

# Clinical Guideline



**HNEkidshealth**  
Children, Young People & Families



**Health**  
Hunter New England  
Local Health District

## Neonatal Jaundice: Identification and Management

<b>Sites where Clinical Guideline applies</b>	All Maternity and Newborn Service sites in HNELHD
<b>This Clinical Guideline applies to:</b>	
1. <b>Adults</b>	No
2. <b>Children up to 16 years</b>	No
3. <b>Neonates – less than 29 days</b>	Yes
<b>Target audience</b>	Maternity and Neonatal unit clinical staff including Medical Officers, GPs, Allied Health, Nurses and Midwives caring for newborns at risk of neonatal jaundice
<b>Description</b>	This guideline has been written to provide guidance for all clinicians responsible for the care of neonates across HNELHD

[Hyperlink to Guideline](#)

<b>Keywords</b>	Jaundice, Newborn, Bilirubin, Hyperbilirubinaemia, JHCH, Kernicterus, Phototherapy, TcB, NICU, SCU, Maternity
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<b>Related Legislation, Australian Standard, NSW Ministry of Health Policy Directive or Guideline, National Safety and Quality Health Service Standard (NSQHSS) and/or other, HNE Health Document, Professional Guideline, Code of Practice or Ethics:</b>	
<ul style="list-style-type: none"> <li>• <a href="#">NSW Health Policy Directive GL2016_027 Neonatal - Jaundice Identification and Management in Neonates ≥ 32 Weeks Gestation</a></li> <li>• <a href="#">HNELHD PD 2005_406:PCP 3 Consent for Clinical Treatment and Care</a></li> </ul>	
<b>Position responsible for Clinical Guideline Governance and authorised by</b>	Dr Paul Craven, Executive Director, Children Young People and Families Services
<b>Clinical Guideline contact officer</b>	Jo Davis, CNC Newborn Services, NICU JHCH
<b>Contact details</b>	<a href="mailto:Jo.davis1@health.nsw.gov.au">Jo.davis1@health.nsw.gov.au</a>
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Note: Over time links in this document may cease working. Where this occurs please source the document in the PPG Directory at: <http://ppg.hne.health.nsw.gov.au/>

## PURPOSE AND RISK

*This document has been developed to provide guidance to clinical staff in Maternity and Newborn Service Units in HNELHD for the recognition, investigation and management of jaundice in the neonate.*

*HNELHD operates within a tiered network of maternity and newborn services which helps to ensure that women and their babies have the appropriate access to higher levels of maternity and newborn care when risk factors are identified beyond the designated role delineation of the local service. Clinicians should make the decision as to the most appropriate facility for care based on the baby's individual needs.*

*Any unplanned event resulting in, or with the potential for injury, damage or other loss to infants/staff/family as a result of this procedure must be reported through the Incident Information Management System (IIMS) and managed in accordance with the Ministry of Health Policy Directive: Incident management PD2007\_061. This would include unintended injury that results in disability, death or prolonged hospital stay.*

**RISK CATEGORY:** Clinical Care & Patient Safety

## CLINICAL PROCEDURE SAFETY LEVEL

Every clinician involved in the procedure is responsible for ensuring the processes for clinical procedure safety are followed. The following level applies to this procedure (click on the link for more information):

[Level 1 procedure](#)

## Staff Preparation

It is mandatory for staff to follow relevant: "Five moments of hand hygiene", infection control, moving safely/safe manual handling, documentation practices and to use HAIDET for patient/carer communication: **H**and hygiene **A**cknowledge, **I**ntroduce, **D**uration, **E**xplanation, **T**hank you or closing comment.

## OUTCOMES

1	To accurately assess jaundice in the neonate and identify risk factors
2	To commence phototherapy treatment utilizing the phototherapy and exchange charts
3	To prevent bilirubin encephalopathy and kernicterus in the neonate
4	To ensure the optimal pathways for investigation are complete

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## GUIDELINE

*While not requiring mandatory compliance, staff must have sound reasons for not implementing standards or practices set out within guidelines issued by HNE Health, or for measuring consistent variance in practice.*

### Introduction

During the first week of life all newborns have increased bilirubin levels by adult standards, with approximately 60% of term and 85% of preterm babies developing jaundice.

Jaundice is the yellow discolouration of the skin and sclera caused by the accumulation of bilirubin in the skin and mucous membranes. Most jaundice in newborns is physiologically normal and usually benign. However, if unconjugated serum bilirubin levels get too high, unbound unconjugated bilirubin can cross the blood brain barrier into the brain where it is neurotoxic, particularly to the auditory nerve and basal ganglia. Brain injury and lifelong disability can result. Because of this, it is important to identify those babies at risk of the rare complication of acute bilirubin encephalopathy and kernicterus.

## Classification of Jaundice in the Newborn

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It is clinically useful to classify jaundice according to the age of the baby when jaundice first becomes visible.

### Onset less than 24 hours of age

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#### Requires **URGENT** review

- Nearly always pathological
- Usually due to haemolysis
  - Rhesus disease
  - Other blood group incompatibilities
  - Rarer, red cell enzyme defects (e.g. G6PD deficiency)
  - Rarer, red cell membrane defects (e.g. spherocytosis, elliptocytosis)
- Uncommonly due to sepsis

## Onset between 24 hours and 10 days

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- Physiological jaundice
- Haemolysis
- ABO incompatibility
- Breakdown of extravasated blood
  - Cephalo-haematoma
  - Severe bruising
  - CNS haemorrhage
- Increased enterohepatic circulation which may be due to
  - Inadequate feeding
  - GI obstruction
- Sepsis
- Breast milk jaundice

## Onset or persistence greater than 10 days

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- Haemolysis
  - Rhesus disease
  - ABO incompatibility
  - Other blood group incompatibilities
  - Rarer, red cell enzyme defects (e.g. G6PD deficiency)
  - Rarer, red cell membrane defects (e.g. spherocytosis, elliptocytosis)
- Hypothyroidism
- Sepsis (particularly urinary tract infections)
- Galactosaemia
- Conjugated hyperbilirubinaemia due to:
  - idiopathic neonatal hepatitis
  - infections (Hepatitis B, TORCH, sepsis)
  - congenital malformations (biliary atresia, choledochal cyst, bile duct stenosis)
  - metabolic disorders (galactosaemia, hereditary fructose intolerance, Alpha-1 antitrypsin deficiency, tyrosinaemia, glycogen storage disease type IV, hypothyroidism)
- Breast milk jaundice (diagnosis of exclusion)

## Risk Factors for Developing Severe Hyperbilirubinaemia

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### Risk factors

- Blood group incompatibility with positive Coombs test
- Gestation < 36 weeks
- Jaundice observed in the first 24 hours
- Previous sibling requiring phototherapy or exchange transfusion
- Cephalo-haematoma or significant bruising
- Macrosomic infant of diabetic mother

A common mnemonic for remembering the risk factors for hyperbilirubinaemia is **JAUNDICE**:

**J** – jaundice within the first 24 hours of birth

**A** – a sibling who required phototherapy as a baby

**U** – unrecognised haemolysis

- N** – non-optimal sucking/feeding
- D** – deficiency of G6PD
- I** – infection
- C** – cephalo-haematoma or bruising
- E** – ethnicity (Asian heritage)

## Bilirubin Toxicity

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Prolonged high levels of bilirubin can lead to acute encephalopathy, which can affect the long term outcomes of the baby, including neuro-sensory deficits such as deafness and cerebral palsy (chronic bilirubin encephalopathy or kernicterus).

### Acute Bilirubin Encephalopathy

**This clinical syndrome presents initially as:**

- Lethargy
- Hypotonia
- Poor feeding
- High pitched cry

**Progression of symptoms may occur to:**

- Hypertonia with opisthotonus or retrocollis
- Seizures
- Impaired consciousness
- Death

**Late sequelae in survivors (chronic bilirubin encephalopathy/kernicterus):**

- Extrapyramidal abnormalities (facial grimacing, drooling, dysarthria, athetosis, dystonia, spasticity) most commonly diagnosed as athetoid cerebral palsy
- Gaze abnormalities
- Sensorineural hearing loss
- Dental dysplasia

The cerebral cortex is relatively spared and intelligence is believed to be close to normal. The late effects of moderate levels of jaundice on extremely preterm infants are unknown, although it is generally accepted they are more at risk than term infants for the same SBR level.

### Chronic Bilirubin Encephalopathy (Kernicterus)

At autopsy, babies display evidence of bilirubin staining of the basal ganglia and brain stem nuclei, neuronal necrosis and scarring known as kernicterus.

### Risk Factors for Kernicterus

Once a baby develops severe jaundice, the risk of progressing to kernicterus is increased by the following:

- Rapidly rising bilirubin level (> 8.5 micromol/litre per hour)
- Clinical features of acute bilirubin encephalopathy
- Acidosis (pH < 7.2)
- Proven sepsis
- Asphyxia (Sarnat stage 2 or more)

## Assessment of the Jaundiced Neonate

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The jaundiced neonate needs to be assessed for

- Wellbeing
- History for risk factors
- Level of jaundice
- Investigation for cause of jaundice
- Risk factors for earlier phototherapy and exchange transfusion

### Well Being

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Signs of being unwell such as marked lethargy, poor responsiveness, temperature instability, poor feeding, cyanosis, apnoea, bradycardia, mottled skin. In this case differential diagnosis of sepsis, metabolic disturbances or other serious disorders that need to be ruled out. A generally unwell neonate is at risk of bilirubin encephalopathy at a lower level of serum bilirubin and should be started on phototherapy at the lower line (Phototherapy with Risk Factors) on the treatment graphs. Examination findings of bruising, pallor and/or plethora may offer clues to causation.

