the TcB results might impact other caretaker practice behaviors, such as the ordering of TSB measurements and compliance with guidelines for the application of phototherapy, whether used in or outside the hospital, as governed by local practice routines. The newly revised American Academy of Pediatrics (AAP) Clinical Practice Guideline on management of hyperbilirubinemia in the newborn (6) would not necessarily affect or predict the interaction of these factors.

In this issue of Clinical Chemistry, Petersen et al. (7) demonstrate that the introduction of TcB measurements for the identification of infants with hyperbilirubinemia was followed by a decrease in the number of hospital readmissions of infants with hyperbilirubinemia per 1000 births/month. However, they found that the interaction of various factors did not contribute to changes in the length of stay for normal newborns and that new costs, in addition to those for TcB measurements, arose from an increased use of laboratory TSB testing and increases in the number and proportion of infants treated with phototherapy. Thus, the net effect of introducing TcB measurements was an increase in overall charges but, arguably, a safer manner of practice, leading to fewer readmissions for hyperbilirubinemia, most likely because of an increase in infants undergoing phototherapy.

This retrospective study is challenged in the usual ways in that it reports only on the consequences of changes in caretaker behavior after the introduction of TcB testing as a diagnostic measurement option. Although decisions to start phototherapy or obtain additional TSB measurements were guided by the Bhutani nomogram (8), the actual decisions to measure TcB or TSB and, ultimately, to initiate phototherapy were made by the attending physician and were not dictated by a strict practice protocol. Perhaps if additional rules had been introduced to direct the use of routine TSB testing, then such testing might have been decreased, leading to a reduction in total overall costs.

Use of the Bhutani nomogram is also recommended in the new AAP Guideline (6). This nomogram uses relatively low concentrations of bilirubin for assignment of risk for hyperbilirubinemia and in the evaluation of causation. These bilirubin concentrations are not thresholds at which treatment is recommended. Separate nomograms (6) are used for decisions to institute phototherapy and other therapies that are initiated at higher thresholds. Clinicians should not use the Bhutani nomogram for treatment decisions; such use would increase unnecessarily the application of phototherapy or other therapies. Nonetheless, it is not necessarily a “bad thing” for more infants to be treated for hyperbilirubinemia, if indeed they do qualify for such an intervention. This is especially so when treatment prevents future readmissions, an event that, in itself, implies that infants are exceeding hour-specific TSB concentrations that represent risks to their health. On the other hand, the argument can be made, justifiably, that adding TcB screening introduces no real advantage over TSB testing unless it replaces such invasive testing, particularly considering that the effort is undertaken to avoid rare injuring events among otherwise healthy near-term and term infants. If TcB screening could replace much of the TSB testing, then the introduction of a surrogate device could be better rationalized. Certainly, there are situations in which TSB testing is not readily available and TcB determinations would allow compliance within the AAP Guideline (5).

The blanket statement that skin pigmentation has been found to have no effect on TcB measurement could lead to an inappropriate lack of attention to certain population differences that could impact the relationship between TcB and TSB. For example, the presence of light-absorbing, nonbilirubin, nutrition-derived yellow pigments in the skin of infants could affect this relationship (9). The consumption of carotene-containing red palm oil, fruits, and vegetables may be high in certain populations, such as the ones studied in Nigeria (5). Moreover, dietary fat-soluble carotenoids can be transferred through breast milk. In as much as the physical and optical characteristics of the carotenoids and bilirubin are similar, the correlation between TcB and TSB could be affected by carotenodermia, although this is unlikely to be a common problem in the United States. In addition, protecting the test site on the forehead from phototherapy is necessary with implementation of TcB testing and should not be overlooked.

If measurements of TcB and TSB are compared regularly within a single institution, a reliable relationship between the two measurements can be documented. The manufacturer recommends validation of TcB twice a year, with TSB measured in serum specimens within 1 h. This may not always be possible. For this validation to be meaningful, it must be done in a sizeable number of specimens, and these may not always be available. If an infant were to have TcB readings performed at one institution and the TSB performed at another, any assumption about the relationship between TcB and TSB would be questionable because the variability of TSB...
measurements between laboratories has been shown to be high (10, 11). Such variation could lead to potentially consequential judgments, either decreasing or increasing the use of phototherapy inappropriately. Until measurement standards are set, as they have been for many other analytes, such interinstitution variation will continue to plague the decision-making of physicians and other caretakers attempting to apply the AAP Guideline.

A reported lower accuracy of the BiliChek™ device (Respirronics, Inc.) at higher TSB concentrations is probably not clinically important (1, 5). Nonetheless, a conservative caretaker could consider validating TcB measurements by use of TSB measurements, knowing that a TSB >120 mg/L is likely to be underestimated by TcB measurements.

One intriguing suggestion by Rubaltelli et al. (12) is that TcB measurements might reflect the concentration of bilirubin that has moved from the plasma into tissue, thus providing a better measure of the bilirubin available for moving into the brain. This hypothesis is intriguing because TSB reflects the concentration of bilirubin in only one compartment (i.e., the blood compartment and, specifically, the plasma portion) and is the result of a dynamic circumstance influenced by bilirubin binding, mainly to albumin. The jaundiced circumstance of the infant is best understood as one reflecting total bilirubin load, which includes not only the bilirubin in circulation, but also the total amount of bilirubin in the body, much of which has been distributed into tissues, such as the skin. Although the hypothesis seems at first plausible, the movement of bilirubin into the skin may be governed by processes different from those that affect bilirubin movement into the brain. Bilirubin entry into the brain is dependent on the integrity of the blood–brain barrier, and its persistence in the brain is determined by a variety of transporters (13) as well as by bilirubin metabolism. Thus, it is unlikely that TcB measurements will provide a better measure of risk for developing kernicterus in the context of high TSB concentrations, which TcB tends to underestimate anyway. The clinical evidence supporting our view is that most severely jaundiced infants do not develop kernicterus (14).

In conclusion, we agree with Petersen et al. (7) that TcB measurements are useful and reliable for estimating TSB concentrations in neonates, including heavily pigmented ones. Stricter rules for measuring TSB when using TcB measurements as a surrogate might decrease the cost of TSB testing. In addition, rigorous application of the revised AAP Guideline might further reduce the inappropriate use of phototherapy in near-term and term infants. Furthermore, the appropriate use of home phototherapy might further reduce costs by avoiding hospitalization. Nonetheless, the identification of infants at risk for hyperbilirubinemia and early intervention can reduce the number of infants needing readmission for evaluation and treatment, which can have other psychosocial benefits for the parents, including the avoidance of the “vulnerable child” syndrome.

References


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