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Neonatal Jaundice

REPUBLIC OF KENYA
MINISTRY OF HEALTH

NEST360°

University of Nairobi

KENYA PAEDIATRIC ASSOCIATION

KEMRI | Wellcome Trust

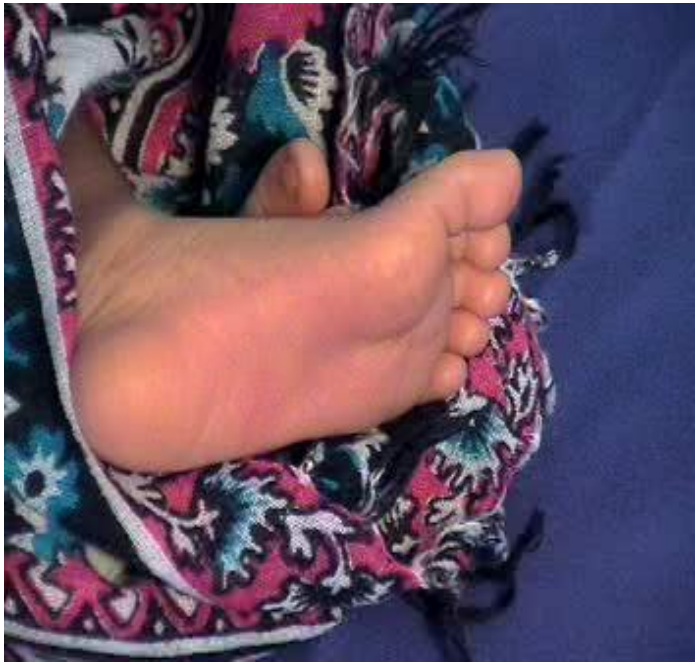
Keprecon
Kenya Paediatric Research Consortium

Objectives

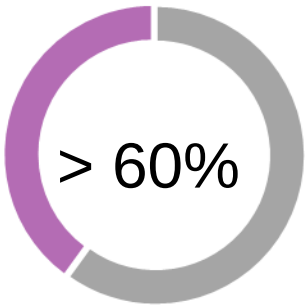
- To define the neonates who should have serum bilirubin test
- To describe risk factors for bilirubin encephalopathy
- To describe the use of Nomograms to determine appropriate intervention
- To illustrate the correct use of phototherapy

Introduction

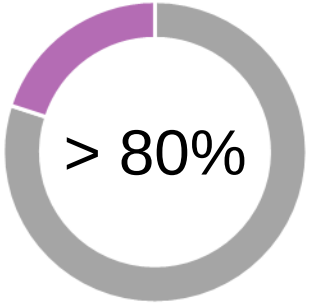
Introduction



Jaundice is a yellowish discoloration of the **skin**, **sclerae**, and **mucous membranes** caused by tissue deposition of pigmented bilirubin



Term neonates[2]



Preterm neonates[2]

Neonatal jaundice - usually observed in **first week** of life when **total serum bilirubin** level reaches **86 micromol/L** (5 mg/dL)[1].

1.Willy T, Hansen R. Core Concepts . Bilirubin Metabolism.NeoReviews: 2010;11(6).
2.Bhutani VK, et al .Predischarge screening for severe neonatal hyperbilirubinemia identifies infants who need phototherapy. J Pediatr.

High levels of haemoglobin lead to high levels of bilirubin

Intrauterine environment – relatively hypoxic

- Foetal Hb has enhanced oxygen binding capacity
- High Hb at term (Hb 19.3 +/- 2.2g/dl)