### History for Risk Factors

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Factors that may be significant in causation in the maternal history include blood group, antibodies and maternal infections in pregnancy. In labour and delivery trauma such as bruising is a risk factor. A family history of siblings requiring phototherapy can be a risk factor. A baby's feeding history with significant weight loss or poor weight gain may suggest inadequate milk intake.

### Level of Jaundice

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The level of jaundice can be estimated by clinical examination of colour or measurement by a transcutaneous bilirubinometer and definitively by measuring blood bilirubin level or serum bilirubin by suitable point of care testing (compatible i-stat machines) or formally via pathology. Always assess jaundice in a well-lit room or in daylight at a window by blanching the baby's skin with a finger and observing the underlying skin colour. Jaundice appears first in the face and progresses caudally to the trunk and extremities.

Kramer recognised the cephalo-caudal progression of jaundice with increasing total serum bilirubin levels and visually divided the baby into 5 zones, with a total serum bilirubin level measurement associated with each zone (see Figure 1). This is known as Kramer's rule and has traditionally been used to visually assess the severity of jaundice (see Figure 2).

Zone	1	2	3	4	5
Definition	Head and neck	Upper trunk	Lower trunk and thighs	Arms and lower legs	Palms and soles
Bilirubin (micromol/L)	100	150	200	250	> 250

Figure 1. Kramer's rule (zones with estimated SBR)

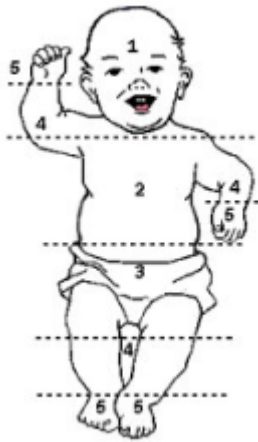


Figure 2. Kramer's rule (Picture from Google images)

***Kramer's rule is unreliable on a baby who has already commenced phototherapy.***

Visual estimation of bilirubin levels can lead to errors especially in darkly pigmented babies. A total serum bilirubin level (SBR) should be used to assess response to phototherapy and may be necessary if clinical assessment is difficult in babies with darker skins. In darker skinned babies rubbing and visualizing the gums can assist in assessing the level of jaundice.

## Investigation Methods

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### Transcutaneous Bilirubin Level

Bilirubin levels can be measured transcutaneously by a Transcutaneous Bilirubinometer. Available devices differ in accuracy; safe use of this device requires knowledge of the accuracy of the particular device being used.

### The Transcutaneous Bilirubinometer (TcB)

The TcB is a portable, non-invasive handheld device designed to measure the yellow pigments including bilirubin in the skin. Note, this can affect the accuracy of reading with babies with darker skin pigmentation. TcB use reduces the number of unnecessary painful bloodletting and reduces pathology costs without adverse outcomes to the newborn.

The device transmits light into the skin when directed over the sternum or the forehead and collects and analyses the reflected light by spectral subtraction to obtain the bilirubin concentration. Similar devices as those currently in use across the HNELHD have proven ability of providing a reliable measure that is comparable to the serum bilirubin levels within a range difference of 34-50 $\mu$ mmol when the total serum bilirubin level is  $\leq$  260 $\mu$ mmol.

Although the SBR remains to be the gold standard for jaundice screening in most maternity hospitals, the transcutaneous bilirubinometer can indicate infants who would not need a formal SBR and may avoid delays with discharge. As differences in reliability of measurement exists between individual babies, trending of TcB measurements are more reliable than those made on a single value as the basis for clinical decision making.

### When to consider the use of a TcB

- Newborns  $\geq$  24hours of age with no other clinical risk factors

### When not to use a TcB

- Newborn  $\leq$  24 hours of age
- When a baby had received phototherapy within the previous 72 hours

<b>SCREENING FOR HYPERBILIRUBINAEMIA</b>	
<b>Signs of Jaundice &lt; 24hrs of age</b>	<b>Complete an:</b> <ul style="list-style-type: none"> <li>Urgent SBR and seek medical review</li> </ul> <b>Further investigations should include:</b> <ul style="list-style-type: none"> <li>Maternal &amp; infant blood group</li> <li>DAT &amp;</li> <li>BSL</li> </ul>
<b>Signs of Jaundice &gt; 24hrs of age + risk factors</b> (maternal antibodies; history of G6PD)	<b>Complete an:</b> <ul style="list-style-type: none"> <li>Urgent SBR and seek medical review</li> </ul> <b>Further investigations should include:</b> <ul style="list-style-type: none"> <li>Maternal &amp; infant blood group</li> <li>DAT &amp;</li> <li>BSL</li> </ul>
<b>Signs of Jaundice 24 - 48hrs of age</b> Well Infant/no risk factors	<b>If TCB measurement &gt;140µmol/L:</b> <ul style="list-style-type: none"> <li>Do formal SBR</li> </ul>
<b>Signs of Jaundice 48 - 72hrs of age</b> Well Infant/no risk factors	<b>If TCB measurement &gt;200µmol/L:</b> <ul style="list-style-type: none"> <li>Do formal SBR</li> </ul>
<b>Signs of Jaundice 72hrs of age</b> Well Infant/no risk factors	<b>If TCB measurement &gt;260µmol/L:</b> <ul style="list-style-type: none"> <li>Do formal SBR</li> </ul>

**\*NOTE - A formal SBR is required if the TcB level is within 50 micromol/L of the threshold for phototherapy OR a term baby's TcB level is > than 250 micromol/L**

## Total Serum Bilirubin (SBR)

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Total SBR should always be used for treatment decisions regarding jaundice. Venous and capillary SBR levels should be treated the same. SBR can be measured either in the laboratory on a serum sample or on a gas machine where available.

### A total SBR should always be obtained in the following situations:

- Visible jaundice in the first 24 hours
- Jaundiced baby whose mother has rhesus or other red blood cells antibodies
- A TcB level is within 50 micromol/L of the threshold for phototherapy
- Term baby with estimated serum bilirubin levels or TcB level is greater than 250 micromol/L
- Any baby, if there is clinical doubt about the degree of jaundice
- Any unwell baby with jaundice
- Any baby with clinical signs of obstructive jaundice (pale stool and dark urine)
- Prolonged jaundice greater than 2 weeks in term babies and greater than 3 weeks in preterm babies
- In the 72 hours after phototherapy ceases



## Repeated Assessment of Jaundice Level

Jaundiced babies require repeated assessment of jaundice level until the clinician is confident the bilirubin level is decreasing. This may be done by any of the methods mentioned above i.e. clinical judgment by Kramer's rule, TcB by bilirubinometer, POC testing or SBR. **Blood sample SBR must always be used in babies who have had or are receiving phototherapy.**

For babies having or just completed phototherapy see [Monitoring and Stopping Phototherapy](#)

## Investigations for Cause of Jaundice

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Investigation for a cause of neonatal jaundice should be considered in the following situations:

- Any baby that is clinically unwell
- Early onset jaundice (first 24 hours)
- Total SBR above phototherapy threshold at any time
- Rapidly rising bilirubin level (> 8 micromol/L/hour)

### ***Suggested investigations include:***

#### **Clinically unwell baby**

- Workup for sepsis – FBC and film, blood culture, +/-urine culture, +/-blood gas
- Review mother's blood group and antibody status
- Blood group and DAT
- Other investigations indicated from clinical situation and findings e.g. consideration for metabolic investigations
- **Contact NETS for advice and possible retrieval**

#### **Early onset jaundice**

- Review mother's blood group and antibody status
- Blood group and DAT
- FBC and film
- Glucose-6-phosphate dehydrogenase (G6PD) deficiency screen in babies with high risk family history or ethnic/geographic origin (Mediterranean, Middle Eastern, African, Asian)
- Consider need for workup for sepsis, including urine screen
- Other investigations indicated from clinical situation and findings
- **Contact NETS for advice and possible retrieval**

#### **Late onset or prolonged jaundice**

Central to the management of late onset or prolonged jaundice is whether the hyperbilirubinaemia is conjugated or unconjugated. If the conjugated bilirubin is over 30 micromol/L then it is a conjugated hyperbilirubinaemia which is always significant and serious. It needs urgent investigation and management and referral to a tertiary centre for review by a Neonatologist &/or Gastroenterologist.

The list of possible causes of conjugated hyperbilirubinaemia is very long (see Appendix 8). Unconjugated hyperbilirubinaemia is nearly always benign.

#### **Investigations should include:**

- Review for history suggestive of obstructive jaundice e.g. pale stools and dark urine that stain the nappy
- Total and direct (conjugated) bilirubin

- For unconjugated hyperbilirubinaemia
- Review mother's blood group and antibody status
- Blood group and DAT if not already done (interpret the result taking account of the strength of reaction and whether mother received prophylactic anti-D immunoglobulin during pregnancy)
- FBC
- Urine culture
- Ensure that routine metabolic screening (including screening for congenital hypothyroidism) has been performed
- Free T4 and TSH

## Assessment of Risk Factors for early Phototherapy and Exchange Transfusion

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The risk factors are listed in an earlier section [Risk Factors for Kernicterus](#). The presence of a risk factor should prompt use of the lower thresholds for phototherapy and exchange transfusion on the graphs.

