

Phototherapy

INTRODUCTION

- Phototherapy has been used since 1958 for the treatment of neonatal hyperbilirubinaemia.¹ It causes unconjugated bilirubin to be mobilised from the skin by structural isomerisation to a water soluble form (lumirubin) that can be excreted in the urine.²
- The aim of phototherapy is to decrease the level of unconjugated bilirubin in order to prevent acute bilirubin encephalopathy, hearing loss and kernicterus.³
- Lamps emitting light between the wavelengths of 400 - 500 nanometres (peak at 460nm) are specifically used for administering phototherapy as bilirubin absorbs this wavelength of light. The light is visible blue light and contains no ultraviolet light.²
- The decision to start phototherapy is based on the level and rate of rise of serum bilirubin, the gestational and postnatal age of infant and the underlying cause of the hyperbilirubinaemia.
- Factors that influence the efficacy of phototherapy include: the light wavelength and irradiance, bilirubin level, birthweight, gestational age, postnatal age, surface area exposed, skin thickness and pigmentation and the etiology of the jaundice. ^{2, 3, 4}
- Once the decision to administer phototherapy is taken, both the required **dose** and the most appropriate **method** of delivery should be determined.

IRRADIANCE

- There are several methods of delivering phototherapy, all of which administer different dosages of spectral irradiance (light intensity) to the infant.
- The only way to ascertain the actual dose received is to measure the irradiance at the skin with a phototherapy radiometer. We have a Minolta Fluoro-Lite Meter 451 (Air-Shields Drager) which measures light in the 400 - 480 nm bandwidth of the spectrum.
- It is best to use the radiometer designed by the manufacturer for their specific phototherapy device.³
- The irradiance level varies depending on where the measurement is taken. The irradiance should be measured in 3 places where the infant will be lying and an average of the measurements should be made.³
- The irradiance decreases exponentially as the distance from the baby increases.³
- The higher the irradiance the larger the rate of bilirubin decline.³
- There may be a saturation point at 30m W/cm²/nm where an increase in irradiance has no increased benefit in decreasing bilirubin levels.^{3, 5} But, currently we do not know the maximum effective dose of phototherapy.³
- The current AAP guidelines suggest that if intensive phototherapy is required then blue lights should be used to deliver at least 30m W/cm²/nm to the greatest surface area available. ³

MEASURING THE IRRADIANCE

- Turn on the light source.
- Turn the radiometer on and follow the instructions on the box.
- The radiometer should read between 0.5 to 0.9 m W/cm²/nm under normal fluorescent ceiling lights.
- Hold the radiometer near the infants skin, at the abdomen or back and the reading will stabilise.
- Document the dosage e.g. 15 m W/cm²/nm when the infant is commenced on phototherapy on the orange Neonatal Jaundice chart next to the date and time of commencement.
- Aim for an irradiance of >12 m W/cm²/nm
- Clean the radiometer with Lemex before and after use

- Measure the irradiance daily

PHOTOTHERAPY LIGHTS USED IN NEWBORN CARE



Micro-Lite White Halogen lights

These should be positioned above the infant and can deliver 10 to 30 m W/cm²/nm. They deliver light via a quartz halogen bulb and have a tendency to become quite hot so should not be positioned closer to the infant than the manufacturers recommendations of 52cm. The lights can continue to be bright despite having low irradiance levels. Please send them to the biomedical technician if the irradiance delivered falls below 10 mW/cm²/nm.



Fluoro-Lite - 2 Blue and 2 White Fluorescent lights

The fluorescent blue tubes must have the serial number F20T12/BB or TL52/20W to be special phototherapy lights. Blue light is the most effective light for reducing the bilirubin.⁵ This combination should deliver 12mW/cm²/nm. The bulbs degenerate with time so any units delivering less than 10 mW/cm²/nm should be sent to the biomedical technician for replacement of tubes even though they still appear to be working.⁴ Directing the light from the side of the infant significantly reduces the dose delivered.



Ohmeda Biliblanket - Blue Halogen light

This uses a halogen bulb directed into a fiberoptic mat. There is a filter that removes the ultraviolet and infrared components and the eventual light is a blue-green colour. There are three settings: low = 15 m W/cm²/nm; medium = 25 m W/cm²/nm and high = 35 m W/cm²/nm. The blanket must be positioned directly next to the infant's skin to be effective. It can be used as the sole source of phototherapy or as an adjunct to conventional treatment by laying the infant on the blanket to give "double" phototherapy and increase the surface area exposed.^{2, 6}

Biliblankets are not to be used on infants less than 28 weeks gestation or infants with broken or reduced skin integrity.



