

Transcutaneous Bilirubinometer

Neonatal jaundice occurs in nearly 70% of term and 80% of preterm babies. Management of jaundiced neonates often requires measurement of total serum bilirubin (TSB). Total serum bilirubin (TSB) is commonly determined by spectro-photometric methods by analyzing plasma or serum sample. Such techniques require drawing of blood causing pain and trauma to the neonate. In addition, there is a wide range of intra- and inter-laboratory variability in the performance of the bilirubin analyzers. These problems have led to search for a non-invasive, reliable technique for estimation of TSB.

A large number of studies have demonstrated the possibility of prediction of serum bilirubin in neonates by measuring the yellowness of the skin in the jaundiced neonate using transcutaneous bilirubino-meters.

Principle

High correlation between cutaneous bilirubin and TSB form the basis of Transcutaneous Bilirubinometry. These meters work by directing light into the skin of the neonate and measuring the intensity of specific wavelength that is returned. The number of wavelengths, used is variable in different transcutaneous bilirubinometers. The meter analyzes the spectrum of optical signal reflected from the neonate's subcutaneous tissues. These optical signals are converted to electrical signal by a photocell. These are analyzed by a microprocessor to generate a serum bilirubin value.

The major skin components, which impart the spectral reflectance in neonate, are (i) melanin, (ii) dermal maturity, (iii) hemoglobin, and (iv) bilirubin.

Earlier, the transcutaneous bilirubinometers utilized only a few wavelengths. In these meters, there was no provision to overcome the impact of dermal maturity and melanin content. Therefore, separate analysis for each patient population (different ages and races) was required one had to refer to different conversion tables for each population. However, a new product, BilicheckTM (Specter, Inc) performs a spectral analysis at more than 100 different wavelengths. By subtracting the spectral contribution of the known components, the bilirubin absorbance is quantified. The available meters can be divided into 2 categories:

- (i) Multi wavelength Spectral Reflectance meters (Bilicheck)TM
- (ii) Two-wavelength (460 nm, 540 nm) Spectral Reflectance meters
(Minolta, Bili-test)

How do these meters report the results?

The earlier transcutaneous bilirubino-meters reported the result in form of Transcutaneous Bilirubin Index (TcBI). The TcBI can be converted to bilirubin values in mg/dl or $\mu\text{mol/L}$ by using different multiplication factors for different populations. BilicheckTM, however, displays the results in clinically appropriate units: mg/dl or $\mu\text{mol/L}$.

Basic operating procedure

While each transcutaneous bilirubinometer has a different detailed operating procedure, the basic principle remains the same. The optic head of the meter is gently pressed against the neonates skin (usually forehead or upper part of sternum). For correct measurement, the optic head should make full contact with the skin and there should be no gaps between the head and the skin. This should be achieved by gentle pressure.

BilicheckTM differs from the other meters, in that, each time, 5 values are recorded at different sites in a neonate and then the result gets displayed.

Site of measurement

The commonly used sites are the forehead and the upper end of sternum. The meter readings for each site should be compared with the actual TSB before a particular site is chosen. The correlation coefficients for other sites such as the lower limbs are poor.

Hyperemia at the test site may affect the results. Measurements against bruises, birthmarks and subcutaneous hematoma should be avoided.

Advantages of BilicheckTM over other meters

- (i) The measurements are accurate for newborn of all races and ages; therefore separate analysis/conversion table are not required for each population.
- (ii) It is optimized for measuring bilirubin in the venous plexus.
- (iii) The results are displayed in clinically appropriate units mg/dl or $\mu\text{mol/L}$.
- (iv) The instrument automatically calibrates with the BiliCal before each measurement. Other instruments are factory calibrated.
- (v) The optical tip (Bili-Cal) has a small 0.5 cm “platform” ensuring proper skin/tip contact. Other equipment have a larger optical head.

However, the disadvantage of Bili-checkTM is the need for changing the tip (Bili-Cal) for each measurement. This adds to the cost of operation.