The following investigations should be considered before performing exchange transfusion:

- Serum albumin level. Low albumin levels may be a risk factor for kernicterus
- Liver function tests (LFT)
- Conjugated bilirubin
- Newborn screening test (NBST)
- G6PD testing (not just screening)

**If the total SBR approaching exchange transfusion thresholds the clinical team should contact NETS**

## Documentation

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All investigation results must be documented on the appropriate HNELHD phototherapy charts according to their current gestation at time of investigation. There are 3 gestational phototherapy charts;

- < 29 weeks (see Appendix 3)
- 29 – 34+6 weeks (see Appendix 4)
- ≥ 35 weeks (see Appendix 5)

## Treatment of Neonatal Jaundice

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Severe hyperbilirubinaemia can be treated with:

- Phototherapy
- Exchange transfusion
- Pharmacological agents

Treatment should include general management of hydration in babies with excess weight loss (more than 10% of birth weight) and treatment of any underlying illnesses that may be causing jaundice (e.g. infection). Phototherapy and hydration management can occur in SCU, babies requiring an exchange transfusion or further management should be transferred to a tertiary centre.

## Phototherapy

Phototherapy is the first line treatment for neonatal jaundice and is effective in most babies in stabilising or reducing SBR level. Phototherapy should be initiated when the SBR (laboratory or blood gas machine) is above the phototherapy threshold shown on the graph appropriate to the baby's gestation at birth and postnatal age.

When administering phototherapy there are five key points to consider achieving effective treatment and decreasing the time of treatment. These are:

- Intensity of the light (irradiance output)
- Spectral qualities of the light source
- Distance between the light and the infant's skin
- Body surface area exposed (top and bottom lights will achieve high surface exposure)
- Impact of mother-infant separation

## Commencement guide

- SBR < 30 above treatment line commence on Biliblanket and observe the repeat SBR for response, with consideration to risk factors for haemolysis or steep rate of rise. If either are factors, commence as if the SBR > 30
- SBR > 30 above treatment line commence minimum of Biliblanket and one overhead unit positioned to provide maximum exposure
- Addition of an extra unit(s) if any of the following:
  - SBR levels close to exchange levels
  - Overhead phototherapy unit not providing adequate cover from head to toe

## Phototherapy side effects

Be aware that phototherapy can cause side effects to the infant including:

- Loose stools
- Dehydration
- Hyperthermia
- Lethargy
- Skin rashes
- Eye damage
- Bronze baby syndrome

## Phototherapy Equipment

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### The BiliSoft™ phototherapy blanket

The BiliSoft unit consists of a light box attached to a pole and a detachable fiber optic light pad with a long, flexible fiber optic cable (see Figure 2). The cable delivers light from a high intensity LED module in the light box to the fiber optic light pad. The blanket is covered with a soft BiliSoft pad cover and placed directly under the infant, either back or chest, ensuring the light emitting side is facing up (see Figure 3). This is the preferred method over the Bilibed due to the higher irradiance output. The irradiance delivered is up to 35uW/cm<sup>2</sup>/nm. Eyewear protection products are required for the baby when using this form of phototherapy (see Figures 10 & 11).



Figure 2: BiliSoft blanket (Picture from NICU, JHCH) Figure 3: Infant nursed on BiliSoft (Picture from Google images)

### Giraffe™ Spot Phototherapy (PT) lite

These phototherapy lights are attached to giraffe incubators, available in both a blue or white light option (see Figure 4). The white spot PT lite has an irradiance of output of  $35\text{uW}/\text{cm}^2/\text{nm}$ , and the blue spot PT lite has a higher irradiance output at  $45\text{uW}/\text{cm}^2/\text{nm}$ . Both lights need to be positioned 38cms above the infant. Both of these phototherapy lights can generate varying heat levels, so it is recommended that any infant receiving phototherapy treatment with these lights be nursed on servo temperature mode to ensure overheating of the infant does not occur. Eyewear protection products are required for the baby when using this form of phototherapy (see Figures 10 & 11).



Figure 4: Giraffe Spot Phototherapy light (Picture from NICU, JHCH)

### Natus Neoblue Mini™

The Natus Neoblue Mini is a condensed unit with a flexi-arm that attaches to either a mobile pole or bed pole (see Figure 5). It can be tilted to achieve direct light of the infant, and it is not to be placed directly under radiant heaters. This light needs to be positioned 30cm above the infant. The irradiance is  $30\text{uW}/\text{cm}^2/\text{nm}$ . Eyewear protection products are required for the baby when using this form of phototherapy (see Figures 10 & 11).

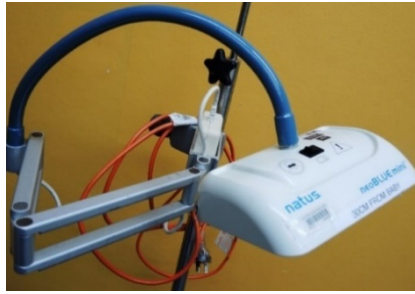


Figure 5: Natus Neoblue mini (Picture from NICU, JHCH)

### **Natus Neoblue™**

Natus Neoblue is a freestanding unit, it can be adjusted horizontally and vertically and can also be tilted to approximately 40 degrees (see Figure 6). This light is to be positioned 30cm above the infant. It can be set on low or high intensity. Irradiance settings are: low  $12\mu\text{W}/\text{cm}^2/\text{nm}$ , high  $30\mu\text{W}/\text{cm}^2/\text{nm}$ . Eyewear protection products are required for the baby when using this form of phototherapy (see Figures 10 & 11).



Figure 6: Natus Neoblue freestanding unit (Picture from NICU, JHCH)

### **MediLED mini™**

MediLED mini is a compact and portable unit that has padded suction feet that are fixed to the top of any incubator directly over the infant (see Figure 7). It has 3 intensity settings low, medium and high. The irradiance at these settings are low  $\geq 20\mu\text{W}/\text{cm}^2/\text{nm}$ , medium  $\geq 35\mu\text{W}/\text{cm}^2/\text{nm}$ , and high  $\geq 50\mu\text{W}/\text{cm}^2/\text{nm}$ . Eyewear protection products are required for the baby when using this form of phototherapy (see Figures 10 & 11).



Figure 7: MediLED mini (Picture from Google images)

### **GE Lullaby™**

This a compact and portable phototherapy unit that is omnidirectional with a tilt action to allow for use with incubators and open care systems (See Figure 8). The head unit is also removable from the portable trolley system for use on top of any incubator. It has 2 intensity settings, low and high. The irradiance output on the low settings is  $22\mu\text{W}/\text{cm}^2/\text{nm}$ , and for the higher setting is  $\geq 45\mu\text{W}/\text{cm}^2/\text{nm}$ . Eyewear protection products are required for the baby when using this form of phototherapy (see Figures 10 & 11).



Figure 8: GE Lullaby unit (Picture from Google images)

## Medela Bilibed™

A blue fluorescent tube is fitted into a plastic crib with a stretched plastic cover over the top for the baby to lie on. The baby is dressed in the Bili combi baby suit and nursed on the soft plastic cover (see Figure 9). The suit attaches to the crib by Velcro attachments. The irradiance delivered is  $30\text{uW/cm}^2/\text{nm}$ . Eyewear protection products are **not** required for the baby when using this form of phototherapy.



Figure 9: Medela Bilibed (Picture from Google images)

These can be used for infants who are:

- Well infants with physiological jaundice (i.e. jaundice appears after 24 to 48 hours of age)
- Infants with birth trauma – caput succedaneum, cephalohaematoma, bruising
- Initial mode of therapy whilst further investigations are awaited
- Infants previously admitted to a neonatal unit for phototherapy and the jaundice has been controlled

It is important to maintain the functionality of the equipment. This should be done by ensuring phototherapy units are serviced by local Bio-Medical Services 6 monthly with output of the device clearly recorded on the equipment.

## Procedure Considerations

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- Plot SBR result on **appropriate phototherapy chart for gestation**.
- Explain procedure and proposed treatment to mother/parents (give parent information sheet, see [link](#) in Appendix 2) and provide emotional support to the family.
- Encourage parents to continue with the same care plan including cares and feeding.
- Choose appropriate light source for the infant depending on the SBR level and medical orders.