Medela Bilibed Blue Fluorescent light

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 Bilicombi baby suit and nursed on the soft plastic cover. The suit attaches to the crib by Velcro attachments. The irradiance delivered is up to 40 m W/cm²/nm.

CHOOSING THE APPROPRIATE LIGHT SOURCE

Physiological jaundice

- This is caused by increased production, increased enterohepatic circulation and decreased excretion of bilirubin in a normal baby.
- Infants should be nursed on the postnatal ward on a Bilibed if the baby is over 48 hours old and there is no risk of rapidly rising jaundice or the need for an exchange transfusion.
- In preterm infants < 28 weeks with mild jaundice where treatment threshold is reached, the Biliblanket may be used. However, the Biliblanket is not as effective as conventional phototherapy for reducing the bilirubin in term infants
- Infants who have been initially treated with overhead phototherapy can receive phototherapy by the Bilibed as the bilirubin levels improve
- The overall aim is to treat the jaundice but also to minimise maternal and infant separation

Pathological jaundice

- This is rapidly rising jaundice that could be due to haemolysis (ABO or Rhesus incompatibility, G6PD deficiency), jaundice in premature infants or jaundice in infants with a co-morbidity (eg sepsis, dehydration, respiratory distress, hypotension or acidosis)
- Term infants with an SBR ³ 380 should be treated as having pathological jaundice until all investigations are back
- Infants require overhead phototherapy lights and blue lights are more effective.³
- Adding an additional phototherapy light ie: a 2nd overhead phototherapy light or a biliblanket which increases the surface area exposed will increase the dose and effectiveness of the phototherapy
- When adding extra lights the irradiance level and/or the surface area exposed is increased.
- Adding lights with suboptimal irradiance (<10 m W/cm²/nm) will be ineffective.

A Cochrane review of fibreoptic phototherapy for neonatal jaundice showed that fibreoptic devices were less effective in decreasing the bilirubin level than conventional phototherapy except in preterm infants. Combining a fibreoptic device with conventional phototherapy was more effective than conventional phototherapy alone.⁷

NURSING CARE OF THE INFANT RECEIVING PHOTOTHERAPY

Phototherapy is not without side effects so a comprehensive plan of nursing care should be implemented to avoid any complications.

Explanation and reassurance to parents

- Encourage parents to continue feeding, caring for and visiting their infant.
- Explain to the parents what newborn jaundice is, why the infant is being treated, what precautions will be taken and that the lights being used do not contain ultraviolet light.

Place of Nursing

- Isolette for infants receiving phototherapy by blue or white overhead lights and Biliblanket.
- *be aware that the Micro-Lite phototherapy systems can become very hot*
- Cot for infants on a Bilibed.

Skin care

- Infants in isolettes who are < 1200gm are generally nursed without a nappy on an absorbent sheet protector (Incohelp)
- Infants in isolettes who are > 1200gm may be nursed with a nappy on if the bilirubin is not rising rapidly ⁸
- If intensive phototherapy is required then the nappy should be removed.³
- Keep the infant clean and dry
- Clean only with water. Do not apply oils or creams to the exposed skin.

Eucerin has been proven to be safe for use when the infant is receiving phototherapy

- Infants nursed in nappies where the buttocks are not exposed may have zinc and castor oil applied to areas of skin excoriation

Observations

- Infants must be weighed on admission to the nursery and 2nd daily as per the guideline
- All infants in Newborn Care receiving phototherapy should have a temperature, pulse and respiration rate documented 4 hourly.
- If an infant requires continuous cardio-respiratory monitoring for other reasons, then, this should continue whilst under phototherapy.
- Infants under the **Blue fluorescent lights** need at least saturation monitoring as it is difficult to assess the infants colour under these lights.
- If the infant receiving phototherapy by the Micro-Lite system is tachycardic, plethoric or restless, then the temperature should be rechecked as the infant may be overheating.
- Well babies > 35 weeks gestation who are receiving white light phototherapy do not require any monitoring unless they are nursed prone and then they will require cardiorespiratory monitoring.