Extrauterine environment - high oxygen concentration

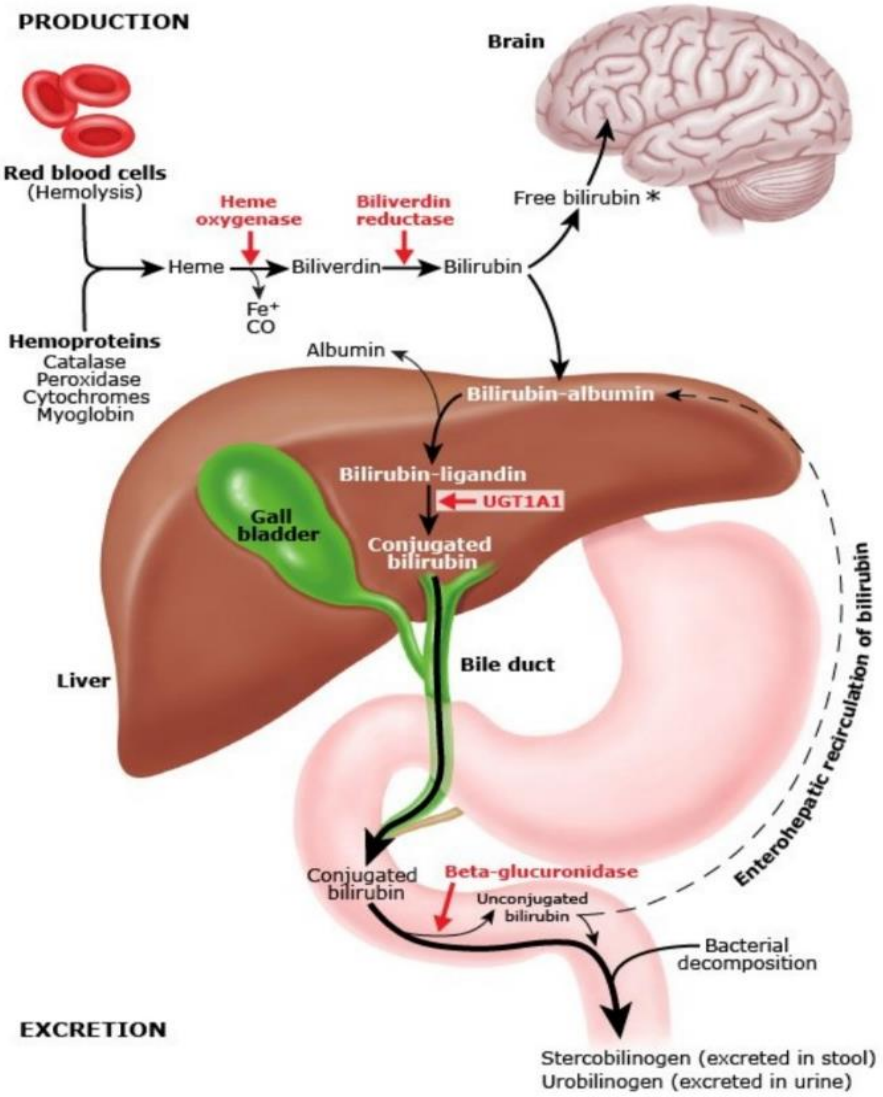
- Lower Hb
- Increase in adult Hb

Anemia and Polycythemia in the Newborn Erica Hyman Kates, Jacqueline S. Kates Pediatrics in Review Jan 2007,

Bilirubin Metabolism

High bilirubin level can cause irreversible brain damage.

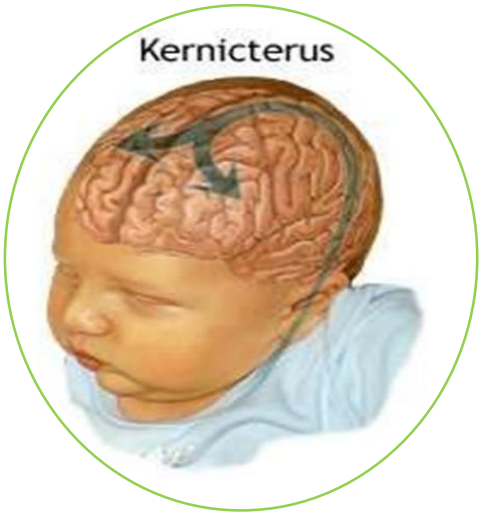
Chief rationale of treating newborn jaundice is the prevention of kernicterus



Care of the jaundiced neonate, Stevenson DK, Maisels MJ, Watchko JF (Eds), McGraw Hill Companies, New York 2012

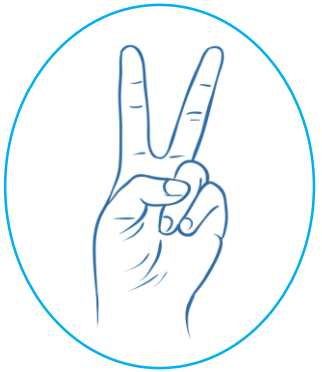
Why worry about high levels of unconjugated bilirubin ?

Bilirubin Encephalopathy



Kernicterus or bilirubin encephalopathy is a neurologic syndrome resulting from the deposition of unconjugated bilirubin in the basal ganglia and brainstem nuclei

Bilirubin encephalopathy occurs in 2 forms:



1. Acute bilirubin encephalopathy
2. Chronic bilirubin encephalopathy

Karimzadeh P, Fallahi M, Kazemian M, Taslimi Taleghani N, Nouripour S, Radfar M. Bilirubin Induced Encephalopathy. Iran J Child Neurol. 2020;14(1):7-19.

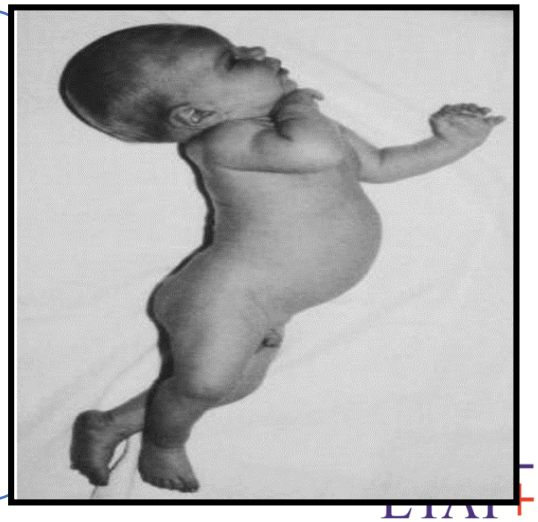
Signs of bilirubin encephalopathy

Acute Form

- **Phase 1 (first 1–2 days):** decreased alertness, poor feeding, hypotonia and weak Moro
- **Phase 2 (middle of first week):** irritability, hypertonia of extensor muscles, opisthotonos
- **Phase 3 (after the first week):** hypotonia, apnoea

Chronic Form

- **First year**: hypotonia, hyperreflexia, delayed motor skills, obligatory tonic neck reflexes
- **After first year**: sensorineural hearing loss, upward gaze, dental enamel hypoplasia, movement disorders (dystonia and athetosis),