- Prepare incubator/open care (if applicable) in the infant's neutral thermal zone due to being undressed.
- Remove the infant's clothes.
- Infants may lie on a nappy that is undone or partially secured to increase light exposure.
- Place infant into incubator or onto open care.
- Apply monitor leads if required (may need cardio-respiratory or saturation monitor or both depending on infants' history).
- Record baseline observations and time of commencement of phototherapy on plotted phototherapy chart appropriate for gestation.
- Monitor vital signs and temperature at least 4 hourly, more often if needed.
- Protect the infant's eyes with either Neoshades™ or Eyemax™ masks (see Figures 10 & 11).
- For Neoshades, place small circular tabs of Velcro & DuoDERM™ provided with masks on either side of the infant's head, near the temple and then place the shades over the top.
- Commence phototherapy, refer to specific phototherapy units irradiance output for selection of strongest and best available phototherapy unit.
- When infant is suck feeding phototherapy can cease for  $\leq 30$  minutes with medical team approval, and the eye shades are to be removed for parental baby bonding and observe for discharge/infection/damage and document any changes. If a Biliblanket is being used the infant can feed with the Biliblanket still in use, ideally swaddle the baby with the Biliblanket insitu to minimise eye strain for the mother/carer.
- Ensure infant has appropriate hydration ordered, or has their total fluid volume increased appropriately to prevent dehydration.
- Carefully observe the infant for signs of hypo/or hyperthermia.
- Assess skin integrity regularly due to an increase in urine output and bowel movements needed to excrete bilirubin.
- Ensure that phototherapy unit is turned off during collection of blood for TSB/SBR levels, as both conjugated and unconjugated bilirubin are photo-oxidized when exposed to white or ultraviolet light.
- Some caregivers, parents or staff, may be sensitive to the prolonged exposure to light from the phototherapy. This may include eye strain, nausea or headaches, and in this case manufacturer provided protective goggles may be used by the caregiver. Regular eye protection is not otherwise required for caregivers.



Figure 10: Neoshades eye protection (Picture from NICU, JHCH)



Figure 11: Eyemax shades (Picture from NICU, JHCH)

## Ongoing Monitoring and Stopping Phototherapy

[Top](#)

### Repeat Bilirubin after Starting Phototherapy

After initiating phototherapy measure SBR in 6 hours. This measure is to ensure phototherapy is effective and to gauge the rate of any continued rise in bilirubin level.

### Further Monitoring

Repeat SBR measurements are based on level, rate of rise of bilirubin, cause of jaundice and clinical situation. A suggested guide is below:

- If SBR is less than 30 above the line measure SBR again in 24 hours.
- If SBR is more than 30 above the phototherapy line and rising but more than 30 below exchange transfusion line measure SBR in 12 hours.
- If SBR is within 30 of the exchange transfusion line measure SBR again in 6 hours.
- Continue to measure SBR until level is more than 50 below phototherapy threshold.

### Ceasing Phototherapy

Stop phototherapy when the SBR is more than 50 units below the phototherapy line in use. A rebound in total serum bilirubin levels can occur after phototherapy is discontinued. Babies at increased risk of clinically significant rebound are those:

- Born at less than 37 weeks gestation or,
- With haemolytic disease.

**Repeat the SBR measurement 12 – 24 hours after stopping phototherapy**

### Restarting Phototherapy

Before restarting phototherapy the level should be at least 25 micromol/L above the phototherapy line.

## Discharge Planning for the Jaundiced Baby

[Top](#)

All newborns that are visibly jaundiced in the first 24 hours of life should be investigated as per guideline and must not be discharged until cause is known and jaundice is settling.

Never discharge a baby with a conjugated jaundice without attempting to find the cause and making appropriate referral and follow up arrangements.

All babies should be assessed for risk of developing severe hyperbilirubinaemia at hospital discharge. This assessment is particularly important if discharge occurs before 72 hours of age, as these babies are likely to still have a rising total serum bilirubin level. Kramer's rule has traditionally been used to visually assess the severity of jaundice. Visual estimation of bilirubin levels can lead to errors, especially in darkly pigmented babies and in infants who have received phototherapy. Transcutaneous bilirubinometers (see section above) may be useful to more accurately assess bilirubin levels.

### Parental Advice at Discharge

It is recommended that information be given to parents at the time of discharge. Mothers of jaundiced breastfed babies should be encouraged to breastfeed frequently (minimum of 3-4<sup>th</sup> hourly) and the baby should be woken to feed if necessary.

Parents should be advised to contact a healthcare professional/GP if:



- Baby becomes jaundiced
- Baby's jaundice is worsening
- Jaundice is persisting beyond 14 days
- Baby is passing pale stools

### **Re-admission for Phototherapy**

Commonly babies that rebound and require a repeat admission for phototherapy have underlying feeding issues. For this reason, it is important that in this event good lactation support is put into place.

Some newborn services have the option of engaging the Paediatric Hospital in the Home (pHITH) service. This service may be available to provide phototherapy care in the patient's home to support mother and baby feeding, please refer to your local HITH guideline for more guidance.

## IMPLEMENTATION PLAN

The clinical guideline will be:

- Circulated to General Managers and Sector Managers.
- Circulated to the clinicians via Tiered Neonatal Network/Newborn Services and the Children Young People and Families Services and the Women's Health and Maternity Network.
- Made available on the intranet (PPG) and HNEKidshealth website.
- Presented at facility units meetings and tabled for staff to action.

## MONITORING AND AUDITING PLAN

- The person or leadership team who has approved the clinical guideline is responsible for ensuring timely and effective review of the guideline.
- Evaluation will require a review of the most current evidence as well as consideration of the experience of HNELHD staff in the implementation of the clinical guideline.
- Data derived from monitoring and evaluation should inform the review of the clinical guideline either as required or scheduled.
- Implementation, education support and monitoring compliance be completed by local Clinical Educators and Managers.
- Amendments to the guideline will be ratified by the Manager and Head of Newborn Services and WHaM Networks prior to final sign off by the Children Young People and Families Services.

## CONSULTATION WITH KEY STAKEHOLDERS

<b>AUTHOR:</b>	<b>Jo Davis, CNC Newborn Services Dr Larissa Korostenski, Acting Head of Newborn Services Louise Bright, CMC Risk Management</b>
<b>REVIEWERS:</b>	Dr Paul Craven, Neonatologist, NICU JHCH Dr Javeed Travadi, Neonatologist, NICU JHCH Dr Koert De Waal, Neonatologist, NICU JHCH Jo Proctor, CNE, Special Care Unit, The Maitland Hospital Siubhan McCaffrey, CMC Northern, Tamworth Hospital Sarah Whyte, CME Tablelands, Glen Innes Hospital Sinead Redman, Manager Newborn Services, NICU JHCH
<b>CONSULTATION:</b>	Tiered Neonatal Network/Newborn Services HNELHD Women's Health and Maternity Services Network Children, Young People and Family Services
<b>APPROVED BY:</b>	Sinead Redman, Manager Newborn Services, NICU JHCH Dr Larissa Korostenski, Acting Head of Newborn Services, NICU JHCH Dr Paul Craven, Executive Director, CYPFS

## APPENDICES

1. Abbreviations & Glossary
2. Parent information sheet – Jaundice in Newborn Babies  
[http://www.schn.health.nsw.gov.au/files/factsheets/jaundice\\_in\\_newborn\\_babies-en.pdf](http://www.schn.health.nsw.gov.au/files/factsheets/jaundice_in_newborn_babies-en.pdf)
3. Phototherapy Chart:  $\leq 29^0$  weeks
4. Phototherapy Chart:  $29^0$  to  $34^{+6}$  weeks
5. Phototherapy Chart:  $\geq 35^0$  weeks
6. Causes of Neonatal Hyperbilirubinaemia according to Mechanism (Table)
7. Classification of Hyperbilirubinaemia
8. Causes of Conjugated Hyperbilirubinaemia
9. Differential Diagnosis of Neonatal Cholestasis

**OTHER USEFUL LINKS**

- [HNELHD PD 2017\\_032:PCP 2 Clinical Procedure Safety \(Levels 1, 2 and 3\)](#)
- [NSW Health PD 2017\\_013 Infection Prevention and Control Policy](#)

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12. Ohmeda Medical. Giraffe Spot Phototherapy Lite, Operation and Maintenance Manual. <https://www.manualslib.com/manual/1525194/Ohmeda-Giraffe-Spot-Pt-Lite.html>

**FEEDBACK**

Any feedback on this document should be sent to the Contact Officer listed on the front page.

## APPENDIX ONE

## ABBREVIATIONS &amp; GLOSSARY

Acronym or Term	Definition
ABO incompatibility	Breakdown of red blood cells in baby if mother and baby's blood types are incompatible and antibodies are formed
Bilirubin	Yellow pigment created in the body during the normal breakdown of red blood cells which leads to the production of unconjugated bilirubin
CNS	Central Nervous System
Conjugated Bilirubin	Unconjugated bilirubin is taken up by the liver cells and conjugated to form water soluble bilirubin di-glucuronide
DAT	Direct antiglobulin test-(also called Coombs test)-looks for antibodies that stick to RBCs and lead to haemolysis
GP	General Practitioner
G6PD deficiency	Glucose-6-phosphate dehydrogenase deficiency - Inherited condition where a lack of enzyme occurs that protects the red blood cell leading to haemolysis
Hyperbilirubinaemia	SBR measurement above that which requires treatment to prevent encephalopathy and kernicterus
Jaundice	Yellow colouration of the skin and sclera
Local CERS	Local specific Clinical Emergency Response System (CERS) process should be in place to escalate care and access a senior medical officer or specialist paediatrician who has the care of the neonate incorporated in their scope of practice, and if required, speciality paediatric/neonatal expertise
Neonate	Any baby from birth up to and including 28 days
Pathological jaundice	When non-physiological causes result in jaundice of the neonate, most commonly due to blood group incompatibility (ABO or rhesus blood group incompatibility). Other causes include sepsis, bruising, metabolic disorders or obstruction. High conjugated fraction (> 20 micromol per litre (micromol/L) or > 20% of total SBR) is always pathological and should be investigated urgently
Physiological jaundice	Jaundice occurring in health newborns with no apparent cause and not requiring treatment
Preterm	A baby born before 37 weeks gestation
Severe hyperbilirubinaemia	SBR measurement above exchange transfusion level
SBR	Total Serum Bilirubin

