NEST-ED
Clinical Modules

June 2020

Newborn Essential Solutions and Technologies-Education (NEST-ED) Clinical Modules provide educational support for each of the technologies included in the NEST360 bundle for newborn care. These materials are intended to strengthen locally developed neonatal and technical trainings in pre-and in-service settings and are not intended to be comprehensive clinical guidelines or targeted towards intensive care of the newborn.

FACILITATING THE CLINICAL USE OF TECHNOLOGIES FOR NEWBORN CARE IN LOW-RESOURCE SETTINGS
Clinical Education Modules: Phototherapy

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In addition, all forms, instructions, checklists, guidelines, and examples are intended as resources to be used and adapted to meet national and local health care settings’ needs and requirements.
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This series has been designed with the intent of supporting the clinical use of technologies in newborn care units.

Newborn Essential Solutions and Technologies—Education (NEST—ED) Clinical Modules provide educational support for each of the technologies included in the NEST360 bundle for newborn care. These materials are intended to strengthen locally developed neonatal and technical trainings in pre- and in-service settings. Of note, these materials are not intended to be comprehensive clinical guidelines or targeted towards intensive care of the newborn. They are to be used to facilitate the implementation of comprehensive newborn care, including bubble CPAP, in a resource limited setting.

The NEST-ED Clinical Modules were developed through a combination of international standard review, international expert feedback, and multinational NEST360 expert consensus opinion. NEST-ED Modules form the backbone of all lectures, power points, job aids, and other supportive education materials supplied by NEST360.

To view the full series, visit www.nest360.org/resources
# ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>ABC</td>
<td>Airway, Breathing, Circulation</td>
</tr>
<tr>
<td>bCPAP</td>
<td>Bubble continuous positive airway pressure</td>
</tr>
<tr>
<td>dL</td>
<td>Decilitre</td>
</tr>
<tr>
<td>FiO₂</td>
<td>Increased Fractional Concentration of Oxygen</td>
</tr>
<tr>
<td>Fr</td>
<td>French size</td>
</tr>
<tr>
<td>HAI</td>
<td>Hospital acquired infections</td>
</tr>
<tr>
<td>HCWs</td>
<td>Healthcare workers</td>
</tr>
<tr>
<td>HFNC</td>
<td>High flow nasal cannula</td>
</tr>
<tr>
<td>IV</td>
<td>Intravenous</td>
</tr>
<tr>
<td>KMC</td>
<td>Kangaroo mother care</td>
</tr>
<tr>
<td>LBW</td>
<td>Low birth weight</td>
</tr>
<tr>
<td>LCD</td>
<td>Liquid crystal display</td>
</tr>
<tr>
<td>LED</td>
<td>Light emitting diode</td>
</tr>
<tr>
<td>mm Hg</td>
<td>Millimeters of mercury</td>
</tr>
<tr>
<td>NEST360</td>
<td>Newborn Essential Solutions and Technologies</td>
</tr>
<tr>
<td>NEST-ED</td>
<td>Newborn Essential Solutions and Technologies-Education</td>
</tr>
<tr>
<td>NGT</td>
<td>Nasogastric tube</td>
</tr>
<tr>
<td>nm</td>
<td>Nanometer</td>
</tr>
<tr>
<td>O₂</td>
<td>Oxygen</td>
</tr>
<tr>
<td>OGT</td>
<td>Orogastric tube</td>
</tr>
<tr>
<td>ppm</td>
<td>Parts per million</td>
</tr>
<tr>
<td>ROP</td>
<td>Retinopathy of Prematurity</td>
</tr>
<tr>
<td>SpO₂</td>
<td>Peripheral blood oxygen saturation</td>
</tr>
<tr>
<td>UPS</td>
<td>Uninterruptible power supply</td>
</tr>
<tr>
<td>WASH</td>
<td>Water, sanitation and hygiene</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organization</td>
</tr>
<tr>
<td>wks</td>
<td>Weeks</td>
</tr>
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</table>

