

## Role and responsibility of nurse during care of neonates undergoing phototherapy

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### Abstract

Phototherapy is a safe, effective method for decreasing or preventing the rise of serum unconjugated bilirubin levels and reduces the need for exchange transfusion in neonates. The aim of phototherapy is to decrease the level of unconjugated bilirubin in order to prevent acute bilirubin encephalopathy, hearing loss and kernicterus. Mainly 5 types of jaundice- pathological jaundice, physiological jaundice, breast milk jaundice, breastfeeding jaundice, and jaundice of prematurity. Phototherapy works by 3 process Configurational isomerization, Structural isomerization, and oxidation. In phototherapy Blue light- emitting diodes (LEDs), Fluorescent special blue light, Halogen white light, Fiberoptic blankets, and Biliblanket - blue halogen light or pends are used to deliver phototherapy. Electric shock, Hypothermia, Hyperthermia, bronze baby syndrome shows as complication of phototherapy. In the nursing role and responsibility of nurse during phototherapy firstly preparation of phototherapy, nursing care of neonates during phototherapy, Nurses role while terminating the phototherapy.

**Keywords:** Biliblanket, fiberoptic blankets, phototherapy, nurses

### Introduction

- Phototherapy is also called as light therapy. Phototherapy has been used since 1958 for the treatment of neonates.
- Which is commonly used as a treatment for reducing the high level of 'unconjugated bilirubin' into soluble form by the process of photo isomerization by using fluorescent light.
- Phototherapy is the use of visible light to treat severe jaundice in the neonatal period. Approximately 60% of term babies and 85% preterm babies will develop clinically apparent jaundice, which classically becomes visibly apparent on day 3, peaks days 5-7 and resolves by 14 days of age.
- Phototherapy is a safe, effective method for decreasing or preventing the rise of serum unconjugated bilirubin levels and reduces the need for exchange transfusion in neonates.
- The aim of phototherapy is to decrease the level of unconjugated bilirubin in order to prevent acute bilirubin encephalopathy, hearing loss and kernicterus.

### Terminology

#### Bilirubin

The orange-yellow pigment of bile, formed principally by the breakdown of hemoglobin in red blood cells at the end of their normal life-span (normal level of bilirubin 0.1 to 1.2mg/dl)

#### Bilirubinaemia

The presence of bilirubin in the blood.

#### Hyperbilirubinaemia

The excess amount of bilirubin in the blood (above 5mg/dl)

#### Serum Bilirubin (SBR)

Reports the unconjugated and conjugated bilirubin levels.

#### Unconjugated bilirubin (indirect)

Most common form of neonatal hyperbilirubinaemia. Unconjugated bilirubin binds with lipids and albumin, and results in the yellow appearance of the skin and sclera. Due to hemolysis or defective bilirubin (reference range of indirect bilirubin 0.1 – 0.4 mg/dl)

#### Conjugated bilirubin (direct)

The bilirubin has been metabolized and water soluble, but accumulates in the blood usually due to hepatic dysfunction. Conjugated bilirubin does not cross the blood-brain barrier. (range of direct bilirubin 0.1 – 0.4 mg/dl)

#### Jaundice

The yellow appearance of the skin that occurs with the deposition of bilirubin in the dermal and subcutaneous tissues and the sclera or too much bile pigment (bilirubin) in the blood. It is also known as hyperbilirubinemia or icterus.

### Classification of jaundice

The most common types of jaundice are-

- **Physiological (normal) jaundice:** Most newborns have this mild jaundice because their liver is still maturing. It often appears when a baby 2 to 4 days old and disappears by 1 to 2 weeks of age. This is caused by increased production, increased enterohepatic circulation and decreased excretion of bilirubin in a normal baby. It is mainly treated by phototherapy.
- **Pathological jaundice:** it include appearance of jaundice within 24 hours after birth. This occurs because of hepatocellular, hemolytic and obstructive jaundice. 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) For treatment of this exchange blood transfusion done
- **Jaundice of prematurity:** This is common in premature babies since their bodies are even less ready to excrete bilirubin effectively. To avoid complications, they'll be treated even when their bilirubin levels are lower than those of full-term babies with normal jaundice.
- **Breastfeeding jaundice:** Jaundice can happen when breastfeeding babies don't get enough breast milk due to difficulty with breastfeeding or because the mother's milk isn't in yet. This is not caused by a problem with the breast milk itself, but by the baby not getting enough of it. If a baby has this type of jaundice, it's important to involve a lactation (breastfeeding) consultant.
- **Breast milk jaundice:** develops within 2-4 days of birth, is most likely related to limited fluid intake as breast milk supply is established, jaundice is caused by substances in breast milk that can make the bilirubin level rise. It's may peak at 7-15 days of age and may persist for weeks.