**Neonatal Jaundice: Identification and Management HNELHD CG 19\_40**

SCU	Special Care Unit
NICU	Neonatal Intensive Care Unit
TcB	Transcutaneous Bilirubin - estimation by transcutaneous bilirubinometer
T4 & TSH	Thyroid hormones - jaundice with low levels of T4 & Thyroid stimulating hormone may indicate hypothyroidism or hypopituitarism
TORCH	Infections, collectively grouped under the acronym TORCH for Toxoplasmosis, Other organisms (parvovirus, HIV, Epstein-Barr, herpes 6 and 8, varicella, syphilis, enterovirus), Rubella, Cytomegalovirus and Hepatitis
Unconjugated bilirubin	The lipid –soluble form of bilirubin that binds to albumin and is metabolised in the liver to form conjugated bilirubin
pHITH	Paediatric Hospital in the Home
PT	Phototherapy

APPENDIX TWO

PARENT INFORMATION SHEET

# FACTSHEET

This fact sheet is for education purposes only. Please consult with your doctor or other health professionals to make sure this information is right for your child. If you would like to provide feedback on this fact sheet, please visit: [www.schn.health.nsw.gov.au/parents-and-carers/fact-sheets/feedback-form](http://www.schn.health.nsw.gov.au/parents-and-carers/fact-sheets/feedback-form).

## Jaundice in newborn babies

### What is jaundice?

Jaundice is a yellow colouration of the skin and the whites of the eyes. Visible jaundice occurs in nearly a half of all normal newborn babies. It usually does not cause problems and generally fades by the end of the first week after birth. If the jaundice appears within 24 hours of birth, or is still present after 2 weeks, contact your doctor or local hospital.

### What causes the yellow colour?

In the human body, new blood is being made all the time and old blood is being destroyed. One of the products of destroyed red blood cells is called bilirubin. Bilirubin normally goes to the liver to be processed (called conjugation) and then leaves the body in the poo. For the first few days after birth your baby's liver does not work as well as it does later, so there tends to be a build-up of bilirubin in the blood. This causes the yellow colour in the skin and whites of the eyes.

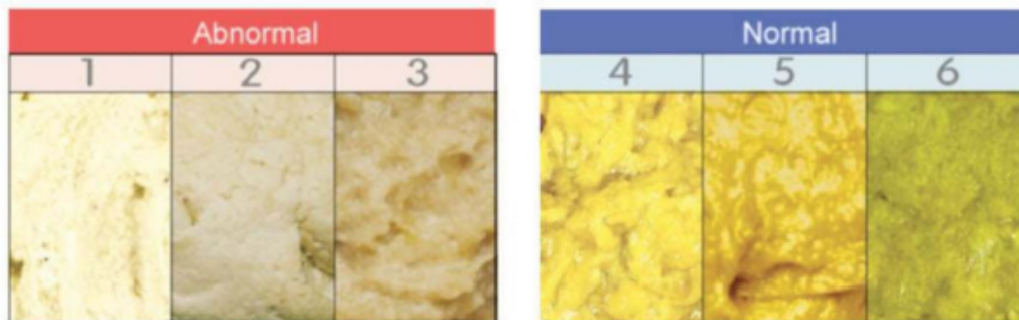
### Is jaundice harmful?

For most babies, jaundice is not harmful. Very high levels of unprocessed (unconjugated) bilirubin in the blood can lead to hearing problems and brain damage. In hospital, care is taken to ensure that the bilirubin level does not get too high. Sometimes babies will require treatment if the levels are too high. The commonest treatment in this situation involves keeping the baby under special lights (called phototherapy).

Prolonged jaundice may also be due to illnesses such as urinary tract infection, thyroid problems or liver disease. This is why it is important to contact your local doctor if jaundice is prolonged (lasting longer than 2 weeks).

### Liver disease – the importance of poo colour

One of the signs of liver disease would be your baby's poo being very pale rather than a rich yellow, green or brown colour. If your baby is jaundiced and has pale poo, as in examples 1, 2 or 3 in the stool colour card below, please take your baby to the doctor for assessment.



We thank the Health Promotion Administration, Taiwan Ministry of Health and Welfare and Professor Mei-Hwei Chang for authorizing the use of the Taiwan Stool Color Card image above.



The Sydney children's Hospitals Network



The Sydney children's Hospitals Network



Children, Young People & Families

This document was last reviewed on 1 August 2018

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### What tests might be needed?

A urine test to rule out infection and a blood test to look at thyroid function may be required. A blood test to check the bilirubin levels (BOTH total and conjugated fractions) is the best way to know if a liver problem is present.

The presence of bilirubin in a urine analysis is another means of assessing for conjugated bilirubin, which suggests that liver disease is causing the baby's jaundice.

**Jaundice due to liver disease needs to be investigated immediately so that appropriate treatment can be started.**

### Which babies are more likely to have jaundice?

Babies who may be more likely to get jaundice include:

- Premature babies.
- Babies with an infection, such as a urinary tract infection.
- Rhesus or Rh babies. The blood cells of a baby who has a different blood group from their mother may be destroyed more rapidly, resulting in jaundice.
- Babies who are breast fed may also have prolonged jaundice for up to 4 weeks or more, for reasons that are not completely understood. However this is a "diagnosis of exclusion" and it should not be automatically accepted that breast milk is the cause of a baby's prolonged jaundice.
- Babies with liver disease. These babies might look otherwise well in the early stages. It is very important to look at the colour of the baby's stool. If it is pale, the baby should have a blood test to check whether the level of processed (conjugated) bilirubin. If this is elevated, the baby needs to be referred to a specialist doctor called a paediatric gastroenterologist as soon as possible. One of the commonest liver diseases to cause jaundice in babies is a condition called Biliary Atresia.

### Measuring how much jaundice the baby has

A blood test checks the bilirubin level. Some hospitals also use an instrument placed on your baby's skin as a screening test to help decide if a blood test is needed.

A blood test is required to determine if the jaundice is due to liver disease. This requires measurement of liver function tests, plus both the total and the conjugated fraction of bilirubin.

Note: Many labs may measure just the total bilirubin unless the conjugated fraction is specifically requested by the doctor.

Hospital staff will do a blood test if:

- There are risk factors present such as prematurity.

- Jaundice is present within the first day of life.
- Jaundice is extensive
- Persisting jaundice beyond two weeks of age
- Jaundice is associated with pale poos

### Treatment

Mild jaundice in the first week needs no treatment except fluids. Good fluid intake is essential for newborn babies, as jaundice is often exaggerated with mild dehydration.

Moderate jaundice is treated by placing your baby naked (with a protective mask over the eyes) under a bright light or a bluish-coloured light. This is called phototherapy and can be delivered safely in many different ways. The phototherapy light breaks down the bilirubin in the skin and makes the jaundice fade. This light treatment may cause your baby to have loose poos. This is dealt with by increasing your baby's fluid intake. Unsupervised exposure to direct sunlight is not recommended, as it can be harmful causing sunburn.

In severe jaundice your baby may need to have a special blood transfusion in which your baby's blood is replaced (exchanged) with fresh blood to wash the bilirubin out of the system.

If there is evidence of liver disease (pale stools, dark urine, elevated conjugated bilirubin, abnormal liver function tests) then immediate referral to a Paediatric Gastroenterologist is required.

### Are there any long term problems from jaundice?

There are usually no long-term problems following jaundice in babies. Babies who have had high levels of jaundice should have their hearing checked at regular intervals. This is best discussed with your doctor or early childhood nurse. Brain damage due to very high levels of jaundice is now extremely rare because the levels are carefully monitored during the first few days of life in hospital or at home with an early discharge program.

#### Remember:

- If jaundice persists after 2 weeks, contact your doctor or local hospital.
- Although breast milk is a common cause of prolonged jaundice, your doctor or hospital should also consider other causes such as liver disease.
- Pale stools and dark urine can indicate liver disease. In this situation it is important to have a blood test to check the total and conjugated bilirubin levels, and liver function tests.

