PHOTOTHERAPY

Overview — Phototherapy, using light of specific wavelengths and doses, is considere
plasma bilirubin (TB) levels based upon its extensive use in millions of infants over six
green light wavelength range (425 to 475 nm) that reduces TB, it also contains the har
risk of sunburn and potential for skin malignancies. Therefore, unfiltered sunlight sho
below.)

Phototherapy, using approved light sources, is the most commonly used treatment fo
micromol/L) [1]. However, there is growing concern that phototherapy may be overpre
exceeds its potential harm. There is some evidence that there may be long-term adver
inappropriate use may unnecessarily prolong birth hospitalization and impede matern
must be treated like any other medication and administered using regulated and appr
appropriate and correct dosing of phototherapy based on a risk/benefit assessment fo
phototherapy. (See "Unconjugated hyperbilirubinemia in term and late preterm infant
phototherapy' and "Unconjugated hyperbilirubinemia in term and late preterm infant
on risk severity assessment'.)

Efficacy — Phototherapy reduces TB concentrations and decreases the trajectory or b
hyperbilirubinemia, regardless of the patient's ethnicity or the etiology of the hyperbil
prevent the TB from rising to a level at which exchange transfusion is recommended. I
development of chronic bilirubin encephalopathy (CBE), previously referred to as kern
for phototherapy are generally considered to be well below those at which bilirubin ne
hyperbilirubinemia in term and late preterm infants: Epidemiology and clinical manife

Effective phototherapy results in a decline of TB of at least 2 to 3 mg/dL (34 to 51 micr
measured as soon as two hours after initiation of treatment. Twenty-four hours of pho
decrease in initial TB levels [14-16]. (See 'Dosing' below.)

Dosing — The rate of declining TB is dose-dependent and based on the amount of ph
exposed to the light [1]. In turn, the amount of irradiance (measured as microW/cm^2 o
depends upon the light source used (wavelength, bandwidth, and intensity), the distan
exposed BSA of the infant. The product of the irradiance and BSA is known as the spec
phototherapy provided [3]. Under standard phototherapy, an infant is exposed to an ir
the 2004 American Academy of Pediatrics (AAP) Guideline primarily focused on preven
(342 micromol/L), rapidly rising TB levels or if TB >25 mg/dL (428 micromol/L), intensit

For TB levels >20 mg/dL (342 micromol/L), phototherapy should be administered cont
phototherapy can be interrupted for feeding and/or parental holding. The use of fiber
discussed below.

Intensive phototherapy ("crash-cart" phototherapy) — Intensive phototherapy (als
with severe hemolysis, poor responses to standard phototherapy, TB levels close to th
time period needed to set up for the exchange transfusion [1]. Intensive therapy could
(ABE) and may avoid the need for exchange transfusion. This approach should also be
levels are not known or are pending. Intensive phototherapy uses higher levels of irra
microW/cm^2/nm can be used in term infants [gestational age (GA) ≥37 weeks]) with ex
much of an infant's BSA as possible with a combination of available devices, and/or in
pad/mattress, or special blue lights placed below the infant. Another option is the use
that it provides increased efficacy [17].

Light sources and devices — Although several light sources are available for phototh
the safest and most efficacious [19,20]. Other alternate light sources include fluoresce
lighting is temporarily suspended, LED-based pads/mattresses or fiberoptic blankets c

- Blue LEDs – Blue LEDs uses high-intensity gallium nitride gas that emits light at a
available as both overhead and underneath (pad/mattress) devices [2,21,22]. Thes
absorption spectrum of bilirubin and do not emit UV light [19,20]. Reviews of the l
source, as it is the safest and most effective [19,20]. A subsequent trial in extreme
found that the absolute and relative decrease of TB during the first 24 hours of lif
fluorescent blue lights, and then fiberoptic blankets [23]. (See "Unconjugated hyp
gestation)", section on 'Initiation of phototherapy'.)

  LED-based mattresses are preferable to fiberoptic pads because they are large en

- Fiberoptic blankets or pads – Fiberoptic blankets or pads generate little heat and c
irradiances than fluorescent lights [14]. However, blankets are typically small and
in term infants. They can be used as an adjunct to overhead lights. Fiberoptic blan
lighting is discontinued. This is particularly helpful for infants with severe hyperbi
should be used with caution to minimize risk of skin breakdown.