### Meaning

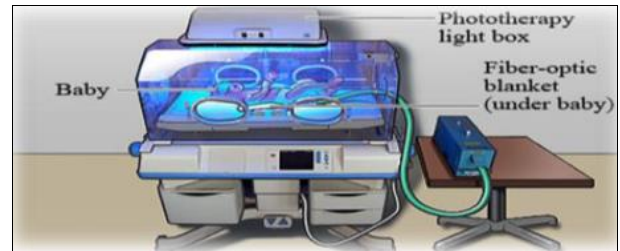
#### Phototherapy

It is also called as light therapy. The treatment of disease with certain types of light. Phototherapy can use lasers, LED, fluorescent lamps, and ultraviolet or infrared radiation.

#### Definition

Phototherapy is non-invasive, inexpensive and easy method of degradation of unconjugated bilirubin by photo-oxidation. The light waves convert the toxic bilirubin into water soluble non-toxic form which is easily excreted from the blood in the bile, stool and urine.

Phototherapy started early when serum bilirubin approaches 15mg/dl in full term baby and in preterm babies, phototherapy is started at a serum bilirubin level of 5mg/dl.



### Indication of phototherapy

- Phototherapy should be used when the level of bilirubin may be hazardous or increased.
- Prophylactic phototherapy indicated in special circumstances such as extreme low birth infant or with severely bruised infant.
- Phototherapy is usually contraindicated in infants with direct hyperbilirubinemia caused by liver disease or obstructive jaundice because phototherapy may lead to the bronze baby syndrome.

### Current practice for starting phototherapy in neonates

- **Infants < 1,000g:** Phototherapy is started within 24 hours and at bilirubin level of 5 mg/dl.
- **Infants 1,000 to 1,500 g:** phototherapy is started at bilirubin level of 7-9 mg/dl
- **Infants 1,500 to 2,000g:** phototherapy is started at bilirubin level of 10-12 mg/dl
- **Infants 2,000 to 2,500g:** Phototherapy is started at bilirubin level of 13- 15 mg/dl.

### Articles required for phototherapy

- Incubator or warmer
- Phototherapy machine or overhead photo light
- Weight machine
- Thermometer
- Intake output chart
- Bilirubin light meter
- Eye shield or patches
- Diaper

### Mechanism of action

Phototherapy works by 3 process

- **Configurational isomerization:** Natural isomer of unconjugated bilirubin is rapidly converted to a less toxic polar isomer that diffuse into the blood and is excreted into the bile without conjugation. Here the Z-isomers of bilirubin are converted into E-isomers. The reaction is instantaneous upon exposure to light but reversible as bilirubin reaches into the bile duct. After exposure of 8-12 hr of phototherapy, this constitutes about 25% of TSB, which is nontoxic.
- **Structural isomerization:** Process of converting bilirubin to lumirubin which is excreted out of body. Irreversible reaction where the bilirubin is converted into lumirubin. The reaction is directly proportional to dose of phototherapy.
- **Oxidation:** it is slow process that converts bilirubin to small polar products that are excreted in the urine. It is colourless bile product excreted through liver and kidney without need for conjugation.



- Bilirubin is a naturally occurring molecule of the red blood cells. It is released into the bloodstream when the red blood cells break down. This is normal and occurs often. Our livers breakdown the bilirubin and it is excreted.
- Baby skin and blood absorb these light waves. These light waves are absorbed by baby's skin and blood and Change bilirubin into products, which can pass through their system.
- Wavelength of 420-448 nm, oxidized the bilirubin to biliverdin, a soluble product that does not contribute to kernicterus.

#### Technique of phototherapy

- Blue light is most effective for phototherapy. White day light lamps are also effective. The wavelength of the light should have in the range of 420 to 600 nm for maximum absorption by the bilirubin.
- A combination of white and blue lamps are preferred. A baby care unit with 6 to 8 light source or tube lights can be used which should be covered with plastic sheet or plexiglass.
- A naked infant is placed under the light source at a distance of about 45cm from the skin of the baby. It can be reduced to 15 to 20cm for intensive phototherapy.