APPENDIX THREE: PHOTOTHERAPY CHART < 29<sup>0</sup> WEEKS



HUNTER NEW ENGLAND LOCAL HEALTH DISTRICT

Facility: \_\_\_\_\_

PHOTOTHERAPY AND EXCHANGE TRANSFUSION GUIDE - GESTATION AT BIRTH <29<sup>0</sup> WEEKS

BINDING MARGIN – DO NOT WRITE

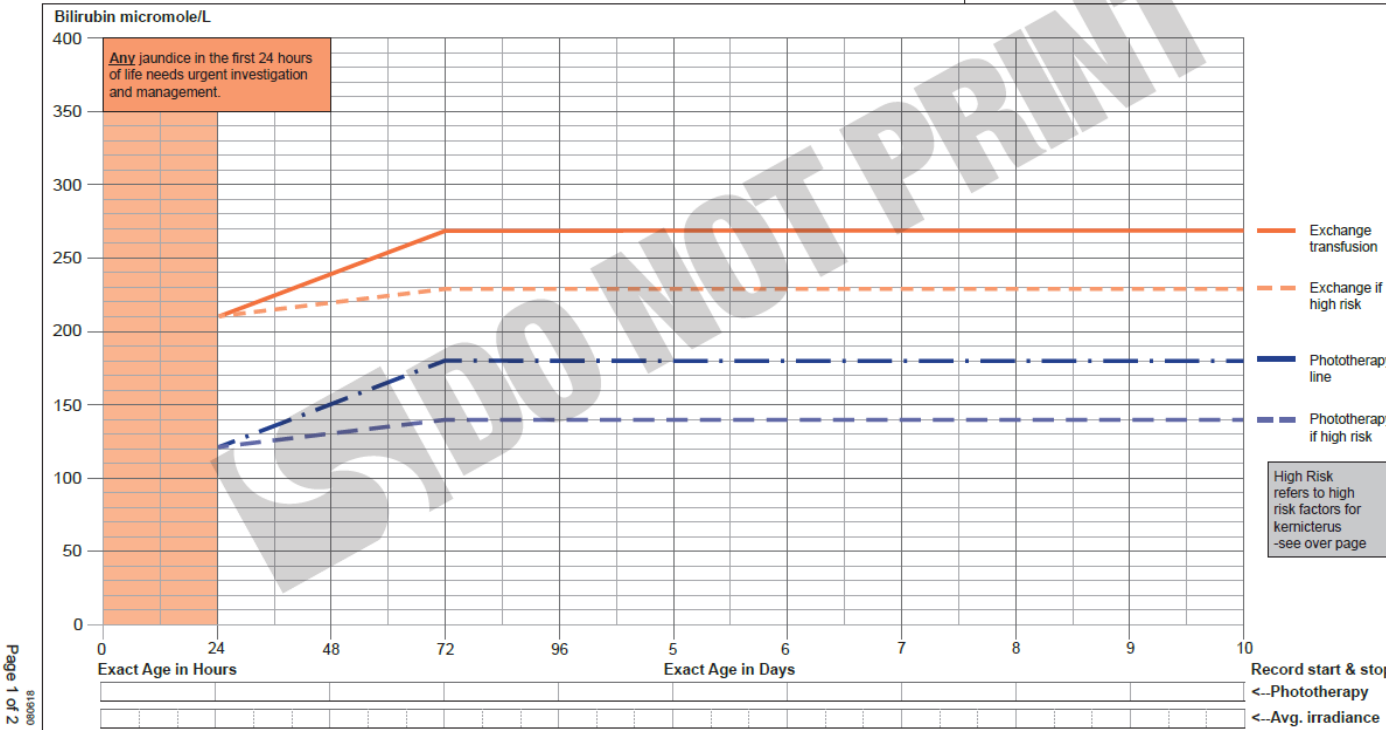
Time of birth: \_\_\_\_\_ hrs

Maternal blood group: \_\_\_\_\_

Babies blood group: \_\_\_\_\_

DAT: \_\_\_\_\_

FAMILY NAME		MRN
GIVEN NAME		<input type="checkbox"/> MALE <input type="checkbox"/> FEMALE
D.O.B. ____/____/____	M.O.	
ADDRESS		
LOCATION / WARD		
COMPLETE ALL DETAILS OR AFFIX PATIENT LABEL HERE		



Page 1 of 2

Paediatrics

PHOTOTHERAPY AND EXCHANGE TRANSFUSION GUIDE - GESTATION AT BIRTH <29<sup>0</sup> WEEKS

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BINDING MARGIN – DO NOT WRITE

HUNTER NEW ENGLAND LOCAL HEALTH DISTRICT

Time of birth: \_\_\_\_\_ hrs

Facility: \_\_\_\_\_

Maternal blood group: \_\_\_\_\_

Babies blood group: \_\_\_\_\_

DAT: \_\_\_\_\_

**PHOTOTHERAPY AND EXCHANGE TRANSFUSION  
GUIDE - GESTATION AT BIRTH <29<sup>o</sup> WEEKS**

FAMILY NAME		MRN
GIVEN NAME		<input type="checkbox"/> MALE <input type="checkbox"/> FEMALE
D.O.B. ____/____/____	M.O.	
ADDRESS		
LOCATION / WARD		
COMPLETE ALL DETAILS OR AFFIX PATIENT LABEL HERE		

**Risk Factors for Kernicterus**

- Rapidly rising bilirubin level (>8 micromol/L/hour)
- Isoimmune haemolytic disease
- G6PD deficiency
- Acidosis (pH<7.2)
- Proven sepsis
- Asphyxia (Sarnat stage 2 or more)
- A generally unwell neonate - temperature instability, significant lethargy

**Bilirubin Results in the first 24 hours**

If a SBR in the first 24 hours is over 80 micromol/L then a repeat bilirubin should be done in 4 to 6 hours and the jaundice guideline consulted for further advice. If still in doubt consult the neonatologist.

**Bilirubin Results from Gas Machine and Laboratory**

If concurrent samples have been obtained, action according to the laboratory result (regarded as the gold standard) If concurrent results are widely discrepant repeat the test on a venous sample



APPENDIX FOUR: PHOTOTHERAPY CHART 29<sup>0</sup> - 34<sup>+6</sup> WEEKS



HUNTER NEW ENGLAND LOCAL HEALTH DISTRICT

Facility: \_\_\_\_\_

PHOTOTHERAPY AND EXCHANGE TRANSFUSION  
GUIDE - GESTATION AT BIRTH 29<sup>0</sup> - 34<sup>+6</sup> WEEKS

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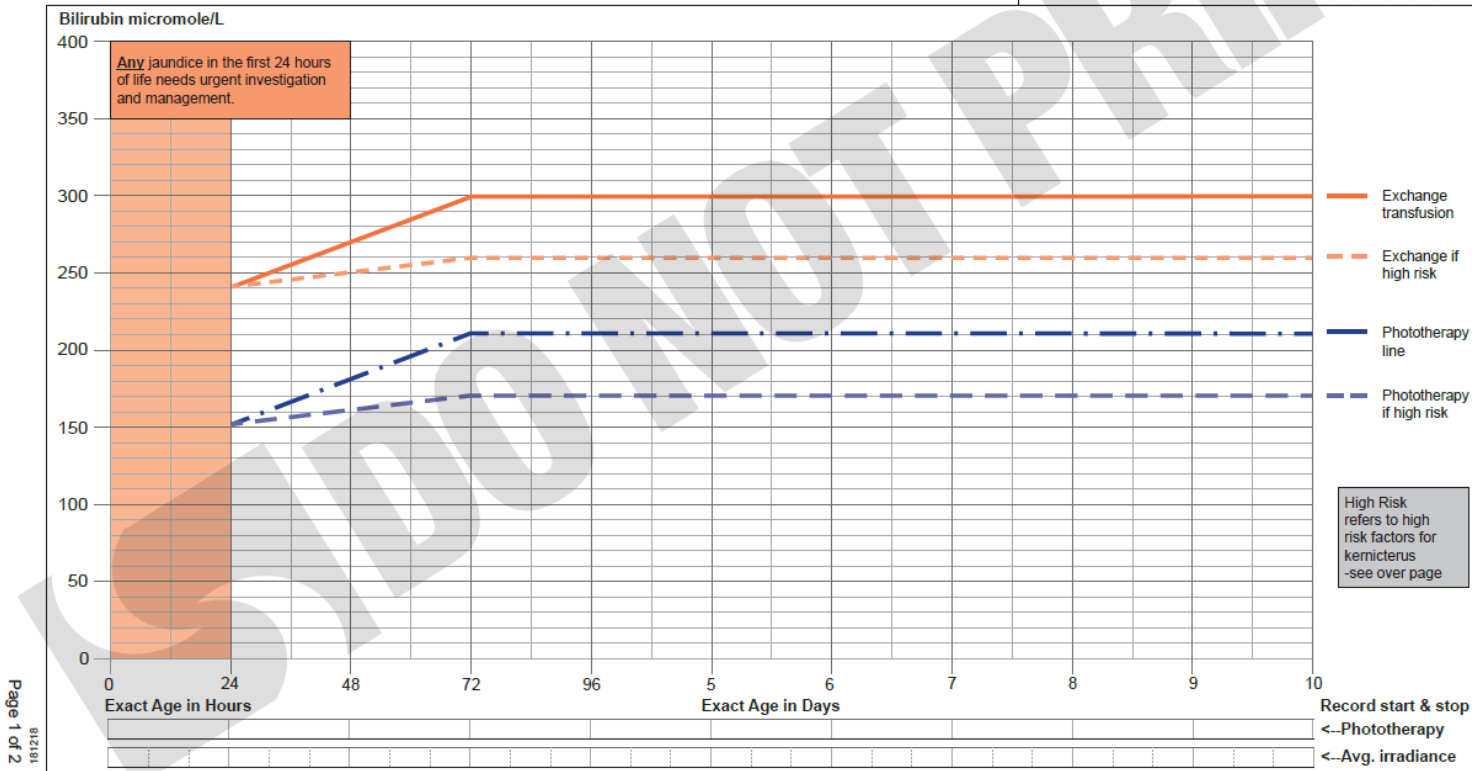
Time of birth: \_\_\_\_\_ hrs