Usman F, Diala UM, Shapiro SM, Le Pichon JB, Slusher TM. Acute bilirubin encephalopathy and its progression to kernicterus: current perspectives. Research and Reports in Neonatology. 2018;8:33-44 https://doi.org/10.2147/RRN.S125758

Risk factors for Bilirubin Encephalopathy

1. High total serum bilirubin levels
2. Hemolysis
3. Preterm infants
4. Acidosis
5. Sepsis
6. Hypercarbia
7. Hypoxia
8. Asphyxia
9. Dehydration

Danger signs

- Poor feeding
- Lethargy
- Fever
- Irritability
- Seizures

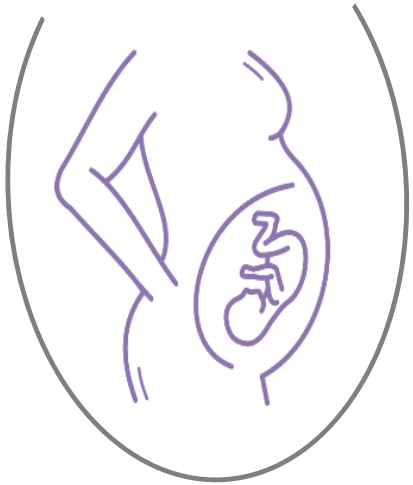
Usman F, Diala UM, Shapiro SM, Le Pichon JB, Slusher TM. Acute bilirubin encephalopathy and its progression to kernicterus: current perspectives. Research and Reports in Neonatology. 2018;8:33-44 https://doi.org/10.2147/RRN.S125758

Management of Indirect Hyperbilirubinaemia

Primary Prevention and Early Detection

Prevention

- **Educate PG women** on recognition of NNJ[1].
- Determine mother's **blood type and timely** provision of anti-D globulin[1].
- **Pre-discharge counselling** of mothers
- Good **lactational support**[2]



Early detection

- Examine newborns within **24hrs** and in the following 2 days.
- Caregivers be encouraged to **look** for jaundice
- **Monitoring** of high risk infants
- Ongoing **HCW training** on S/S of acute bilirubin encephalopathy and **timely treatment**

Bhutani VK, Zipursky A, Blencowe H, Khanna R, Sgro M, Ebbesen F, et al.Neonatal hyperbilirubinemia and Rhesus disease of the newborn: incidenceand impairment estimates for 2010 at regional and global levels. Academy of Breastfeeding Medicine Protocol Committee. ABM clinical protocol #22: guidelines for management of jaundice in the breastfeeding infant equal to or greater than 35 weeks' gestation.

Phototherapy

Enhancing conversion of the lipid soluble unconjugated bilirubin to harmless water soluble bilirubin

Lipid soluble ; can cross the blood brain barrier

Breakdown of Rbc and hemoglobin → Unconjugated bilirubin

Unconjugated bilirubin → No intervention → Kernicterus

Bilirubin encephalopathy

Phototherapy

Converts

Unconjugated bilirubin → Water soluble isomers

Water soluble isomers

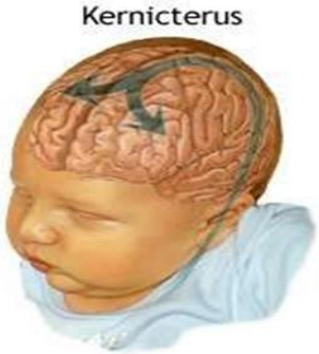
Easily excreted in urine and feaces

Jasprova J, Dal Ben M, Vianello E, Goncharova I, Urbanova M, Vyroubalova K, et al. (2016) The Biological Effects of Bilirubin Photo isomers. PLoS ONE 11(2): e0148126. doi:10.1371/journal.pone.0148126

Goals of Phototherapy

Main purpose of treatment of hyperbilirubinemia is to prevent encephalopathy.

Kernicterus is a devastating, permanently disabling neurologic condition resulting from bilirubin neurotoxicity[2]