#### Preparation while phototherapy

- The photo therapy unit will be placed over the top of the incubator occasionally more than one unit may be used.
- Phototherapy can be switched off when baby needs to come out for feeding.
- Checked phototherapy machine for proper working before starting and it should be start with incubator or warmer.
- Baby is placed naked 45 cm away from the phototherapy lights in a crib or incubator.
- Start frequent breastfeeding or 10-20% extra fluid is provided.

Phototherapy is discontinued if two serum bilirubin values are < 10 mg/dl. Discontinue phototherapy once two TSB values 12 hours apart fall below current age specific cut offs.

#### Types of lights used in Phototherapy

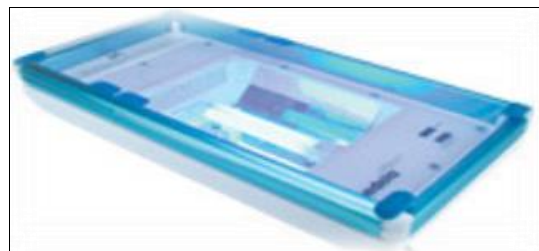
The phototherapy unit available in the market have a variety of light sources that includes fluorescent lamps and different Colors- cool white, blue, green, blue-green or turquoise and Shapes- straight, or U-shaped (CFL) halogen bulb and high intensity light emitting diodes and fiberoptic light source.

#### Blue light- emitting diodes

(LEDs) provide optimal high intensity light in the absorption spectrum of bilirubin and are available as either overhead or underneath devices.



- **Fluorescent special blue light:** it lower total bilirubin most effectively because they deliver light in the blue green spectrum providing maximal absorption and good skin penetration.



- **Halogen white light:** are placed at the recommended distance 52 cm from the infant because they are hot and can cause thermal injury. They deliver light via a quartz halogen bulb and have a tendency to become quite hot.



- **Fiberoptic blankets, Biliblanket - blue halogen light:** or pends can be placed directly under the infant generate little heat and provide higher irradiance than fluorescent light due to their small size they rarely cover enough surface area to be effective when used alone in terms infant and thus are typically used together with overhead lights. 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. Biliblankets are not to be used on infants less than 28 weeks gestation or infants with broken or reduced skin integrity.



### Advantages of phototherapy

- Inexpensive and easy to use.
- Most effective of all modes of prevention and treatment of neonatal hyperbilirubinemia.
- Phototherapy (light treatment) is the process of using light to eliminate bilirubin in the blood.
- The phototherapy will help the liver to process bilirubin, bringing baby's level down to normal.
- The light waves convert the bilirubin to water soluble nontoxic forms which are easily excreted.
- Promote infant parent interaction
- Reduce the chance of exchange blood transfusion

### Complication of phototherapy

- Diarrhoea- condition in which the loose stool or green and watery stool present. When light convert the unconjugated bilirubin into the conjugated bilirubin than it can be excreted by the urine or stool and baby passed frequently watery stool.
- Bronze-baby-syndrome- it is the dark grey brownish pigmentation on skin, mucous membrane and urine. It seen mostly in babies with conjugated hyperbilirubinemia.
- Transient skin rash- exposure of phototherapy light Redding of the skin occur which called as skin rashes or erythema and prolonged exposure of light during phototherapy light may cause burn or damaging the upper layer of skin.
- Electrolyte disturbance- because of light exposure some electrolyte disturbance occur like hypocalcaemia.
- Electric shock
- Hypothermia
- Hyperthermia

### Long term problems

- Retinal damage- after several days of light exposure cause retinal degeneration or retinal damage.
- Skin cancer- after continue exposure of blue light or UV light sometimes it can occur.
- Disturbance of endocrine or sexual maturation
- Kernicterus: also known as bilirubin encephalopathy. a disorder occur due to severe jaundice in the neonates, with deposition of the bile pigment bilirubin in the brain that causes damage to the brain.

### Nursing role

#### Preparation

Phototherapy is essential and easy treatment for jaundice in neonates. For preparing the neonates and their family for this treatment nurses are given the full education and reassurance to the family and explain the cost, available places of this treatment.