Eye care

- Eye pads are required for the infants comfort if overhead white or blue fluorescent lights are used :
 - Size N720 (micro) if < 1500g
 - Size N721 (small) if 1500 - 2500g
 - Size N722 (large) if > 2500g
- Eye pads should be removed 4 hourly and eye cares attended with normal saline.
- There have never been human studies showing that retinal damage occurs from with phototherapy

Fluid Requirements

- **All Infants**
 - Accurately document fluid intake (oral or intravenous) and output.
 - Urinalysis and specific gravity should be checked 8 hourly.
 - Assess and record stools.
- **Term Infants**
 - Breast fed infants should continue on demand breast feeds.
 - Sucking, attachment and mother's supply should be observed and documented.
 - Bottle fed infants should be fed on demand 4-6th hourly
 - Complementary feeds in the form of intragastric or bottle feeds with EBM/formula may be required if oral intake is insufficient and there are concerns that the infant is dehydrated.
 - Breastfed infants > 32 weeks gestation should be complemented with a hydrolysed formula (eg: Nan Ha) if there is insufficient breastmilk and the parents consent to formula feeding
 - Assessment of dehydration should take into account the babys fluid input and output, weight and urine specific gravity.
- **Preterm Infants**
 - Preterm infants have about a 20% increase in transepidermal water loss when they receive phototherapy despite being nursed in humidity and a double walled crib. ^{10, 11}
 - The daily fluid rate may need to be increased by 10ml-15ml/kg/day to prevent dehydration.⁸
 - When increasing the daily fluid rate the gestational and postnatal age, fluid input and output, serum sodium levels and urine specific gravity need to be reviewed and the fluid rate must be **individualised** for each infant

Side Effects

- Skin rashes usually only temporary but if the phototherapy lights are too hot there is the potential to overheat the skin.
- Temperature instability phototherapy can cause overheating, especially when using the Micro-Lite system and must be monitored.

- Loose stools and perianal excoriation
- Increased insensible water loss this occurs despite nursing in humidity and in double walled cribs but can be counteracted by increasing the daily fluid intake but this needs to be individualised on a case by case basis.
- Maternal-infant separation this can interfere with bonding and breastfeeding but can be minimised by utilising Bilibeds on the postnatal wards when appropriate.

PHOTOTHERAPY ON THE POST NATAL WARDS

Potential Candidates

- Well infants with physiological jaundice (ie: after 48 hours of age).
- Infants with birth trauma caput succedaneum, cephalohaematoma, bruising.
- Initial mode of therapy whilst further investigations are awaited.
- Infants that have been in the nursery for overhead phototherapy and the jaundice has been controlled
- Any baby with jaundice in the first 48 hours, a bilirubin of > 380 $\mu\text{mol/L}$ or rapidly rising jaundice needs more intensive phototherapy in the nursery.**

Bilibed

- Newborn Care has Medela Bilibeds for loan.
- The number of the bed and date of use and return needs to be written in the Bilibed book.
- 2 washable Bilicombi suits will be loaned with each Bilibed.
- The infant must remain on the Bilibed at all times (apart from when being fed) for the phototherapy to be effective.

PHOTOTHERAPY AT HOME

Infants with moderate physiological jaundice can receive phototherapy at home via a loaned Bilibed. This can be considered either as a continuation of phototherapy commenced in hospital or as a new treatment in babies who have gone home on early discharge.

- The decision for home phototherapy must be made by the Neonatal Fellow or Consultant and the management of jaundice should be consistent with this policy, and the RPA Newborn Care [Jaundice Guideline](#)
- The process should be initiated either through MDSP, for babies on early discharge or going home from the postnatal wards or NFST, for babies being reviewed in the jaundice clinic or being discharged home from the nurseries.
- Contact details as follows:
 - NFST Office Numbers : (02) 9515 6435 or 9515 6436
 - Link Paging service: Phone 132222
 - MDSP Pager 2590
 - NFST Pager 15929
 - Leave name and number and person on call will answer
- Babies who commence phototherapy at home should have the following investigations if they have not been done previously:
 - Full Blood Count and film
 - Baby blood group and direct antiglobulin(Coombs) test
 - G6PD in male babies of high risk ethnic groups (Asian, Middle Eastern, Mediterranean and African).
- Home phototherapy cannot be offered for babies who live outside the area covered by MDSP and NFST. A list of [suburbs](#) serviced by RPA Women and Babies
- The parents must be educated about the use of the Bilibed prior to discharge or at home and a log of all Bilibeds used in the community must be kept. Documentation is to include the date the Bilibed is taken out, the family name of the baby for whom it is intended and the return date of the Bilibed. There is a designated book in 5E1 in the room where the Bilibeds are stored.
- MDSP and NFST should liaise with the Neonatal Fellow or Consultant on service for timing of repeat bilirubin tests and when to discontinue phototherapy. Use of the Bilirubinometer may help to reduce

the number of SBRs performed ([see Bilirubinometer policy](#)).