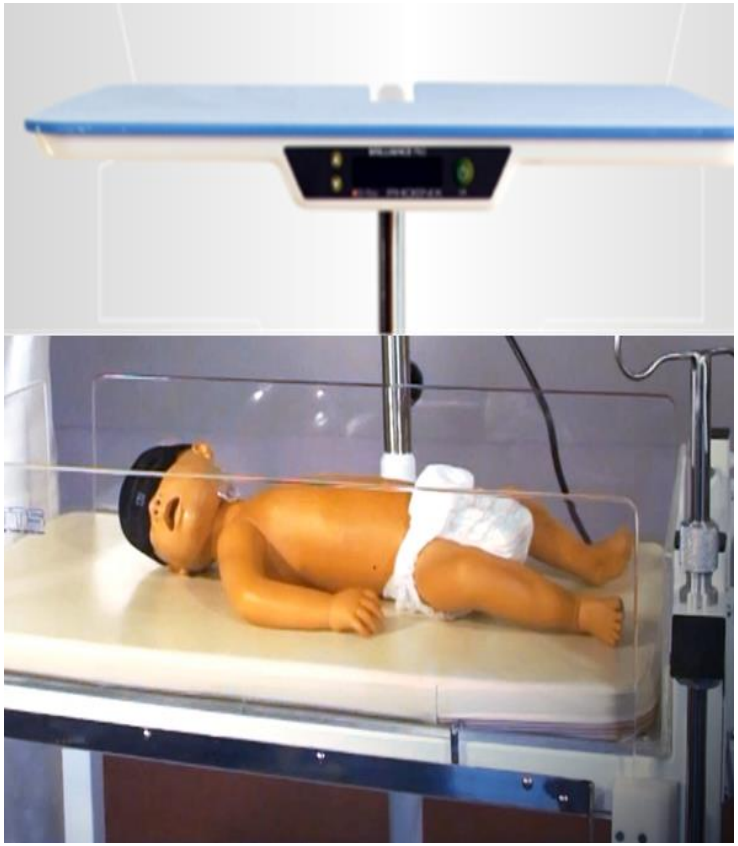


This requires **timely** detection , diagnosis and appropriate management[1]

Mothers should be shown how to recognize jaundice very early and seek timely health care. Best time to teach mothers- antenatal period

Olusanya et al. Management of late-preterm and term infants with hyperbilirubinaemia in resource-constrained settings. BMC Pediatr. 2015;15:39.Okolie F, South-Paul JE, Watchko JF. Combating the Hidden Health Disparity of Kernicterus in Black Infants: A Review JAMA Pediatr. 2020;

Principles of Phototherapy



- Treatment of significant hyperbilirubinemia.
- Delivered by light-emitting diode (LED), fibreoptic or fluorescent lamps or tubes or bulbs.
- Maximize BSA exposed to phototherapy - diaper only and eyes must be covered
- Maintain hydration and urine output

Not indicated in conjugated hyperbilirubinemia-- will develop “Bronze baby syndrome”

Vandborg PK, M HB, Greisen G, Ebbesen F. Dose-response relationship of phototherapy for hyperbilirubinemia. Pediatrics[1] 2012;130(2):e352-e7[1] Olusanya BO, Ogunlesi TA, Kumar P, et al. Management of late-preterm and term infants with hyperbilirubinaemia in resource-constrained settings. BMC Pediatr. 2015;15:39. Published 2015 Apr 12. doi:10.1186/s12887-015-0358-z

Principles of Phototherapy

Standard Phototherapy irradiance 25-30 μW/cm^2/nm.

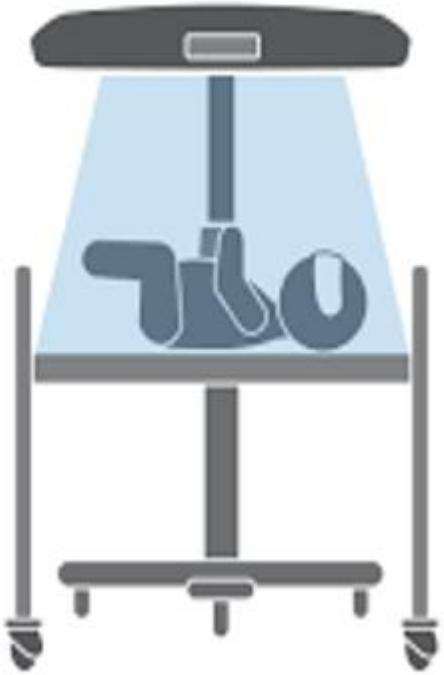
Intensive phototherapy- irradiance 30-35 μW/cm^2/nm

Dose depends on wave length, the irradiance and average spectral irradiance

- **Wavelengths – 430 - 490nm and blue - green range**
- **Irradiance** is the amount of **energy flowing out the light** received by the exposed body surface area
- **Higher spectral irradiance-** faster **decline** in the bilirubin levels

Intensified phototherapy

- Consider intensified phototherapy to treat if the serum bilirubin is:



1. Rising rapidly **>8.5 µmol/l** per hour
2. Is **50 µmol/l below threshold** for exchange transfusion
3. Continues to rise or does not fall **within 6 hours** of starting phototherapy.

Do not interrupt intensive phototherapy for feeding ,but continue administering enteral feeds using the NGT, If indicated- IV fluids

Expect ↓ 34 µmol/l within 6 hrs

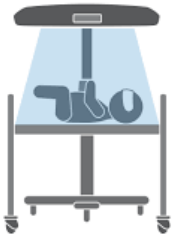
https://www.nice.org.uk/guidance/cg98/evidence/addendum-pdf 2490921037file:///C:/Users/Lenovo/Downloads/KPA%20PROTOCAL%20(E.%20WEB%20FEb%2024th(4)%20(1).pdf
Olusanya et al. Management of late-preterm and term infants with hyperbilirubinaemia in resource-constrained settings. BMC Pediatr. 2015

Role of Filtered Sunlight

Filtered sunlight

- Do not recommend the use unfiltered sunlight
  - Risks- UV radiation, hyperthermia and sun burn[1].
- Role of **filtered sunlight –** where Film canopies are used to Filter out most Ultraviolet A,B and C and infrared (heat) radiation.
- After filtering allows passage of therapeutic blue light **400-520 nm**

Phototherapy



- Filtered sunlight provides above **the threshold of intensive phototherapy**(at least 30uW/cm^2/nm)

Filtered sunlight is noninferior to conventional phototherapy for the treatment of neonatal hyperbilirubinemia[2]