# NOMENCLATURE

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>bCPAP prongs</td>
<td>bCPAP patient interface</td>
</tr>
<tr>
<td>Cot</td>
<td>Bassinet, infant crib</td>
</tr>
<tr>
<td>Christmas tree nozzle</td>
<td>Barbed oxygen fitting, nipple and nut adapter</td>
</tr>
<tr>
<td>Flow splitter</td>
<td>Oxygen splitter, flow meter stand</td>
</tr>
<tr>
<td>Glucometer</td>
<td>Glucose meter</td>
</tr>
<tr>
<td>Hospital Acquired Infection</td>
<td>Iatrogenic infection, nosocomial infection</td>
</tr>
<tr>
<td>Nasal prongs</td>
<td>Oxygen catheter, oxygen cannula, oxygen prongs</td>
</tr>
<tr>
<td>Positive Pressure</td>
<td>Positive end expiratory pressure, positive airway pressure</td>
</tr>
<tr>
<td>Radiant warmer</td>
<td>Resuscitaire, resuscitation table</td>
</tr>
<tr>
<td>Suction pump</td>
<td>Suction machine</td>
</tr>
</tbody>
</table>
Introduction

This NEST-ED Clinical Module has been prepared to help healthcare staff & students understand when & how to use bubble CPAP in newborn care. This is one module in a series of NEST-ED Clinical and Technical modules available that may be used by teaching institutions to supplement current newborn care curricula or by hospitals, clinical departments, and individuals to update their knowledge and to better facilitate the effective and safe use of newborn care equipment.

Whilst reading this series on a digital device, download and open the document in Adobe Acrobat, on the toolbar click View, Navigation Panes, and then click Bookmarks. Use the Bookmarks pane to navigate between sections of the document:

Every module has a similar structure with sections and subsections. The sections have similar headings and subheadings to make it easy for the user to navigate them. However, words may have different meanings for the various cadres of staff reading them and so to reduce misinterpretation, the heading titles are explained below.

An exception to this structure is the Infection Prevention & Control: General Infection Prevention module. This module describes general infection prevention measures in relation to the use of equipment in the ward. There are also sections on reprocessing of single use items and a useful table of suitable disinfectants.

CLINICAL PROBLEM

This describes the situations in which a piece of equipment may be clinically useful. It does not include all the clinical background in making that decision, as this should be covered in country-specific neonatal care protocols & clinical training materials.

ASSESSMENT

This section explains how a piece of equipment works, as well as how it may be useful in certain patient care settings (e.g., why an overhead radiant heater is useful for short term warming in the labour ward while resuscitating a newborn).

MANAGEMENT

Step by step preparation for setting up, checking, and using the equipment is described. This is followed by explanations of how to remove the equipment from a baby when it is no longer needed, how to clean it, and how to store it safely until further need.

INFECTION PREVENTION

In this section infection prevention measures are described for the equipment when in use, followed by instructions on how to disinfect the equipment both during and after use.
COMPLICATIONS

The complications described in this section are those relating to the use of the equipment and do not include all clinical complications that may arise from underlying medical problems. These are beyond the scope of the modules and should be covered in clinical training materials.

CARE & MAINTENANCE

Advice is given on where to place equipment for use, how to safely handle such devices and their consumables, and how to keep them functioning well by using preventive maintenance measures.

TROUBLESHOOTING &

This section provides helpful advice on what to check if equipment is malfunctioning on the ward. It is intended to help healthcare staff deal with minor technical difficulties for which there are simple remedies. Detailed machine maintenance is beyond the scope of these modules and is covered in the technical modules that accompany these clinical ones.

ASSESSMENT QUESTIONS

A few questions are attached based on module content. These may be used, for example, during mentoring visits or to emphasise some of the points raised in teaching with the module.

REFERENCES & ALERTS

References and alert boxes are included within each module to provide clarity on areas where recommendations are governed by published standards, evidence, and/or expert opinion. This is included for the dual purpose of facilitating (1) feedback and continuous improvement of NEST-ED Education Modules and (2) implementer review of content for incorporation in local trainings.

QUERY ALERT BOXES appear where there may be controversy or disagreement. In these cases, alert boxes provide background to the recommendations that are made in the body of the document. Relevant documents are cited and brief explanation of reasoning for current module content provided.