- As far as possible repeat bilirubin tests should be done at home but if this is not possible they will need to attend the morning Jaundice Clinic. A copy of the Neonatal Jaundice sheet with the infants details and flowchart of bilirubin results must be made and stored at the front desk so it is available when the baby is reviewed. The baby needs to be reviewed by the Neonatal Fellow at 10.30am prior to the Blood Collector taking the repeat bilirubin level at 11am. If it is necessary for the baby to come in for bloods, then the baby will continue under the care of either MDSP or NFST in liaison with the Neonatal Fellow or Consultant as above.

WHEN TO STOP PHOTOTHERAPY

- There are no established guidelines for discontinuation of phototherapy.¹²
- In view of this lack of evidence, the following are suggested guidelines for stopping phototherapy:
- Term babies:
 - Day 3: Stop at the discretion of the consultant as the jaundice is likely to be pathological
 - Day 4: Stop phototherapy when the SBR is ≥ 280 mmol/L for term infants with physiological jaundice
- Premature babies: Stop at the discretion of the consultant

REBOUND BILIRUBIN LEVELS

- It is unnecessary to keep a baby in hospital for a rebound bilirubin level.^{12,13}
- If a baby does not appear visibly jaundiced 48 hours after stopping phototherapy then they do not require a repeat bilirubin level.
- Term babies who are readmitted for phototherapy (usually between day 3-6) for physiological jaundice do not require a routine rebound level after lights are stopped.¹⁴
- Reasons to check a rebound bilirubin 24 hours after stopping phototherapy may include:
 - positive direct Coombs^{12, 13, 14}
 - <37 weeks gestation¹⁴
 - bruising¹³
 - early use of phototherapy (started < 72 hours of age)¹⁴
- Consider using the transcutaneous bilirubinometer to assess the need for further bilirubin levels to prevent unnecessary blood tests. ([See TCB policy](#))

REFERENCES

1. Cremer RJ, Perryman PW, Richards DH. Influence of light on the hyperbilirubinaemia of infants. *Lancet* 1958; **1**: 1094-7.
2. Vreman HJ, Wong RJ, Stevenson DK. Phototherapy: current methods and future directions. *Seminars Perinat* 2004; **28**: 326-33.
3. American Academy of Paediatrics Clinical practice guideline. Management of hyperbilirubinaemia in the newborn infant 35 or more weeks gestation. *Paediatrics* 2004; **114**: 297-316.
4. Tan KL. Phototherapy for neonatal jaundice. *Clinics in Perinat* 1991; **18**: 423-39.
5. Tan KL. The pattern of bilirubin response to phototherapy for neonatal hyperbilirubinaemia. *Pediatr Res*. 1982; **16**: 670-4.
6. Tan KL. Comparison of the efficacy of fiberoptic and conventional phototherapy for neonatal hyperbilirubinaemia. *J. Pediatr* 1994; **125**: 607-12.
7. Mills JF, Tudehope D. Fiberoptic phototherapy for neonatal jaundice. *Cochrane Library* 2001.
8. Pritchard MA, Beller EM, Norton B. Skin exposure during conventional phototherapy in preterm infants: a

randomised controlled trial. *J Paediatr Child Health* 2004; **40**: 270-4

9. Lane AT, Drost SS. Effects of repeated application of emollient cream to premature neonates skin. *Paediatrics* 1993; **92**: 415-9

10. Grunhagen DJ, De Boer MG, De Beaufort A, Walther FJ. Transepidermal water loss during halogen spotlight phototherapy in preterm infants. *Pediatr Res* 2002; **51**: 402-5.

11. Maayan-Metzger A, Yosipovitch G, Hadad E, Sirota L. Transepidermal water loss and skin hydration in preterm infants during phototherapy. *Am J Perinat* 2001; **18**: 393-6.

12. American Academy of Pediatrics, Subcommittee on Hyperbilirubinaemia.. Management of hyperbilirubinaemia in the newborn infant 35 or more weeks of gestation. *Pediatrics* 2004; **114**: 297-316

13. Maisels MJ, Kring E. Rebound in serum bilirubin level following intensive phototherapy. *Arch Pediatr Adolesc Med* 2002; **156**: 669-672.

14. Kaplan M, Kaplan E, Hammerman C et al. Post-phototherapy neonatal bilirubin rebound: a potential cause of significant hyperbilirubinaemia. *Arch Dis Child* 2006; **91**: 31-34.

Last Reviewed: August, 2005