#### Education and reassurance to parents

- Encourage parents to continue feeding, caring for and visiting their infant.
- Explain to the parents what neonatal jaundice.
- Explain why the infant is being treated, what precautions will be taken and that the lights being used do not contain ultraviolet light.
- Instruct about care and feeding of neonates
- Explain about the available place and cost of phototherapy

### Available place for phototherapy

- Phototherapy should be given in NICU ward or in postnatal ward
- It is also given by caregiver in home by the use of biliblanket. Infants with moderate physiological jaundice can receive phototherapy at home via a loaned Bilibed.

### Cost of phototherapy

- Phototherapy cost vary according to the hospital policies and the severity of the neonatal jaundice.
- Phototherapy charge in India approx. 3000 – 5000
- Alternate option is home phototherapy

### During procedure

At the time of phototherapy nurses should give nursing care to the neonates for reducing the some complication of phototherapy such as kernicterus and bronze baby syndrome.

### Nursing care of neonates during phototherapy:

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

### Room temperature

- Temperature inside neonate's room or NICU should be between 68°F and 75°F (25°C and 28°C).
- Close windows and doors to decrease drafts in the room. Make sure neonate bed is dry. This will help him or her stay warm.

### Position

- Change neonate's position every 1 to 2 hours. This exposes all areas of the skin to the lights.
- This help the lights break down the bilirubin as quickly as possible. Ask about the best ways to position neonate.
- Baby is turned every two hours or after each feed.

### Body temperature

- Place the thermometer in neonate arm area while the phototherapy lights are on. Maintain temperature of neonate between 97°F and 100°F (36.1°C and 37.8°C).
- Temperature is monitored every 3 to 4 hours.
- If neonate is too warm, than remove the curtains or cover from around the light set. Decrease the room temperature. Check neonate's temperature every 15 minutes until it decreases.
- If neonate is too cold, wrap him or her in blankets and hold him or her close to you. Feed him or her warm breast milk or formula. Check neonate's temperature every 15 minutes until it increases.

### Skin care

- 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.

- The use of creams, lotions or oils on the infant's skin is not recommended while undergoing phototherapy; however a barrier cream may be applied to the nappy area to main skin integrity.

### Fluids

- Monitor the infant's intake and output closely. Weigh nappies to monitor output.
- Maintain strict fluid balance chart.
- Encourage to increase daily fluid requirement 20 – 30 ml/kg/day.
- Monitor over hydration.
- Refer infant to dietician as clinically indicated
- Discuss the infants' fluid requirements with neonatologist.
- Daily urinalysis for specific gravity i.e. > 1012 or signs of dehydration.
- Observe for frequent loose green stools.

### Feeding

- Provide support to the mother who gives breast feeding, with the necessary support and advice to allow her to continue breastfeeding or to express milk if required.
- The infant may need to be breastfed 8-12 times a day.
- All mother must be emotionally and physically prepared for giving successful breast feeding cracked nipples must be managed during pregnancy so that baby is not faced with any difficulties during breast feeding.
- The child should feed on demand most babies are satisfied with feeds taken every two to three hours.
- The mother should sit up comfortably and keep the baby head slightly raised and supported on her elbow. The baby should allow to suck till he or she is satisfied which usually takes 15-20 min.
- He or she may need to feed more often. This will help get rid of the bilirubin through his or her urine and bowel movements. Care giver may need to feed him or her with the phototherapy lights on.
- If baby not take breast feed directly than instruct the mother for expressed breast milk and help her for giving the feed with katori spoon or other artificial feeding techniques.
- Record feeding time, amount of feed and duration of feeding.

### Care of the umbilical stump

- Betadine should be applied at the tip around the base of the umbilical stump daily to prevent colonization. The dressing should not be applied.
- The stump need not be kept moistened in babies with future need for exchange transfusion but precautions should be taken to keep the stump bacteria free by using polybactericidal powder containing neomycin, and polymyxin.
- Normally cord falls after 5 to 10 days but may take longer, if it is dry and shriveled or when infected. The delayed falling of the cord is also a useful marker of immunodeficiency state.
- The stump should be inspected for any discharge or infection and kept clean and dry till complete healing takes place.

### Eye care

- Do cleaning of eyes routinely
- Eye pads should be removed 4 hourly and eye cares attended with normal saline.
- Eyes should be cleaned daily with sterile cotton swabs soaked in normal saline using one swab for each eye.