RECOMMENDATION ALERT BOXES appear where there are recommendations based largely on expert opinion or consensus, or to emphasize an important element of care. Relevant documents are cited and brief explanation of reasoning for current module content provided.
Jaundice Management

Phototherapy
1 Clinical Problem

Infants have a large volume of bilirubin in the bloodstream because they have a high red cell mass (haemoglobin) and rapid breakdown of red blood cells in the first days of life. A newborn’s immature liver is often unable to rapidly remove bilirubin, leading to an excess of unconjugated bilirubin and thus jaundice.

Phototherapy should be commenced for neonates with:

- Any visible jaundice on the day of birth
- Jaundice extending below the umbilicus
- Bilirubin level indicating need for treatment

Phototherapy should also be considered for neonates with jaundice and the following complications:

- Prematurity
- Sepsis
- Significant bruising or cephalohaematoma
- Maternal-infant blood incompatibility (e.g., ABO or Rhesus incompatibility)
- G6PD deficiency

Initiation of phototherapy is very rarely required after 14 days of life in term infants and 21 days in preterm infants. Jaundice due to breast feeding may last for a long time (but the baby is well). Prolonged jaundice (>14 days) warrants further investigation and discussion for possible referral to a tertiary centre.

2 Assessment

Phototherapy uses blue light transmitted on the patient’s skin within the wavelengths of 425 to 475 nm to break down unconjugated bilirubin to a water-soluble, non-toxic form that can be easily excreted.

Phototherapy lights may be integrated into units with overhead, over- and under-body, or flexible blanket lights. Most phototherapy units can be used in tandem with other devices (e.g., radiant warmers, incubators, and oxygen therapy). This clinical module will provide guidelines for the use of overhead phototherapy lights.
Phototherapy lights are most effective when providing blue light within 425 to 475 nm via LEDs.

Other types of bulbs providing blue light within 425 to 475 nm (e.g., halogen or fluorescent) are less effective for treating jaundice, have a shorter lifetime, and are not as sustainable for long term use. Halogen and fluorescent bulbs are less efficient than LEDs and may also be a source of heat, introducing a potential risk for hyperthermia.4,5 Other types of phototherapy are also used, but are typically not recommended:

- **UV lights**: not recommended for neonatal therapy due to increased melanoma risk associated with childhood UV exposure.
- **Natural sunlight**: traditionally used in lieu of phototherapy devices; natural sunlight is not ideal due to increased challenges with temperature control of the patient and UV radiation risks.
- **Filtered sunlight**: there is emerging evidence that devices that filter sunlight, while requiring close monitoring in order to prevent temperature instability, can be used in babies > 2.2kg in tropical climates to treat neonatal jaundice.6-9

There are different methods to determine need for phototherapy, all of which rely on measuring or estimating the bilirubin levels in the blood. Bilirubin levels can be measured in all babies using a blood test and transcutaneous devices10,11 or estimated through visual assessment with reference to the Kramer’s scale. (2.4)

**Kramer’s Scale**

<table>
<thead>
<tr>
<th>Score</th>
<th>Bilirubin Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4 - 6mg/dL, 70 - 100 µmol/L</td>
</tr>
<tr>
<td>2</td>
<td>8 - 10mg/dL, 130 - 170 µmol/L</td>
</tr>
<tr>
<td>3</td>
<td>12 - 14mg/dL, 200 - 240 µmol/L</td>
</tr>
<tr>
<td>4</td>
<td>15 - 18mg/dL, 250 - 310 µmol/L</td>
</tr>
<tr>
<td>5</td>
<td>15 - 20mg/dL, 250 - &gt;340 µmol/L</td>
</tr>
</tbody>
</table>

2.4 Kramer’s Scale visual assessment areas.
In the absence of timely availability of serum bilirubin measurements, which are the gold standard, phototherapy should be started for any visible jaundice on day one of life (make sure to press nose, look in mouth and check conjunctiva), or at a Kramer’s level of 3 for jaundice on day 2 of life and later (when jaundice is visible below the umbilicus). See Alert 2.1 for detailed information about the Kramer’s scale. Assessment should be made in natural or white light to ensure results are accurate. Both transcutaneous bilirubin¹² and the Kramer’s scale are less precise in determining serum levels after phototherapy has begun. Some units may plot bilirubin levels using nomograms as well. Ensure a reference is used which is consistent with unit policy.