. A Randomized Trial of Phototherapy with Filtered Sunlight in African Neonates. N Engl J Med. 2015;373(12):1115-1124.[2] doi:10.1056/NEJMoa1501074

Assessment of Hyperbilirubinemia

Assessment of hyperbilirubinaemia

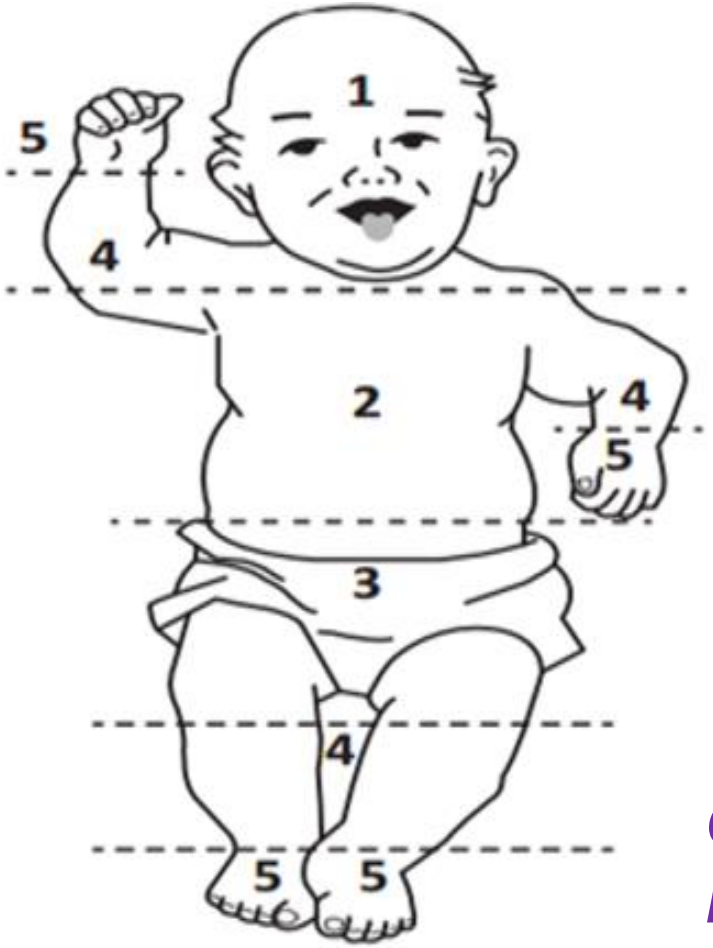
Assessment can be done in three ways:

1. **Using the Kramer's scale**
   Visual estimation of cephalocaudal progression
2. Transcutaneous bilirubin measurement(TcB)
3. Total serum bilirubin levels(TSB)

Objective assessment by means of a TcB or TSB measurement

1. Kramer's scale

The **Kramer's scale** is based on a 1969 study of 108 full term infants which found that bilirubin concentrations. were correlated to five specific dermal zones. At 24 and 48 hours, the infant's skin was blanched using thumb.



Area of body	level	serum bilirubin
Head and neck	1	68-133
Upper trunk(above umbilicus)	2	85-204
Lower trunk and thighs(below umbilicus	3	136-272
Arms and legs	4	187-306
Palms and soles	5	≥306

Check baby in bright and preferably natural light

Kramer LI. Advancement of Dermal Icterus in the Jaundiced Newborn. Am J Dis Child. 1969;118(3):454–458. doi:10.1001/archpedi.1969.02100040456007

2. Transcutaneous bilirubin levels

- Based on **optical spectroscopy**

Advantages

- Non invasive- sternum or forehead
- Immediate results / prescreening
- Less costly
- Viable alternative.

If TcB ≥ 250 µmol/l or ≤ 50 µmol/l /L below threshold for phototherapy measure the TSB.

Okwundu CI, Uthman OA, Suresh G, et al Transcutaneous bilirubinometry versus total serum bilirubin measurement for newborns. Mabogunje CA, Imosemi DO, Emokpae AA. Transcutaneous bilirubin nomograms in African neonates. PLoS One. 2017;12(2):e0172058. Published 2017 Feb 13.; Cochrane Database of Systematic Reviews 2017, Issue 5. Art. No.: CD012660. DOI:[2] McGillivray A, Polverino J, Badawi N, Evans N.
Image source https://philipsproductcontent.blob.core.windows.net/assets/20170616/f722df04b6ce4e7dad79a7940147347a.pdf

2. Transcutaneous bilirubin levels

Disadvantages

- Affected by gestational age and skin colour.
- TcB **overestimates in dark skin colour.**
- **Not recommended if**:
  - Jaundice is prolonged or conjugated hyperbilirubinemia , Baby on phototherapy or had phototherapy
  - Baby had an exchange transfusion

Okwundu CI, Uthman OA, Suresh G, et al Transcutaneous bilirubinometry versus total serum bilirubin measurement for newborns. Mabogunje CA, Imosemi DO, Emokpae AA. Transcutaneous bilirubin nomograms in African neonates. PLoS One. 2017;12(2):e0172058. Published 2017 Feb 13.; Cochrane Database of Systematic Reviews 2017, Issue 5. Art. No.: CD012660. DOI:[2] McGillivray A, Polverino J, Badawi N, Evans N.
Image source https://philipsproductcontent.blob.core.windows.net/assets/20170616/f722df04b6ce4e7dad79a7940147347a.pdf

3.Total serum bilirubin (TSB) levels

TSB-Gold standard for diagnosing hyperbilirubinaemia

Do TSB immediately for any baby with suspected or obvious jaundice:

- *First 24 hours of life and Gestational age of less than 35 weeks*

- Repeat within 6 hours in all babies when levels are 1-50 µ*mol/l* below phototherapy threshold

Olusanya BO, Ogunlesi TA, Kumar P, et al. Management of late-preterm and term infants with hyperbilirubinaemia in resource-constrained settings. BMC Pediatr. 2015;15:39.