Sunlight exposure

- **Direct sunlight** — Although exposure to sunlight is known to lower TB levels [24],
not recommended as a therapeutic option to prevent hyperbilirubinemia (TB >20

phototherapy to assess its effectiveness.

- For infants who required phototherapy during the birth hospitalization, TB levels s phototherapy.

If TB levels have effectively declined, subsequent measurements can be obtained ever based on the subsequent measurements with intensifying dosing with inadequate rec with an adequate response.

If, despite intensive phototherapy, TB levels are at or approach the threshold for excha and cross-match. In addition, if exchange transfusion is being considered, serum albu plasma) bilirubin/albumin (B/A) ratio can be calculated and used in conjunction with th exchange transfusion. (See "Unconjugated hyperbilirubinemia in term and late preter intervention based on risk severity assessment' and "Unconjugated hyperbilirubinemi on 'Exchange transfusion'.)

Hydration — It is important to maintain adequate hydration and urine output duri principal mechanism by which phototherapy reduces TB levels. Thus, during phototh bottle. For TB levels that approach the exchange transfusion level, phototherapy shou 20 mg/dL (342 micromol/L), and LED mattress or fiberoptic blankets/pads can be used threshold, phototherapy can be interrupted for feedings. Enteral nutrition with photot to enterohepatic circulation.

There is no evidence that intravenous (IV) fluid supplementation provides significant a However, IV hydration is a potential option to correct for dehydration, hypovolemia, ar depletion whose oral intake is inadequate [1].

Breastfeeding — Breastfed infants whose intake is inadequate, who have exces of hypovolemia should receive supplementation with human milk either expressed ma Formula may be used if these preferred sources of human milk are not available. If br possible. (See "Unconjugated hyperbilirubinemia in the newborn: Pathogenesis and et "Initiation of breastfeeding", section on 'Assessment of intake' and "Breastfeeding the

Discontinuation — We generally discontinue phototherapy:

- For infants who have been readmitted for phototherapy, when their TB levels are
- For those who required phototherapy during the birth hospitalization, when the T

without hemolysis and do not have other risk factors, who have TB levels 2 to 3 mg/dL level for initiation of hospital phototherapy, are feeding well, and can be closely follow

In a retrospective review of 1324 of 1385 neonates (GA ≥35 weeks) who met inclusion blue-LED-based fiberoptic blankets (irradiance of 20 to 36 microW/cm^2/nm) was effect required hospitalization for hyperbilirubinemia after starting home phototherapy [34] above the threshold hour-specific TB values for initiation of phototherapy (mean TB le age of 94 hours). The decision for home phototherapy was made by the primary care was likely based on the recommendation by the 2004 AAP guideline, which stated that below the treatment threshold and who do not have hemolytic disease. Therefore, it r would have reached the threshold for phototherapy and whether there was unnecess phototherapy was provided by a service company, which did not accept all forms of M can be successfully implemented in selected infants and situations and reduces TB. Al and valued by some families, its cost-effectiveness based on appropriate prescription is safe for infants with hemolytic disease. (See "Unconjugated hyperbilirubinemia in te 'Subthreshold (prophylactic) phototherapy'.)

Transport phototherapy — Transport phototherapy should be provided to infants wh infant can be cared for at a medical center that can provide appropriate hyperbilirubin been shown to be effective and should be provided during transport.

Adverse effects — Because of the potential for adverse effects, especially long-term r extremely preterm infants (GA <28 weeks), phototherapy should be prescribed only wh appropriate light sources that can emit ideal peak wavelengths and filter out harmful and late preterm infants: Management", section on 'Criteria for intervention based on hyperbilirubinemia in the preterm infant (less than 35 weeks gestation)", section on 'M

Short-term effects — Documented potentially adverse effects in human infants in decreased cytokine levels, decreased cardiac output and renal blood flow, increased ce transient, benign, erythematous rashes [3] Increased insensible water losses that are

