Transcutaneous Bilirubinometers to screen for jaundice in the well term infant

Introduction

The incidence of clinical jaundice in newborn infants is reported to be as high as 60 to 80 per cent during the first days following birth. Jaundice is safe for most term infants but high levels of unconjugated bilirubin can cause brain damage in susceptible newborns. Preventative, screening and management strategies therefore remain a significant practice issue during the early postnatal period.

This high incidence of jaundice combined with a relatively low incidence of adverse outcomes and the shortening of postnatal stay means that peak serum bilirubin levels (SBRs) often occur after discharge. Thus effective screening and surveillance are essential to ensure that infants with severe hyperbilirubinaemia are not missed. Importantly it is still not known at what level bilirubin can cause a significant risk of brain damage, however SBRs over 450 micromol/L have been associated with kernicterus in the term infant with co morbidities such as sepsis or haemolysis.

This protocol was developed to improve our screening for significant jaundice and reduce the need for invasive and painful blood tests through the use of new generation bilirubinometers.

Use of Transcutaneous Bilirubinometers (TcBs)

The proposed benefits of using this technology include non-invasive and accurate screening for clinically significant jaundice. TcB readings are instant and results can avoid delay with discharge and / or indicate the need for formal SBR testing. Reduction in invasive blood tests will have an associated reduction in pain and discomfort for the newborn and a reduction in health costs.

TcB measurements have demonstrated linear correlation with SBRs and several investigators have recommended their use as a screening device to detect clinically significant jaundice and thus decrease the need for frequent blood sampling in the well term infant. In addition, both the BiliChek® and the Konica Minolta JM-103® have been trialed in ethnically diverse populations and have had good correlations with SBRs.

The results of a recent audit at RPA Women and Babies demonstrated that both the BiliChek® (Respironics, Inc. Murrysville, PA USA) – see figure one and the Konica Minolta JM-103® (Dräger Air-Shields, USA) – see figure two have sufficient accuracy in the term population when compared with traditional SBR blood tests to justify their use. At this time the use of TcB measurements for infants less
than 37 weeks gestation has not been validated in our population. Further evaluation of the technology in this high-risk group is currently underway.

**Serum bilirubin blood test (SBRs)**

Aside from almost universal screening for rare inborn errors of metabolism, the most frequently ordered blood test on well newborns is the measurement of SBRs. Although frequency of testing has a poor correlation with the number of infants diagnosed with moderate to severe hyperbilirubinaemia, the total SBR remains the “gold standard” for jaundice screening in most maternity units.

Most protocols used to identify infants at risk for moderate – severe hyperbilirubinaemia rely on clinical observation of increasing jaundice and blood tests. Importantly clinical assessment of jaundice is not predictive, reliable or accurate and can lead to over testing.

It is important to balance the potential harms of over diagnosing and over treating infants with safe levels of jaundice and under treating that very small number of infants with jaundice that can potentially cause harm.

The potential harms associated with using invasive blood tests to measure SBRs and over diagnosing jaundice include:

- infant pain and discomfort
- infection
- maternal distress
- interruption to breast feeding and
- maternal infant separation

The potential harms associated with under diagnosis of moderate to severe jaundice include:

- sensorineural hearing loss
- bilirubin encephalopathy (hypertonia, arching, opisthotonos, high pitched cry)
- kernicterus

**Indications for SBR blood tests**

- preterm infants with clinically significant jaundice
- all infants less than 24 hours of age who present with jaundice
- all infants with haemolysis or other significant risk factors for jaundice
- term infants 24 – 48 hours of age where the TcB reading is greater than 140 µmol/L
- term infants 48 – 72 hours of age where the TcB reading is greater than 200 µmol/L
- term infants greater than 72 hours of age where the TcB reading is greater than 260 µmol/L
- first jaundice level after initiation of phototherapy on the postnatal ward or in the home
- all infants receiving overhead phototherapy
Risk factors for jaundice in the term infant

Several factors increase the risk for jaundice in the otherwise well term infant. These include a history of hyperbilirubinaemia in a previous sibling, infants less than 38 weeks gestation, Asian ethnicity and infants who are breast feeding. Asian race and a gestational age less than 38 weeks are strong predictors for maximum SBRs over 428 micromol/L. Maisels et al (1988) also reported a strong relationship between breast feeding (p < .0001) and greater than seven per cent weight loss (p = .0001) and hyperbilirubinaemia.

The list of complex factors that advance bilirubin toxicity in the at risk newborn include high levels of unconjugated bilirubin (excessive bruising, increased entero hepatic bilirubin production, or haemolysis - Rh or ABO incompatibility and glucose-6-phosphate dehydrogenase deficiency), low serum albumin levels (prematurity) and / or impaired binding of bilirubin to albumin (acidosis, sepsis, hypothermia, hypoglycaemia) and decreased bilirubin solubility / increased bilirubin deposition (acidosis, anaemia, sepsis, poor perfusion or respiratory distress) – see Jaundice policy for a detailed list of risk factors, consequences and investigation of jaundice.