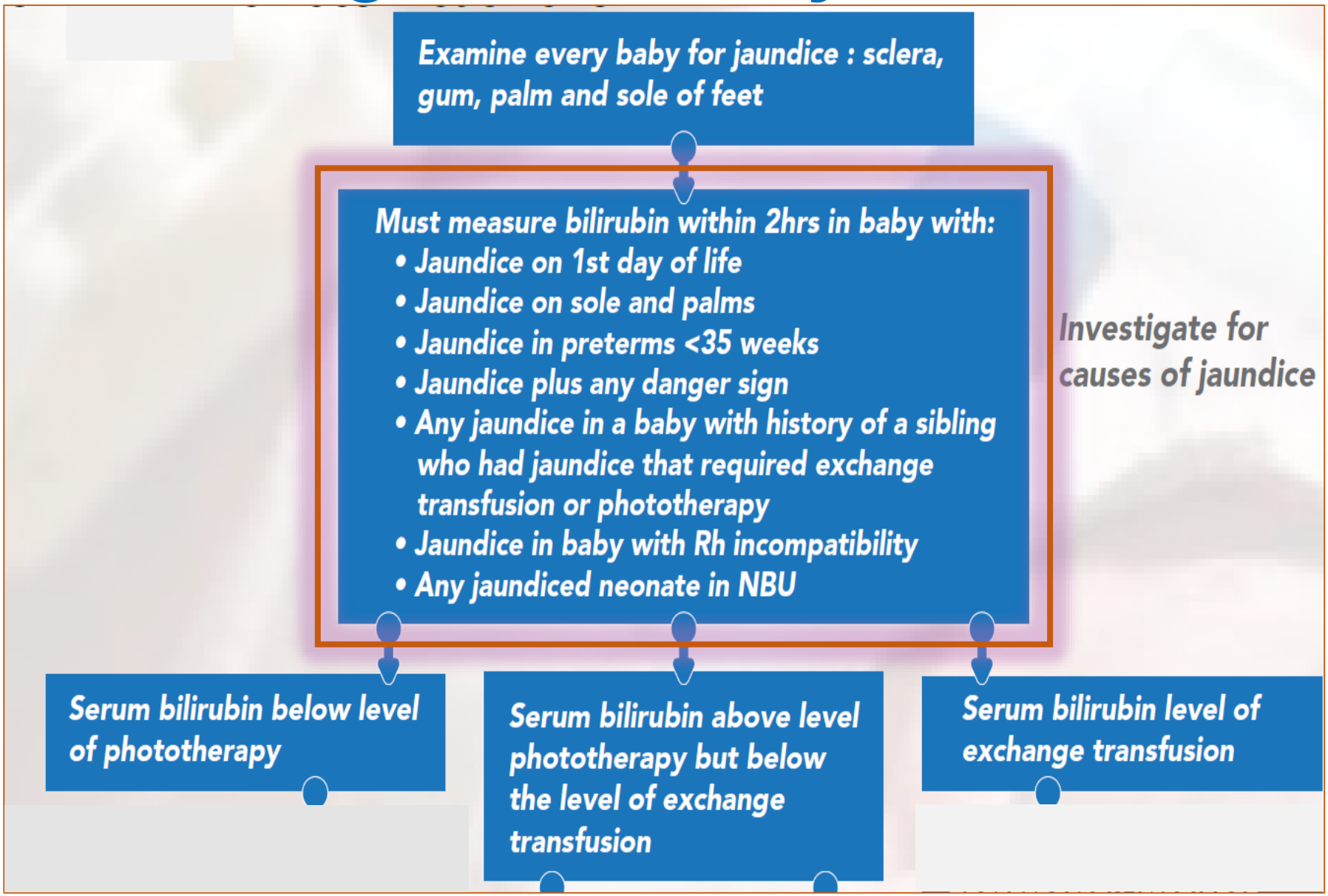
3.Total serum bilirubin (TSB) levels

- For monitoring babies under phototherapy:
- TSB 4–6 hourly until the rise of serum bilirubin is controlled, then 12–24 hourly.
- Guides on when to stop phototherapy
  - *Stop when TSB is greater than 50 µmol/l below line and*
  - *Recheck in 12–24 hours-for rebound hyperbilirubinemia*

Visual estimation leads to errors esp. in darker skin tones or those receiving phototherapy

Olusanya BO, Ogunlesi TA, Kumar P, et al. Management of late-preterm and term infants with hyperbilirubinaemia in resource-constrained settings. BMC Pediatr. 2015;15:39.