Bronze baby — "Bronze baby syndrome" is an uncommon but reversible skin co discoloration of the skin, serum, and urine [35]. It is caused by integumentary deposit photoisomers, and occurs in infants with cholestatic jaundice (conjugate bilirubin >2 m neurotoxicity associated with this syndrome; it usually resolves without sequelae withi pigments are slowly eliminated [37]. Thus, there is no contraindication to the use of ph

Childhood cancer — Concerns that neonatal phototherapy may increase the ris challenging to determine if there is a direct association between cancer and the recom sources) due to challenges of controlling confounding factors (eg, exposure to direct s of light sources (some of which do not filter out UV radiation). If phototherapy is a risk concern of potential long-term risk of cancer serves as another reminder that phototh

Data that demonstrated an association between phototherapy and childhood cancer i

- A retrospective cohort single network study of infants born ≥35 weeks GA betwee childhood cancer in children exposed to phototherapy compared with unexposed overall rates were for any cancer (adjusted hazard ratio [aHR] 1.0, 95% CI 0.7-1.6), leukemia (aHR 1.9, 95% CI 0.6-6.9), and liver cancer (aHR 1.2, 95% CI 0.2-12).

- A study that used linked state-wide data from California with follow-up to one yea diagnosed more frequently for infants with diagnostic codes for phototherapy co 100,000 patients, relative risk [RR] 1.6, 95% CI 1.2-2.0) [41]. After adjusting for pro still remained for infants exposed to phototherapy at one year of age for overall c myeloid leukemia (aOR 2.6, 95% CI 1.3-5.0) and kidney cancer (aOR 2.5, 95% CI 1.2 of cancer was higher in patients with Down syndrome.

Skin manifestations — Data are conflicting regarding the association between review of studies that used blue light phototherapy (using broadband blue fluorescent reported an increased risk of melanocytic nevi in children and adolescents [42], other and melanocytic nevi [43,44]. One of the studies reported there was an increased risk

Unproven retinal effects — Although the effect of phototherapy on the retina c retinal degeneration may occur after 24 hours of continuous exposure [45]. As a result phototherapy are covered to eliminate any potential exposure to light, including the ri primary infantile response and eye shades serve as additional aides for comfort and p

No effect on childhood asthma — There is limited evidence that moderate levels o but phototherapy does not alter this risk [46].

EXCHANGE TRANSFUSION

Overview — Exchange transfusion, an intervention with known risks, should be avoid

of re-equilibration between extravascular and vascular bilirubin. Several studies have s
response (BAER) in infants following exchange transfusion for hyperbilirubinemia [51-

Procedure — Infants who are close to meeting or meet the criteria for exchange trans
NICU or PICU. Urgent and intensive phototherapy (see 'Intensive phototherapy ("crash
time period needed to set up for the exchange transfusion. On admission, a type and
umbilical catheter are performed promptly, so that exchange transfusion, if needed, c

The procedure involves umbilical catheter placement and removing and replacing bloo
the infant's blood volume. The infant's circulating blood volume is approximately 80 to
180 mL/kg) replaces approximately 85 percent of the infant's circulating red blood cell
(from packed RBCs and fresh frozen plasma) blood. It is vital that reconstituted blood
bilirubin binding, as packed RBC is inadequate and may potentiate ongoing bilirubin t
capacity [56]. Irradiated blood products should be used to reduce the risk of graft vers
products should be used to reduce the transmission of CMV in seronegative recipients
on 'Red blood cells'.)

Infusion of albumin (1 g/kg) one to two hours before the procedure shifts more extrav
theoretically allow removal of more bilirubin, has not been shown to decrease the nee
our center, we do not administer albumin prior to exchange transfusion.

Post-procedure management — Following exchange transfusion, phototherapy is re
and continued at the same therapeutic dose used prior to exchange). TB is measured
decisions are made dependent on the level of TB.

Complications — The risks of exchange transfusion result from the use of blood prod
(see "Red blood cell transfusion in infants and children: Administration and complicati

- Blood-borne infections
- Thrombocytopenia and coagulopathy
- Graft versus host disease
- Necrotizing enterocolitis
- Portal vein thrombosis
- Electrolyte abnormalities (eg, hypocalcemia and hyperkalemia)
- Cardiac arrhythmias

Morbidity and mortality — Because exchange transfusions are rarely performed, it is

(See 'Intensive phototherapy ("crash-cart" phototherapy)' above.)