If serum bilirubin or transcutaneous bilirubin is available, Table 2.1 provides reference levels for when to start phototherapy or consider an exchange transfusion.¹³,¹⁴

**TABLE 2.1 JAUNDICE & PHOTOTHERAPY VS TRANSFUSION**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Day of Life</th>
<th>Healthy Term Baby</th>
<th>Premature &lt;35wks, LBW or sick baby</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phototherapy</td>
<td>Day 1</td>
<td>Treat any visible jaundice with phototherapy</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Day 2</td>
<td>15mg/dl 260mmol/l</td>
<td>10mg/dl 170mmol/l</td>
</tr>
<tr>
<td></td>
<td>Day 3</td>
<td>18 mg/dl 310 mmol/l</td>
<td>15mg/dl 260mmol/l</td>
</tr>
<tr>
<td></td>
<td>Day 4 onwards</td>
<td>20mg/dl 340mmol/l</td>
<td>17mg/dl 290mmol/l</td>
</tr>
<tr>
<td>Exchange Transfusion</td>
<td>Day 1</td>
<td>15mg/dl 260mmol/l</td>
<td>10mg/dl 220mmol/l</td>
</tr>
<tr>
<td></td>
<td>Day 2</td>
<td>25mg/dl 425mmol/l</td>
<td>15mg/dl 260mmol/l</td>
</tr>
<tr>
<td></td>
<td>Day 3</td>
<td>25mg/dl 425mmol/l</td>
<td>20mg/dl 340mmol/l</td>
</tr>
<tr>
<td></td>
<td>Day 4 onwards</td>
<td>25mg/dl 425mmol/l</td>
<td>20mg/dl 340mmol/l</td>
</tr>
</tbody>
</table>

If a baby needs a possible exchange transfusion, intensive phototherapy should be given while waiting to be transferred.

**ALERT 2.1 Physical exam estimation of serum bilirubin**

Measurement of serum bilirubin is the best assessment of neonatal jaundice. However, when timely serum bilirubin measurements are unavailable, Kramer’s is the only studied physical exam proxy for estimating serum bilirubin levels in neonates.

The Kramer’s scale has shown observer to observer variance, especially at high bilirubin levels.¹⁶–¹⁷ However, when ruling out jaundice of bilirubin levels >12 mg/dL (215 mmol/L), studies have shown that the Kramer’s scale can be used pre-phototherapy in term infants if limited to zones 1,2.¹³,¹⁷
Usual optimal spectral irradiance for conventional phototherapy is 25–30\(\mu W/cm^2\) as measured by a phototherapy light meter. Higher optimal spectral irradiances of 30–35 \(\mu W/cm^2\) may be used for intensive phototherapy for at risk infants.\(^\text{18}\) Most jaundiced patients require treatment for 24 to 48 hours, and typically do not require treatment for any longer than 7 days. If jaundice persists, further investigation into the cause of the jaundice should be conducted.

3 Management

Management of an overhead phototherapy unit covers how to use the device in a variety of settings, including set up for a patient, patient preparation & commencement, care whilst on the device & removal of the patient from the device.

**SETTING UP FOR A PATIENT**

1 Collect:
   - Phototherapy device
   - Power cable
   - Phototherapy light meter (if available)

2 Plug in phototherapy device. Turn on and check for blue light from the overhead light elements. NOTE: Some phototherapy lights may have white examination lights. In most models, if light emitting from this type of device is white, it is not therapeutic.

3 Turn on light meter if available. Place light meter on the mattress where the patient needing phototherapy will be located. (3.1)

![3.1 Ideal lightmeter reading location.](image1)

![3.2 Adjust height if necessary.](image2)
The phototherapy unit is typically set at a point where the overhead lights are approximately 20 - 30 cm above a typical cot. Check that irradiance provided at this height is within therapeutic ranges and adjust the height if necessary. (3.2)

- If irradiance is too low, lower the height of the phototherapy light until therapeutic ranges are reached without obstructing care.
- If irradiance is too high, raise the height of the phototherapy light until therapeutic ranges are reached.