TcB Measurements

*TcB measurements are used to screen the otherwise well term infant who is greater than 24 hours of age to determine the need for a formal SBR. In addition to the TcB reading it is essential to consider the presence of any risk factors associated with moderate to severe jaundice in the term infant.*

Using the current clinical practice guidelines for the initiation of phototherapy in the term infant (RPA Newborn Care 2003 – see jaundice policy) that is a SBR greater than 320 µmol/L on day three, the correlations for the Konica Minolta JM-103® and SBRs were examined. On the scatter plot for the Konica Minolta JM-103® TcB measurements and corresponding SBRs (n = 95) there was only one TcB reading under 260 µmol/L that had a corresponding SBR over the phototherapy limit of 320 µmol/L (JM-103 220 µmol/L / SBL 330 µmol/L) - see figure two.

The Konica Minolta JM-103® Jaundice Meter (Dräger Air-Shields, USA)

*Procedure (postnatal wards / midwifery discharge programme)*

- TcB measurements are performed to determine the need for a formal SBR
- TcB measurements can be used to facilitate newborn discharge where appropriate
- Serial TcB readings are used to evaluate the effect of phototherapy after formal SBRs have demonstrated falling bilirubin levels. Transcutaneous bilirubin measurements can only be used to monitor efficacy of phototherapy when the Medela Bilibed™ (Fischer & Paykel) is in use. This method of phototherapy does not expose the forehead to therapeutic light.
- Take two single TcB readings – if there is a difference in readings of less than ± 60µmol/L
document the higher reading. Repeat procedure if readings are outside this range.

- All clinicians require accreditation with use of the Konica Minolta JM-103® and associated QI protocols.
- The Konica Minolta JM-103® requires calibration daily - prior to the morning round. The midwives (night shift) will calibrate the Konica Minolta JM-103®, document and sign in the JM-103 Resource Manual. Both the values for the long and short optical paths should read within ±1.0 of the reference value on the unit cover – see resource folder.
- To take a measurement the device is positioned on the forehead flush with the infant’s skin and below the hairline. Avoid any bruising or discoloured areas of skin. The tip is cleaned with an alcohol wipe between infants. The devices are set to take a single measurement\(^2\). While in hospital all TcB readings are taken on the forehead to ensure a standardised technique. Accuracy of both the forehead and sternum has been validated\(^2\).

![The Konica Minolta JM-103 Jaundice Meter (reproduced with permission of Dräger Air-Shields, USA)](image)

**BiliChek® (Respironics, Inc. Murrysville, PA USA)**

The domiciliary midwives have used The BiliChek® to screen for hyperbilirubinaemia in term infants for the last 18 months. To take a measurement using the BiliChek®, the device is calibrated prior to each measurement; the disposable probe (BiliCal™) is applied on the forehead level below the hairline and five readings are used to generate one measurement that is displayed in µmol/L \(^{26}\). When correct pressure is applied a green light alerts the operator to take a reading, if a faulty measure is taken an error message is displayed and the last reading must be repeated. This device uses more advanced technology than the Konica Minolta JM-103® and is currently being evaluated at RPA Newborn Care for use in the sick and preterm infant.

![The BiliChek® in use (reproduced with permission Respironics, Inc. Murrysville, PA USA)](image)
Figure one - correlation between SBRs and BiliChek® measurements – term babies

Figure two - correlation between SBRs and Minolta JM-103® measurements – term babies

Screening for hyperbilirubinaemia in term
### infants: Summary

<table>
<thead>
<tr>
<th>Signs of jaundice</th>
<th>Action</th>
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<tbody>
<tr>
<td>&lt; 24 hours of age</td>
<td><em>Do SBR – see jaundice policy for additional investigations</em></td>
</tr>
<tr>
<td>&gt; 24 hours of age + Risk factors (maternal antibodies; history of G6PD)</td>
<td><em>Do SBR – see jaundice policy for additional investigations</em></td>
</tr>
<tr>
<td>24-48 hours of age Well infant / no risk factors</td>
<td>If TcB measurement &gt; 140µmol/L <em>Do SBR</em></td>
</tr>
<tr>
<td>48-72 hours of age Well infant / no risk factors</td>
<td>If TcB measurement &gt; 200µmol/L <em>Do SBR</em></td>
</tr>
<tr>
<td>&gt;72 hours of age Well infant / no risk factors</td>
<td>If TcB measurement &gt; 260µmol/L <em>Do SBR</em></td>
</tr>
<tr>
<td>Phototherapy using the Medela Bilibed™ Well infant / no other risk factors</td>
<td><em>Do SBR – if level falling Monitor jaundice using TcB</em></td>
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### References:


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