Assessing the severity of Jaundice



Determining which Therapy to use

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Phototherapy – Determining Use

Before initiating phototherapy;

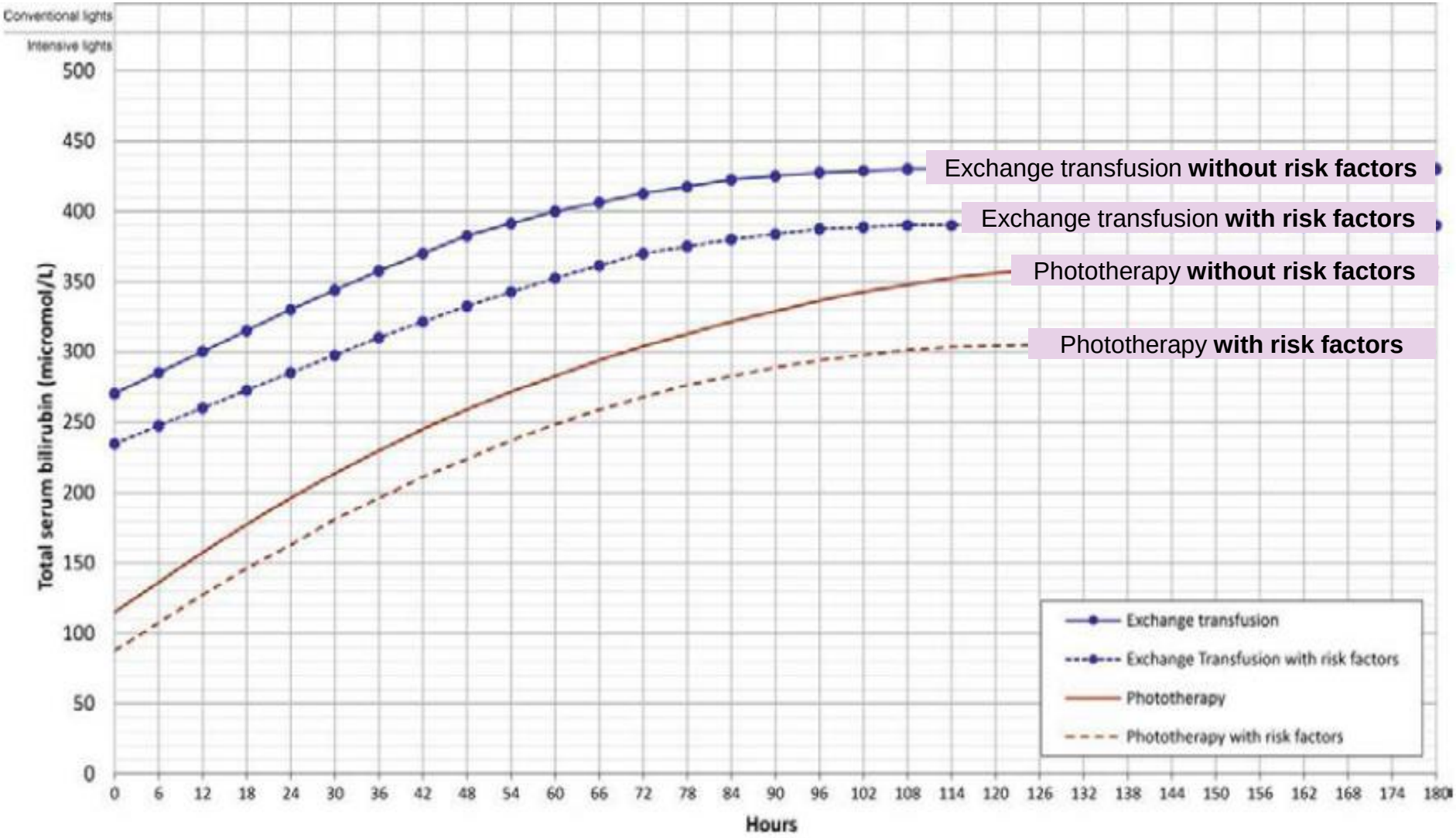
1. Assess neonate for jaundice
2. Measure total serum bilirubin (TSB) levels for patients with jaundice
3. Determine if TSB levels are within phototherapy threshold using available nomograms

Nomograms help determine need for phototherapy & irradiance mode to use based on the neonate's;

1. **Total serum bilirubin**
2. **Postnatal age (hours)**
3. **Presence of risk factors**
4. **Gestation**
5. **Weight (for those less than 35 weeks)**