Light should cover the entire surface on which the patient will be treated.

### PREPARING A PATIENT

1. Always explain the purpose, risks and benefits of a procedure to guardians BEFORE performing the procedure.
2. Follow handwashing protocol.
3. Collect:
   - Eye mask or gauze and tape
4. Remove all clothes. The diaper should cover the minimum necessary to keep the baby clean.
5. Place eye mask so that it fully covers the patient’s eyes. (3.3) The mask should be tight enough that it will remain in place should the patient be active, but not so tight that it is visibly uncomfortable or cutting into the patient’s skin. If a ready-made eye mask is not available, use gauze to cover the eyes and tape to secure in place. Avoid putting tape on the eyebrows and hair.

3.3 Fully cover the eyes.  
3.4 Place the patient in centre of prepared cot with phototherapy light on.
STARTING A PATIENT

1 Place patient directly under phototherapy lights that are switched on in a prepared cot, warming crib or incubator. (3.4) Always document the date and time that phototherapy was started.

CARING FOR A PATIENT

1 Babies should receive as continuous phototherapy treatment as possible.

2 Monitor according to clinical condition, or in accordance to local policy:
   - **Vital signs:** including respiratory rate, heart rate, peripheral blood oxygen saturation, blood sugar and temperature, or any additional danger signs.
   - **Skin rotation:** the baby should be turned 4 hourly to expose more skin to phototherapy lights.
   - **Daily bilirubin levels:** at least 4 hourly if rising rapidly and if available. Document all bilirubin results with date and time. If serum bilirubin measurement is not available, provide daily reference to the level observed on the Kramer scale.
   - **Signs of dehydration:** jaundiced babies must be well hydrated; extra breastfeeds encourage bowel motions and promote bilirubin excretion. Check that urine is being passed frequently.
   - **Daily weight**

3 At every monitoring point (4 hourly), check that:
   - The eye mask fully covers the patient’s eyes and is still secure. (Alert 3.1)
   - The baby is feeding well and weight is not decreasing. If the baby is not feeding well, consider providing additional expressed breast milk via a nasogastric tube (NGT) or cup, or if very ill an IV fluid therapy containing dextrose.
   - There are no abnormal movements.
   - Any underlying conditions are being treated.
   - Serum bilirubin levels or jaundice areas are not increasing. Blue lights must be switched off to accurately assess visible jaundice. Some phototherapy lights may have white examination lights that can be used to better assess the patient.

4 If serum bilirubin levels or jaundice areas are increasing:
   - Check the irradiance at the patient’s bed-level using a lightmeter. If the irradiance is lower than recommended, increase the irradiance provided by changing the machine settings to a higher level (e.g., brilliance mode) if available, or lowering the height of the phototherapy lights.
   - Ensure maximum skin exposed to light and continue regular feeds. Consider starting IV fluids if bilirubin levels or jaundice is rapidly increasing.

5 Always document the date and time that phototherapy settings were changed.
ALERT 3.1

When feeding and not under the blue light, remove the patient’s eye mask and check for any signs of infection. The baby can be removed from the phototherapy unit and fed in mother’s arms. This will facilitate mother-child bonding. Keep mother and baby together as much as possible whilst still allowing effective treatment time.

REMOVING A PATIENT

1. If referring to the Kramer’s scale, stop phototherapy when jaundice is limited to area 1 in premature infants and areas 1 & 2 in term infants. (Alert 3.2) When serum bilirubin or transcutaneous bilirubin measurement is available, stop phototherapy when the measurement is less than 50mmol/L or 3mg/dl below the level requiring treatment.