- During phototherapy, infants should be placed supine in an open crib or bassinet covered by the diaper, and the eyes shielded with an opaque blindfold (picture 1). irradiance dose are monitored throughout the procedure. (See 'Technique' above

- Although several light sources are available for phototherapy, we suggest using b prescribed to treat neonatal hyperbilirubinemia (**Grade 2B**). (See 'Light sources ar

- For resource-limited areas where approved phototherapy devices are not available remove ultraviolet (UV) and infrared light rays, be used to treat mild to moderate exposure' above.)

- Common short-term adverse effects of phototherapy include hyperthermia, interr erythematous rashes. Increased insensible water losses that are not replaced may

- Because of the possibility of long-term adverse effects (childhood seizure and can infants (GA <28 weeks), phototherapy should be prescribed only when target thre sources that filter out UV light. During phototherapy, there is ongoing monitoring (See 'Adverse effects' above and 'Extremely preterm infants and mortality' above a

- Exchange transfusion is a potentially life-saving emergency procedure that acutely rare, expensive, time-consuming procedure, which requires clinical expertise, exch removing bilirubin rapidly. It is used to treat symptomatic infants with moderate t fails to effectively reduce TB in infants with or at-risk for developing severe hyperb 'Exchange transfusion' above.)

- Exchange transfusions should be performed only by trained personnel in a neona with full monitoring and resuscitation capabilities. Patients who are admitted afte for exchange transfusion should be admitted to the intensive care unit to expedite bypassing the emergency room and avoiding unnecessary delay of therapy. (See '

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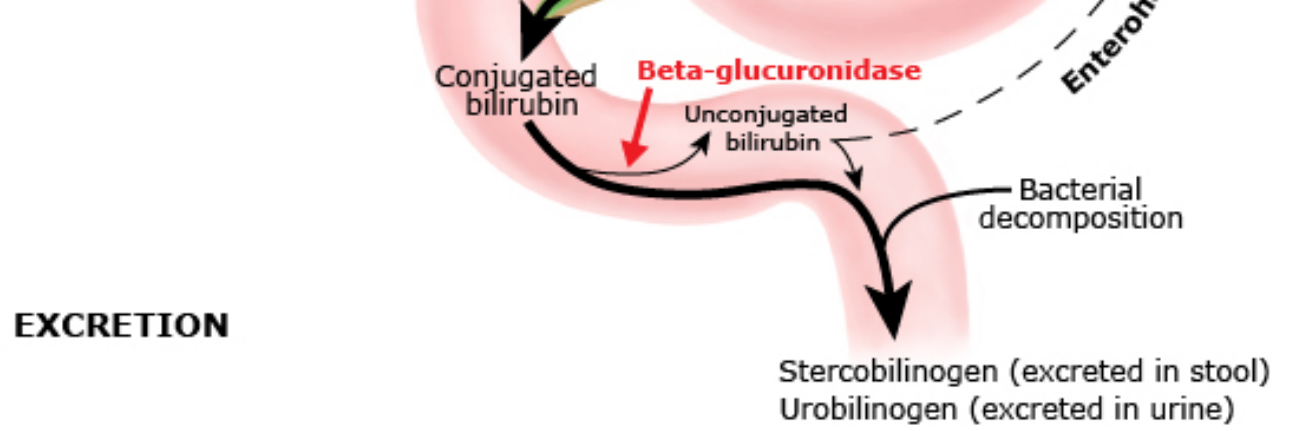

Schematic diagram demonstrating the production, metabolism, and excretion of bilirubin.

*Physiologic mechanisms that reduce the movement of free bilirubin across the blood-brain barrier include binding to plasma albumin and rapid uptake, conjugation, and clearance by the liver. These protective mechanisms are less efficient in neonates (especially preterm infants) and individuals with inherited disorders of bilirubin conjugation. As a result, these patients are at risk for bilirubin-induced neurotoxicity.

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Graphic 121543 Version 4.0

Preterm infant (postmenstrual age of 30 weeks) receiving phototherapy, nasal CPAP, and oral nasogastric feeds.

CPAP: continuous positive airway pressure.

Graphic 116147 Version 1.0