A Primer on Neonatal Phototherapy

What is Neonatal Jaundice?

The term “jaundice” describes a yellow/orange discoloration of the sclera of the eyes and skin in a newborn due to the presence of excessive bilirubin deposits. Bilirubin is formed when red blood cells are broken down in the spleen to biliverdin and then to unconjugated bilirubin. As bilirubin is not water soluble it is then sent to the liver and bound to the plasma protein albumin. Unbound bilirubin is called unconjugated bilirubin while bilirubin bound in the liver is called conjugated bilirubin and can be excreted by the gastrointestinal tract. Neonatal jaundice occurs when imbalance leads to the presence of excessive amounts of unconjugated bilirubin in the blood and tissues. The two main factors causing this imbalance are the increased breakdown of red blood cells and the immature liver function in newborns.

Incidence of Neonatal Jaundice:

Jaundice is one of the most common conditions leading to medical evaluation in neonates with more than half of healthy term infants developing jaundice. This incidence is higher in premature infants. Most clinical articles cite incidence at 50-60% of term infants and up to 80% of premature infants.

Physiological or Pathological Jaundice?

Physiological Jaundice - Refers to elevated levels of unconjugated bilirubin that are due primarily to the immaturity of the liver without other underlying pathology. Usually lasts < 7 days.

Pathological Jaundice - Refers to bilirubin levels are elevated due to underlying pathology that either increases the production of bilirubin or decreases its excretion.

Breastmilk Jaundice - Refers to jaundice occurring later in the newborn period with levels peaking between 6-14 days of life.

Symptoms and Effects of Neonatal Jaundice

Symptoms include the characteristic discoloration, lethargy and poor feeding. In the case of severe hyperbilirubinemia, symptoms can also include a high-pitched cry, fever, seizures and coma. Long-term neurological effects include lasting brain damage, hearing loss and cerebral palsy.

While neonatal jaundice is typically a benign self-limiting condition observed in a high percentage of infants, very high levels of bilirubin can cause toxicity resulting in permanent brain damage also known as bilirubin encephalopathy or kernicterus. It is therefore important to monitor newborns with the goal of identification, diagnosis and management of increased or rapidly increasing levels. Current medical knowledge dictates that kernicterus should be largely preventable, yet cases continue to occur.
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Diagnosis and Treatment

Diagnosis and treatment guidelines should be aimed at preventing severe hyperbilirubinemia and its resulting bilirubin encephalopathy while also addressing and minimizing decreased parental contact and anxiety, barriers to breastfeeding, and unnecessary treatment.

First and foremost, both Canadian and American Paediatric governing bodies recommend the promotion and support of successful breastfeeding as a key preventative. Systematic assessment including observation and examination within a prescribed period is also key. During examination jaundice may be more easily detected by blanching the skin with digital pressure to reveal the underlying colour of the skin and subcutaneous tissue. The face is typically first to become jaundiced, followed by the trunk and extremities (caudal progression). While visualization is a well accepted methodology, visual estimation alone can be inaccurate particularly in darkly pigmented skin, and therefore should never be the sole method utilized. Physical examination for jaundice is not recommended after starting phototherapy as the light minimizes the jaundiced appearance. Awareness and identification of risk factors including ABO and Rh incompatibility should dictate a heightened level of surveillance in clinicians. Early and focused follow-up based on risk assessment is imperative along with the provision of written and verbal information about newborn jaundice.

(Here is a link to the handout provided by the Canadian Pediatric Society on the CPS website https://www.caringforkids.cps.ca/handouts/jaundice_in_newborns).

All clinical settings providing care to neonates should develop guidelines and protocols for treating hyperbilirubinemia. Total serum bilirubin (TSB) or transcutaneous bilirubin (TcB) levels should be measured in all babies with clinical jaundice presenting within 24 hours. All babies in Canada have their bilirubin levels checked within 72 hours of birth. Blood test or a non-invasive transcutaneous method may be used. Limitation of TcB measurements include testing in preterm neonates or after the initiation of phototherapy. Levels should be quantified as a level as low as 34 umol/L may be visible, but treatment level is typically > 255 umol/L. Once a serum level is obtained, clinicians should use an approved threshold table to determine further management which can include follow-up testing, phototherapy or exchange transfusion to prevent severe hyperbilirubinemia and its serious sequelae. It is important that thresholds be determined using postnatal age in hours.

There are several online bilirubin calculators available and a nomogram for designation of risk may be useful in determining follow-up timelines. All nurseries and services treating at risk infants should have necessary equipment to provide intensive phototherapy. Early onset of jaundice, rapidly increasing levels and/or jaundice resistant to treatment should be investigated for underlying pathology where other risk factors are not apparent (e.g. excessive bruising, known blood incompatibility).
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**Severe hyperbilirubinemia** - a total serum bilirubin (TSB) concentration greater than 340 umol/L during the first 28 days of life.

**Critical hyperbilirubinemia** - a TSB concentration greater than 425 umol/L during the first 28 days of life.

**Phototherapy**: Light emitting diodes (LED) are used to convert bilirubin to water soluble waste products that can be excreted in urine and stool reducing blood levels. AAP Guidelines (accepted and endorsed by the Canadian Pediatric Society) for infants of 35 weeks or more weeks of gestation, recommend blue-green spectrum (wavelengths of approximately 430-490 nm) of at least 30 uW/cm²/nm, delivered to as much of the infant’s surface area as possible at an optimal distance of 10-30 cm from infant (with closer distances delivering higher intensity). While fluorescent light can be used to treat hyperbilirubinemia the technology of choice today is LED which allows for an improved amount of light energy. Halogen light does not achieve the optimal wavelength in the blue-green spectrum.

Methods of effective phototherapy delivery include both spot lamps or pad type lights. Spot lamps come in various types and are placed above the neonate. This can be achieved in several ways including a custom stand, IV pole mount, suction cups that allow the lamp to be placed on the top of the incubator or mounting “arms” that allow for attachment to rails. Fibreoptic pad type lights may also be used. In this method lights are embedded in the pad and are placed in contact with the neonate’s skin. The term “bili-blanket” began as a trademark name but has become a colloquial term for the pad type light. Other terms used for pad type phototherapy devices include home phototherapy system, bilirubin blanket, or phototherapy blanket. Method choices are dependant on clinical requirements and should be designed to optimize workflow while allowing for maximum flexibility in providing effective treatment.

**Conventional Phototherapy**: Also known as “single phototherapy” is primarily used in treatment of very low birthweight (VLBW) infants with serum levels that are in the phototherapy range but have not reached a level considered severe hyperbilirubinemia.

**Intensive Phototherapy**: High intensity light (greater than 30uW/cm²/nm). Also known as “double” or “triple” phototherapy.

**Exchange Transfusion**: Exchange transfusion is indicated if phototherapy fails to control rising blood levels of bilirubin. Any infant with clinical signs of acute bilirubin encephalopathy should receive exchange.