2. Turn off the phototherapy light. Gently remove the eye covering from the patient and dispose of the covering. (3.5)

3. Continue to monitor the baby for jaundice over the next 24-48 hours in case the bilirubin level rises again.

ALERT 3.2 Discontinuation of phototherapy when serum bilirubin measurements unavailable

In the absence of timely serum bilirubin measurement, there is no evidence-based method for determining when to remove a patient from phototherapy. WHO Europe guideline suggests a “minimum of 12 hours phototherapy” which is too short for most preterm infants or deeply jaundiced term infants. WHO Pocket Book for Children does not provide guidance on how to stop phototherapy in the absence of utilising serum bilirubin.

Thus, based on expert opinion, although there are no studies addressing the accuracy of the Kramer’s scale after starting phototherapy, it was determined best to give some physical exam guidance based on the Kramer’s scale for when to discontinue phototherapy. Additionally, in the absence of bilirubin levels, cleared conjunctiva are often used as indicating that jaundice has resolved sufficiently to stop treatment. This has not been formally evaluated.

Alternately, if choosing to discontinue phototherapy using length of therapy, based on expert opinion we would recommend a minimum of 24 hours of phototherapy for term infants and longer for preterm infants.
4 Infection Prevention

Routine and adequate cleaning of medical devices is critical to prevent hospital-acquired infections in newborn care units. If devices and equipment are not disinfected or re-processed promptly or adequately between patients, they may pose a significant infection risk.

GENERAL INFECTION PREVENTION

1. Clean hands with soap and water or alcohol before and after placing a patient under phototherapy or handling any materials that will be used on a patient (e.g., eye covers).

2. Ensure that all patient-related equipment (including eye coverings) are new or have been cleaned thoroughly before use. Any patient-related materials, including cot linen, must be cleaned before they are placed on a patient under a phototherapy device.

3. All patient-related equipment should be stored in a clean, dry location. Any cables should be loosely wrapped and secured, preventing sharp bends or kinks, which will decrease the lifetime of the cables. Do not pinch or bend the cables.

4. Only one baby should be under each phototherapy unit. Sharing of a phototherapy light in one cot poses a high risk for infection transmission between patients. Some phototherapy units may be able to provide therapeutic light to multiple patients in several cots at once; though this inevitably means that the cots are close to each other and increases the likelihood of infection transmission. The light should always be tested for efficacy using a light meter near the location in which the patient will be placed.

DISINFECTION AFTER USE

1. Turn off phototherapy light and unplug. Disinfect handle of phototherapy light meter and LCD controls using alcohol. (4.1)

2. Housing of the phototherapy unit (including the casing on the LEDs or lightbulbs) should be cleaned thoroughly according to ward guidelines for disinfecting surfaces.
Disinfection of equipment should always comply with manufacturer guidelines. General guidance on environmental cleaning and disinfection of equipment was taken from the *Infection Prevention and Control: Reference Manual for Health Care Facilities with Limited Resources*, Jhpiego, Module 6 which lists isopropyl alcohol (70-90%), sodium hypochlorite (0.05% or >100ppm available chlorine) quaternary ammonium, and Iodophor germicidal detergent as appropriate for low level disinfection. Phenolic germicidal detergent is also listed in this category but should not be used in neonatal wards since affordable, effective alternatives are available; and, there are concerns it may cause hyperbilirubinemia and/or neurotoxicity in neonates.

When utilizing re-processed devices meant for single-use (like temperature probes), careful attention must always be paid to assure that devices are continuing to function properly.

4.1 Clean the housing of the phototherapy unit according to ward guidelines.
5 Complications

Introduction of equipment in newborn care units poses clinical and device complications for patients. Awareness of potential complications is critical to maximise patient safety.

### CLINICAL COMPLICATIONS

- **Dehydration**: neonatal patients under phototherapy with lights other than LEDs may require more fluid than maintenance volumes. It is important to ensure the patient is feeding well and to monitor for signs of dehydration (not passing urine, weight loss >= 5%, prolonged skin turgor). Additional feeds or intravenous fluids may be required. Dehydration may be worsened by diarrhoea which is a recognised complication of jaundice.\(^{23}\)

- **Hypothermia**: temperature should be carefully monitored as patients are nearly naked under phototherapy. Phototherapy devices are not intended as heating devices. LED bulbs used in most modern devices are very efficient so generate minimal heat; a warming device may be required to avoid hypothermia.