Maternal blood group: \_\_\_\_\_

Babies blood group: \_\_\_\_\_

DAT: \_\_\_\_\_

FAMILY NAME	MRN
GIVEN NAME	<input type="checkbox"/> MALE <input type="checkbox"/> FEMALE
D.O.B. ____/____/____	M.O.
ADDRESS	
LOCATION / WARD	
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Page 1 of 2

Paediatrics

PHOTOTHERAPY AND EXCHANGE TRANSFUSION  
GUIDE - GESTATION AT BIRTH 29<sup>0</sup> - 34<sup>+6</sup> WEEKS

HNEMR295A



BINDING MARGIN – DO NOT WRITE

HUNTER NEW ENGLAND LOCAL HEALTH DISTRICT

Time of birth: \_\_\_\_\_ hrs

Facility: \_\_\_\_\_

Maternal blood group: \_\_\_\_\_

Babies blood group: \_\_\_\_\_

DAT: \_\_\_\_\_

**PHOTOTHERAPY AND EXCHANGE TRANSFUSION  
GUIDE - GESTATION AT BIRTH 29<sup>0</sup> - 34<sup>6</sup> WEEKS**

FAMILY NAME		MRN
GIVEN NAME		<input type="checkbox"/> MALE <input type="checkbox"/> FEMALE
D.O.B. ____/____/____	M.O.	
ADDRESS		
LOCATION / WARD		
COMPLETE ALL DETAILS OR AFFIX PATIENT LABEL HERE		

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Paediatrics

**PHOTOTHERAPY AND EXCHANGE TRANSFUSION  
GUIDE - GESTATION AT BIRTH 29<sup>0</sup> - 34<sup>6</sup> WEEKS**

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**APPENDIX FIVE: PHOTOTHERAPY CHART ≥ 35<sup>0</sup> WEEKS**



BINDING MARGIN – DO NOT WRITE

HUNTER NEW ENGLAND LOCAL HEALTH DISTRICT

Time of birth: \_\_\_\_\_ hrs

Facility: \_\_\_\_\_

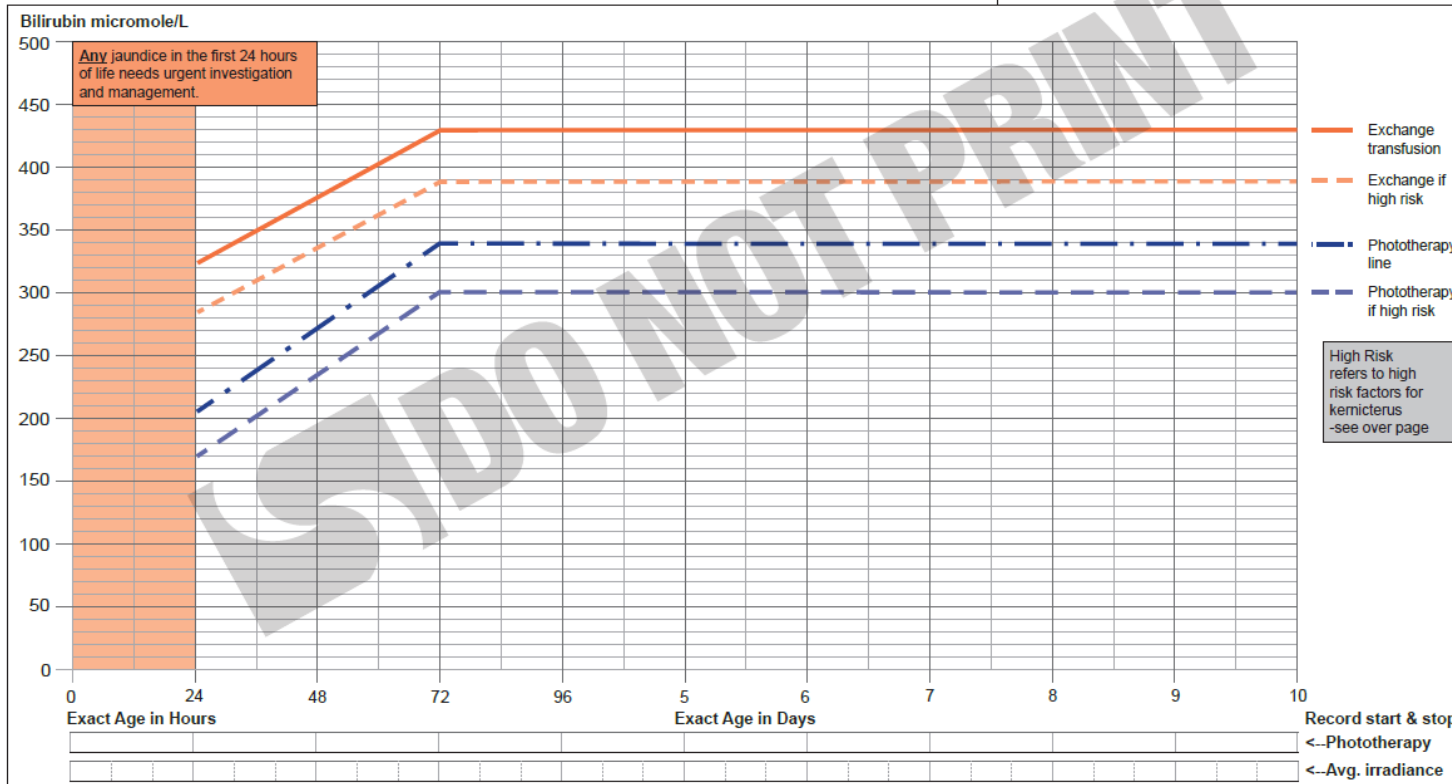
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Babies blood group: \_\_\_\_\_

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**PHOTOTHERAPY AND EXCHANGE TRANSFUSION  
GUIDE - GESTATION AT BIRTH ≥35<sup>0</sup> WEEKS**

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GIVEN NAME		<input type="checkbox"/> MALE <input type="checkbox"/> FEMALE
D.O.B. ____/____/____	M.O.	
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**PHOTOTHERAPY AND EXCHANGE TRANSFUSION  
GUIDE - GESTATION AT BIRTH ≥35<sup>0</sup> WEEKS**

HNEMR2008



BINDING MARGIN – DO NOT WRITE

HUNTER NEW ENGLAND LOCAL HEALTH DISTRICT

Time of birth: \_\_\_\_\_ hrs

Facility: \_\_\_\_\_

Maternal blood group: \_\_\_\_\_

Babies blood group: \_\_\_\_\_

DAT: \_\_\_\_\_

**PHOTOTHERAPY AND EXCHANGE TRANSFUSION  
GUIDE - GESTATION AT BIRTH  $\geq 35^0$  WEEKS**

FAMILY NAME		MRN
GIVEN NAME		<input type="checkbox"/> MALE <input type="checkbox"/> FEMALE
D.O.B. ___/___/___	M.O.	
ADDRESS		
LOCATION / WARD		
COMPLETE ALL DETAILS OR AFFIX PATIENT LABEL HERE		

**Risk Factors for Kernicterus**

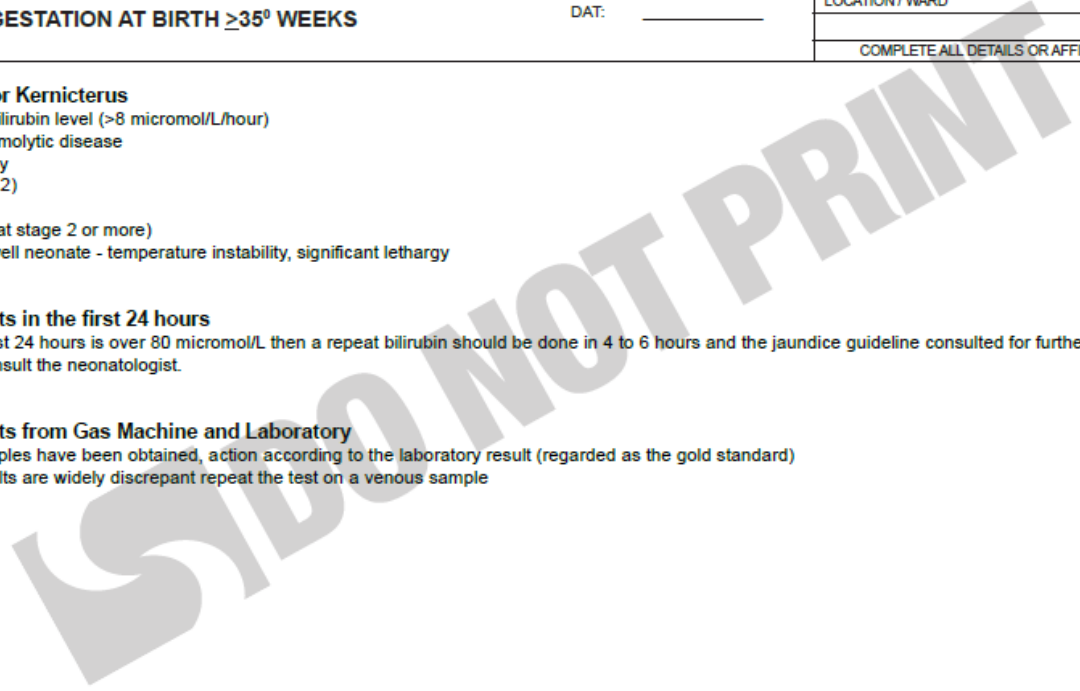
- Rapidly rising bilirubin level (>8 micromol/L/hour)
- Isoimmune haemolytic disease
- G6PD deficiency
- Acidosis (pH<7.2)
- Proven sepsis
- Asphyxia (Sarnat stage 2 or more)
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**Bilirubin Results from Gas Machine and Laboratory**