Clinical utility of Transcutaneous Bilirubinometers

Often a pediatrician is interested to corroborate his clinical estimate of the icterus with actual serum bilirubin level. Any such technique should ideally be accurate, non-invasive and valid. A large number of studies have tested the agreement between transcutaneous bilirubinometer results and TSB. Most studies have found fair to excellent correlation between the two. However, the 'correlation' is not an appropriate statistical technique for judging the agreement. Earlier instruments have been found more useful in whites and some other population; studies in India have not reported the same degree of agreement. While the correlation may be good, the difference between two values may be too large to be acceptable clinically. It appears that the difference between the transcutaneous bilirubin estimate and TSB may be too much to be acceptable. Also, once phototherapy is started for hyperbilirubinemia, these instruments have no utility.

Despite these limitations, transcutaneous bilirubinometers can serve as a screening tool, especially where services of a neonatologist are not available. However, this cannot serve as a substitute for TSB estimations.

Table 8.1: Common transcutaneous bilirubinometer available in the market

S.No.	Make	Principals	Dealers	Cost
1.	Airsheid's-Minolta	Hillrom-Airsheid's	Drager Medical	Rs. 1,00,000/-
2.	Bilitest	Technomedia	Lacteromedik Pharmamen Enterprises	Rs. 1,20,000/-
3.	BiliCheck	Spectrex	Rustagi Surgicals, Phoenix	Rs. 1,75,000/-
4.	Ohmeda	Datex- Ohmeda	Phoenix	Not launched

Frequently asked questions (FAQ's)

Q1. Why is there a need for transcutaneous bilirubinometry?

Neonatal jaundice is a very common condition. Though benign in majority some need investigations and appropriate management. In such a situation, reliable,

non-invasive method of bilirubin estimation will certainly be of great help. Transcutaneous bilirubinometers attempt to achieve this.

Q2. What is the principle of Transcutaneous Bilirubinometry?

High degree of correlation between cutaneous bilirubin and TSB is the basis of transcutaneous bilirubinometry. Simply stated, transcutaneous bilirubinometer measures the yellowness of the skin by analyzing the spectrum of light reflected by the baby's skin.

Q3. What is a multi reflectance spectral bilirubin meter?

The major components which impart the spectral reflectance in neonates are: melanin, dermal maturity, hemoglobin and bilirubin. Most bilirubinometers analyze only a few wavelengths; as a result, the dermal maturity and melanin content would interfere with the result. With these meters, separate analyses for each patient population were required. To overcome this problem, multi-reflectance spectral bilirubin meter has been designed. This instrument perform spectral analysis at more than 100 different wavelengths and by subtraction of spectral combination of the known components, bilirubin absorbance is quantified. This technique eliminates need for different charts for different populations.

Q4. What are the commonly used sites for estimation by these meters?

Forehead and the upper end of sternum are the commonly used sites. Hyperemia at the test site may affect results. Measurement against bruises, birthmark and subcutaneous hematoma should be avoided.

Q5. Does it matter, who is doing the measurement?

Virtually all of the published studies performed with the BilichekTM and the JM-103 have been performed under the relatively rigorous conditions of clinical investigation, with TcB measurements obtained by research nurses or technicians. Such studies almost certainly provide more accurate and precise results than those obtained with "real world" measurements by many different nurses or physicians in different environments and in the course of a normal day's work.

Q6. Do these instruments have any ongoing costs?

For Bilicheck™, the tip (Bili-cal) needs to be replaced for each new measurement, which adds to the cost of operation. Other meters do not require this tip.

Q7. In what unit are the readings of these instruments?

Bilicheck™ gives the reading in mg/dl. However other meters – Twin wavelength spectral reflectance meters give reading in form of transcutaneous bilirubin index (TcBI), which then has to be converted to value in mg/dl by using available formulae/chart.

Q8. How sensitive and specific are the bilirubin estimations by Transcutaneous Bilirubinometer?

Most of the studies performed on older bilirubinometer, have used ‘correlation’ as the statistical technique; they reported various degrees of correlation. In a study at AIIMS, using Bilicheck™, the sensitivity and specificity of the meter to pick up bilirubin >13 mg/dl was 69% and 89.3% respectively. However, the sensitivity was lower at higher cut offs (*Indian Pediatr 2000; 37: 771-775*)

Q9. What is the clinical utility of transcutaneous bilirubinometer? Are these useful as screening tools?

Presently available instruments are not sufficiently sensitive and specific to replace TSB measurement. The difference between transcutaneous bilirubin estimate and TSB appears to be too large to be acceptable.

However, transcutaneous bilirubinometers can serve as screening tools, especially where services of a neonatologist are not available.