- **Retinal damage**: consistent exposure of the eyes to strong light has been shown to cause retinal damage in adults. Although this has not been tested in neonates, care should be taken to keep the eyes covered at all times during treatment. (5.1)

- **Eye infections**: check for redness, swelling or discharge. The skin under the eye pads should be cleaned daily with warm sterile water to prevent infection.

- **Bronze baby syndrome**: some babies develop a greyish colour to their skin (difficult to see in pigmented babies), urine, and plasma during phototherapy. This is attributed to increased accumulation of bilirubin photoisomers, degradation products, or copper-porphyrin conjugates. The true cause remains uncertain. It is self-limiting, resolves after phototherapy is stopped, and has no long-term sequelae.\(^{23-26}\)

5.1 Uncovered eyes during phototherapy can lead to retinal damage.
- **Acute bilirubin encephalopathy (Kernicterus):** extremely high levels of bilirubin can cross the blood brain barrier causing kernicterus. This may manifest as hypertonia and seizures. If the jaundice is not promptly and appropriately treated with adequate phototherapy light, permanent brain damage may occur e.g., development of deafness, choreoathetoid movements, and cerebral palsy. In addition to phototherapy, exchange transfusions are required for serious jaundice.\(^\text{23}\)

**DEVICE COMPLICATIONS**

- **Inadequate light:** after a set period of use (about 20,000 – 50,000 hours, depending on manufacturer recommendations), phototherapy devices may lose their ability to provide therapeutic light. It is important to test the capacity of the phototherapy regularly to ensure that the phototherapy light is still providing a therapeutic range (25 – 35 \(\mu\text{W/cm}^2\)).

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**6 Care & Maintenance**

Users are responsible for basic first-line care and maintenance to ensure equipment lasts to their potential lifetime.

**POWER SOURCE**

Phototherapy units may be powered via mains or grid power with a rechargeable battery, depending on model.

**WARD LOCATION**

Phototherapy devices are usually rolling units with brakeable caster wheels. Devices may be rolled from patient bed to patient bed as needed.

**USER PREVENTIVE MAINTENANCE**

Test the light for therapeutic light levels once a week using the phototherapy light meter, following the steps in *Phototherapy: Management | Setting Up for a Patient.*
7 Troubleshooting & Repair

Although users are not responsible for repairing their devices, there are steps that may be taken to troubleshoot first-line errors that may occur before contacting maintenance or engineering support.

1. **The phototherapy light does not turn on.**
   
   Check that the power cable is securely attached to the phototherapy device (7.1) and that the switch and power outlet are turned on. If the phototherapy unit still does not turn on, contact your maintenance department.

   7.1 If the light does not turn on, check that the power cable is securely attached.

   7.2 If bulbs are not working, ask for replacement bulbs.

2. **The phototherapy light turns on, but only some of the lights are functional. (7.2)**

   Contact your maintenance department and ask for replacement bulbs. Some phototherapy units have different switches for the white examination lights and the blue phototherapy lights. Each set of lights must be switched on separately. Examination lights **do not treat jaundice**. Blue phototherapy lights are therapeutic and must be replaced in order for treatment to be effective.
Assessment Questions

1. Which of the following is the most therapeutically effective and efficient method of providing phototherapy? Please circle an option below.
   
   (A) blue LEDs within 425 – 475 nm  
   (B) blue halogen bulbs  
   (C) UV fluorescent bulbs

2. Under what conditions would you lower the height of the phototherapy unit?
   
   The patient’s jaundice requires increased intensity and the phototherapy unit in use does not have a higher intensity setting.

3. Your patient’s temperature is being managed on a radiant warmer during their first day of life. While monitoring the patient, you note that they shows signs of jaundice. What will you do?
   
   Keep the patient in the radiant warmer. Angle an overhead phototherapy unit to provide treatment at the same time, measuring the provided therapeutic irradiance at the point of the radiant warmer cot using a lightmeter.
References


20 *Neonatology: Effective Perinatal Care.* (World Health Organization Regional Office of Europe, 2010).


22 Sharma, G. Infection Prevention and Control at Neonatal Intensive Care Units. 134.


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