- Massage the nasolacrimal duct area (by massaging the outer side of the nose adjacent to the medial canthus) 5 to 8 times, each time before feeds of the baby.
- Antibiotic eye drops should not be used routinely or give as advised by physicians
- If the eyes are sticky, 10% solution of suphacetamide should be instilled in the eyes every two to four hours. The practice of applying kajal in the eyes is not recommendation because it may transmit infection like trachoma and may even cause lead poisoning.
- Use the gauge or eye patch for covering of eyes.
- Use sterile gauze piece or cotton roll for cleaning the eye it should be wet with sterile water or Luke warm water and cleaning of eye from the inner to outer canthus of eyes clean the eye or give care.

### Genital care

- Diaper should be changed if wet or stool passed by baby. Neonates should have at least 6 wet diapers and 1 soiled diaper each day.
- The urine may be darker as the bilirubin leaves neonate's body. His or her bowel movements may change from yellow to green.



- Diaper should be checked after feeding or every 2-3 hours
- Give the proper genital care to the baby when baby pass the stool.

### Dresses of baby

- Remove all dress or clothes of baby only leave the diaper on the baby body. For preventing the gonadal damage.
- The nappies should be made of thick, soft and absorbent material in order to readily soak the urine and stools.
- The use of plastic napkin should be avoided in home due to increased risk of nappy rashes.

### Infant massaging

Infant massage is a natural way for caregivers to improve health, sleep patterns and reduce colic.



### Steps

1. Apply oil on the palm and start with leg, wrap hands around one of the thigh & pull down one hand after the other. Do not rub the sole.
2. Place hand in triangular shape. First over the chest and move outwards toward the shoulder repeat this 2-3 times.
3. Massage the back make the baby lie comfortably in prone position. Place hands below the neck and go downward till the thigh.
4. Ear and face takes few drops of oil in hands and apply gently.
5. Apply little oil in the head and rotate palm gently.
  - It help to reduce bilirubin levels and increase defecation frequency in neonates who receive phototherapy.
  - It help to improve circulation and provide comfort to the baby and also reduce the stress of baby.
  - It help to promote the positive emotional bonding between parents and babies.

### Monitoring

- Monitor feeding time, amount and the weight of the baby and charted properly.
- Monitor neonate's body temperature for preventing any effects of hypo or hyperthermia.
- Monitor the number of wet or soiled diapers he or she has.
- Number of lamps and types of phototherapy.
- Distance between surface of lamps and infant
- Weight is monitored every day.

### Nurses role while terminating the phototherapy

In the last when the baby serum bilirubin level is reduced than the normal level than start the termination of phototherapy. This time nurses do the proper monitoring and recording of the procedure and replace the all articles.

### Monitoring & Recording

- Occurrence of any side effect.

- Intake and output is monitored
- Chart number of urine frequency and stool.
- Serum bilirubin is monitored at least every 12hours to 24 hours
- Phototherapy is stopped when the bilirubin level decreases.
- Record the weight of baby, vitals, and feeding amount
- Replace the articles of phototherapy when phototherapy is stopped.
- Check the light should be closed when phototherapy is not continue
- Give the comfortable position to the neonates and provide the dress if warmer off or if needed change the diaper.

### Summary

Phototherapy is a safe, effective method for decreasing or preventing the rise of serum unconjugated bilirubin levels and reduces the need for exchange transfusion in neonates. It start early when serum bilirubin approaches 15mg/dl in full term baby and in preterm babies, phototherapy is started at a serum bilirubin level of 5mg/dl. For keeping baby inside the phototherapy unit prepare the baby, remove all clothes except diaper and eye patches, monitoring of baby activity, bilirubin level, time & amount of feeding and eliminating the waste product should be used.

### Conclusion

Phototherapy is an effective method for reducing the serum bilirubin level or treating the hyperbilirubinemia or jaundice in infants. It works in these geometric, isomerization or structural mechanism of phototherapy. In this we discussed about the articles, indication, preparation, complication and nursing care during the phototherapy. In the phototherapy used wavelength 420 – 448 nm. For delivering the phototherapy used the different lights, blue light, fiberoptic light, fluorescent light, high intensive light and CFL, LED, halogen bulb.

### Conflict of Interest

Not available

### Financial Support

Not available

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