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610327

Paediatrics

PHOTOTHERAPY AND EXCHANGE TRANSFUSION  
GUIDE - GESTATION AT BIRTH  $\geq 35^0$  WEEKS

HNEMR2958

## APPENDIX SIX

## CAUSES OF NEONATAL HYPERBILIRUBINAEMIA ACCORDING TO MECHANISM

Mechanism	Causes
Increased enterohepatic circulation	Breast milk (breast milk jaundice) Breastfeeding failure (breastfeeding jaundice) Drug-induced paralytic ileus (Mg sulfate or morphine) Fasting or other cause for hypoperistalsis Hirschsprung's disease Intestinal atresia or stenosis, including annular pancreas Meconium ileus or meconium plug syndrome Pyloric stenosis* Swallowed blood
Overproduction	Breakdown of extravascular blood (e.g., hematomas; petechiae; pulmonary, cerebral, or occult hemorrhage) Polycythemia due to materno-fetal or feto-fetal transfusion or delayed umbilical cord clamping
Overproduction due to hemolytic anemia	Certain drugs and agents in neonates with G6PD deficiency (e.g. acetaminophen, alcohol, antimalarials, bupivacaine, corticosteroids, diazepam, nitrofurantoin, oxytocin, penicillin, phenothiazine, sulfonamides) Materno-fetal blood group incompatibility (e.g. Rh, ABO), RBC enzyme deficiencies (e.g. of G6PD or pyruvate kinase) Spherocytosis Thalassemias ( $\alpha$ , $\beta$ - $\gamma$ )
Under secretion due to biliary obstruction	$\alpha_1$ -Antitrypsin deficiency* Biliary atresia* Choledochal cyst* Cystic fibrosis* ( inspissated bile) Dubin-Johnson syndrome and Rotor's syndrome* Parenteral nutrition Tumor or band* (extrinsic obstruction)
Under secretion due to metabolic-endocrine conditions	Crigler-Najjar syndrome (familial non-hemolytic jaundice types 1 and 2) Drugs and hormones Gilbert syndrome (see <a href="#">Gilbert Syndrome</a> ) Hypermethioninemia Hypopituitarism and anencephaly Hypothyroidism Lucey-Driscoll syndrome Maternal diabetes Prematurity Tyrosinosis
Mixed overproduction and under secretion	Asphyxia Intrauterine infections Maternal diabetes Respiratory distress syndrome Sepsis Severe erythroblastosis fetalis Syphilis TORCH infections
*Jaundice may also occur outside the neonatal period. TORCH = toxoplasmosis, other pathogens, rubella, cytomegalovirus, and herpes simplex. Adapted from Poland RL, Ostrea EM Jr: Neonatal hyperbilirubinemia. In <i>Care of the High-Risk Neonate</i> , ed. 3, edited by MH Klaus and AA Fanaroff. Philadelphia, WB Saunders Company, 1986.	

## APPENDIX SEVEN

### CLASSIFICATION OF HYPERBILRUBINAEMIA

#### Non Conjugated Hyperbilirubinaemia

##### Hemolytic

##### Intrinsic causes of hemolysis

- Membrane conditions
  - Spherocytosis
  - Hereditary elliptocytosis
- Systemic conditions
  - Sepsis
  - Arteriovenous malformation
- Enzyme conditions
  - Glucose-6-phosphate dehydrogenase deficiency (also called G6PD deficiency)
  - Pyruvate kinase deficiency
- Globin synthesis defect
  - sickle cell disease
  - Alpha-thalassemia, e.g. HbH disease

##### Extrinsic causes of hemolysis

- Alloimmunity (The neonatal or cord blood gives a positive direct Coombs test and the maternal blood gives a positive indirect Coombs test)
  - Hemolytic disease of the newborn (ABO)
  - Rh disease
  - Hemolytic disease of the newborn (anti-Kell)
  - Hemolytic disease of the newborn (anti-Rhc)
  - Other blood type mismatches causing hemolytic disease of the newborn

##### Non-hemolytic causes

- Breast milk jaundice
- Cephalohematoma
- Polycythemia
- Urinary tract infection
- Sepsis
- Hypothyroidism
- Gilbert's syndrome
- Crigler-Najjar syndrome
- High GI obstruction

#### Conjugated (Direct) Hyperbilirubinaemia

##### Hepatic causes

- Infections
  - Sepsis
  - Hepatitis A
  - Hepatitis B
  - TORCH infections
- Metabolic
  - Galactosaemia
  - Alpha-1-antitrypsin deficiency, which is commonly missed, and must be considered in DDx
  - Cystic fibrosis
  - Dubin-Johnson Syndrome
  - Rotor syndrome
- Drugs
- Total parenteral nutrition
- Idiopathic

##### Post-hepatic

- Biliary atresia or bile duct obstruction
  - Alagille syndrome
  - Choledochal cyst

##### Non-organic causes

Breastfeeding failure jaundice

## APPENDIX EIGHT

### CAUSES OF CONJUGATED HYPERBILIRUBINAEMIA

#### 1. Presentation with acute liver failure (unwell neonate)

Galactosaemia

Tyrosinaemia

Congenital and acquired infection

Bacterial, Herpes virus,

Coxsackie virus

ECHO virus, Hepatitis B,

Adenovirus, CMV,

Toxoplasma, *Treponema pallidum*

Neonatal haemochromatosis

Mitochondrial diseases

Familial haemophagocytic lymphocytic histiocytosis

#### 2. Well-term neonate

##### *i) Intrahepatic causes*

Alpha-1 antitrypsin

deficiency

Cystic fibrosis

Progressive familial intrahepatic cholestasis

Alagille syndrome

Endocrine causes

Hypothyroidism

Hypopituitarism

Storage diseases

Zellweger's syndrome

Wolman's syndrome

Niemman Pick type C

Gaucher's disease

Neonatal hepatitis

Bile acid oxidation defects

PN associated liver disease

Other systemic causes

Urinary tract infection

Trisomy 13 or Trisomy 18

Ischaemia ('shock liver')

##### *ii) Extrahepatic causes*

Biliary atresia

Choledochal cyst

Inspissated bile syndrome



## APPENDIX NINE

### DIFFERENTIAL DIAGNOSIS OF NEONATAL CHOLESTASIS

- 1) Idiopathic neonatal hepatitis
- 2) Infections
  - Viral:
    - Cytomegalovirus
    - Rubella
    - Reovirus3
    - Adenovirus
    - Coxsackie virus
    - Human herpes virus 6
    - Varicella zoster
    - Herpes simplex
    - Parvovirus
    - Hepatitis B and C
    - Human immuno-deficiency virus
  - Bacterial:
    - Sepsis
    - Urinary tract infection
    - Syphilis
    - Listeriosis
    - Tuberculosis
  - Parasitic:
    - Toxoplasmosis
    - Malaria
- 3) Bile duct anomalies
  - Biliary atresia
  - Choledochal cyst
  - Alagille syndrome
  - Non syndromic bile duct paucity
  - Inspissated bile syndrome
  - Caroli syndrome
  - Choledocholithiasis
  - Neonatal sclerosing cholangitis
  - Spontaneous common bile duct perforation
- 4) Metabolic disorders
  - $\alpha_1$ -antitrypsin deficiency
  - Galactosaemia
  - Glycogen storage disorder type IV
  - Cystic fibrosis
  - Hemochromatosis
  - Tyrosinaemia
  - Arginase deficiency
  - Zellweger's syndrome
  - Dubin-Johnson syndrome
  - Rotor syndrome
  - Hereditary fructosaemia
  - Niemann Pick disease, type C
  - Gaucher's disease
  - Bile acid synthetic disorders
  - Progressive familial intrahepatic cholestasis
  - North American Indian familial cholestasis
  - Agenaes syndrome
  - X-linked adreno-leukodystrophy
- 5) Endocrinopathies
  - Hypothyroidism
  - Hypopituitarism (Septo-optic dysplasia)
- 6) Chromosomal disorders
  - Turner's syndrome
  - Trisomy 18
  - Trisomy 21
  - Trisomy 13
  - Cat-eye syndrome

**APPENDIX NINE**

**DIFFERENTIAL DIAGNOSIS OF NEONATAL CHOLESTASIS (continued)**

- Donahue's syndrome (Leprechauns)
- 7) Toxic
  - Parenteral nutrition
  - Fetal alcohol syndrome
  - Drugs
- 8) Vascular
  - Budd-Chiari syndrome
  - Neonatal asphyxia
  - Congestive heart failure
- 9) Neoplastic
  - Neonatal leukaemia
  - Histiocytosis X
  - Neuroblastoma
  - Hepatoblastoma
  - Erythrophagocytic lymphohistiocytosis
- 10) Miscellaneous
  - Neonatal lupus erythematosus
  - 'Le foie vide' (infantile hepatic non regenerative disorder)
  - Indian childhood cirrhosis