Phototherapy – Nomograms

Nomogram A: Jaundice Management for a baby greater than 38 weeks gestation

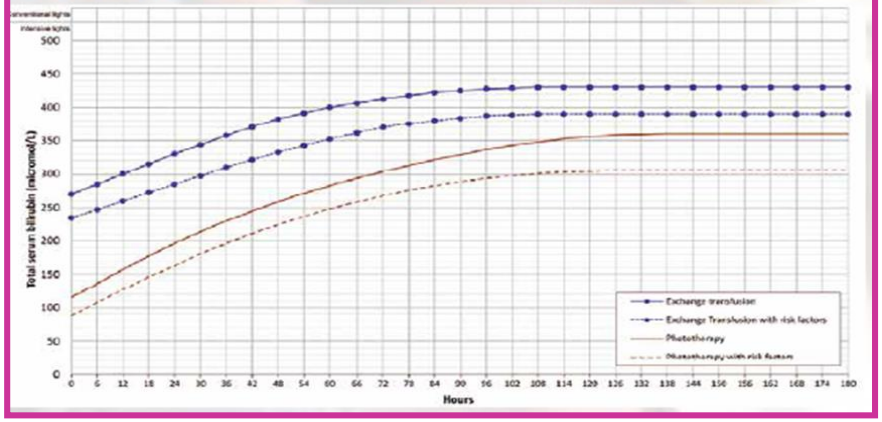


Queensland Clinical Guideline: Neonatal jaundice June 2019

Phototherapy – Nomograms

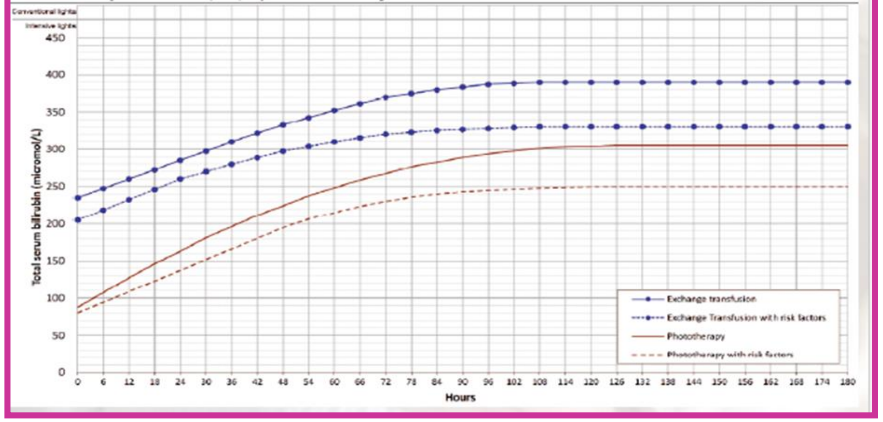
Nomogram A: Jaundice management for baby greater than 38 weeks gestation

In the presence of risk factors (sepsis, haemolysis, acidosis or asphyxia) use the lower line.



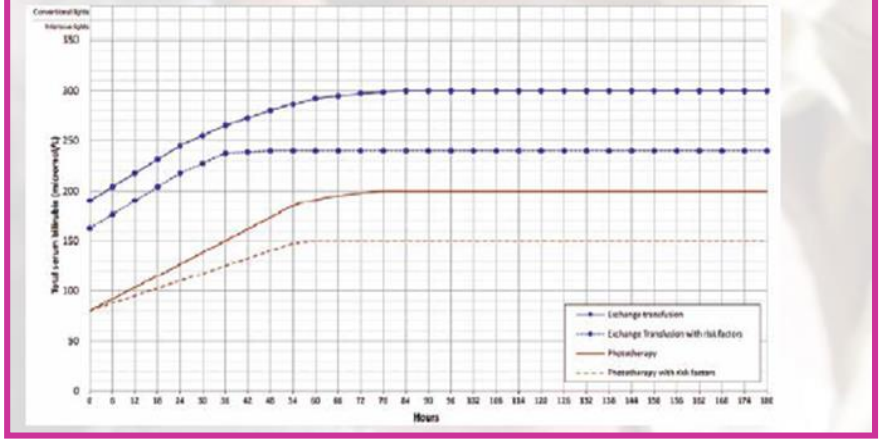
Nomogram B: Jaundice management for baby more than 35 but less than 37 completed weeks gestation

In the presence of risk factors (sepsis, haemolysis, acidosis or asphyxia) use the lower line.



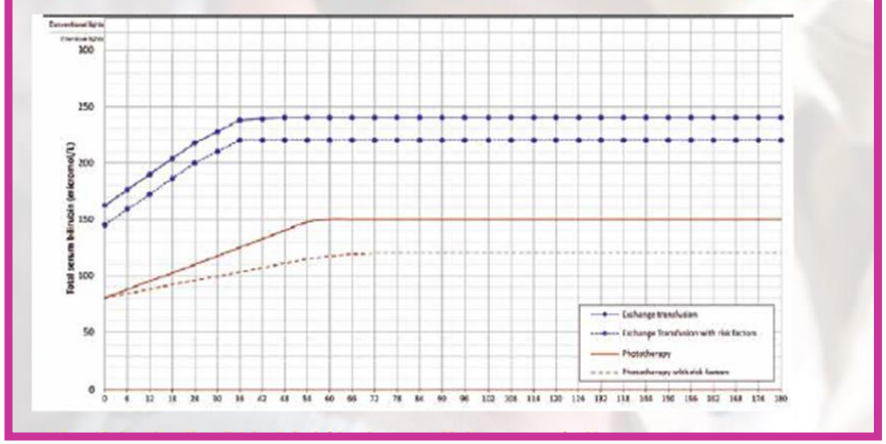
Nomogram D: Jaundice management for baby less than 35 weeks gestation 1500 g to 1999 g birth weight

In the presence of risk factors (sepsis, haemolysis, acidosis or asphyxia) use the lower line.



Nomogram F: Jaundice management for baby less than 35 weeks gestation 1000 g to 1499 g birth weight

In the presence of risk factors (sepsis, haemolysis, acidosis or asphyxia) use the lower line.



Queensland Clinical Guideline: Neonatal jaundice June 2019

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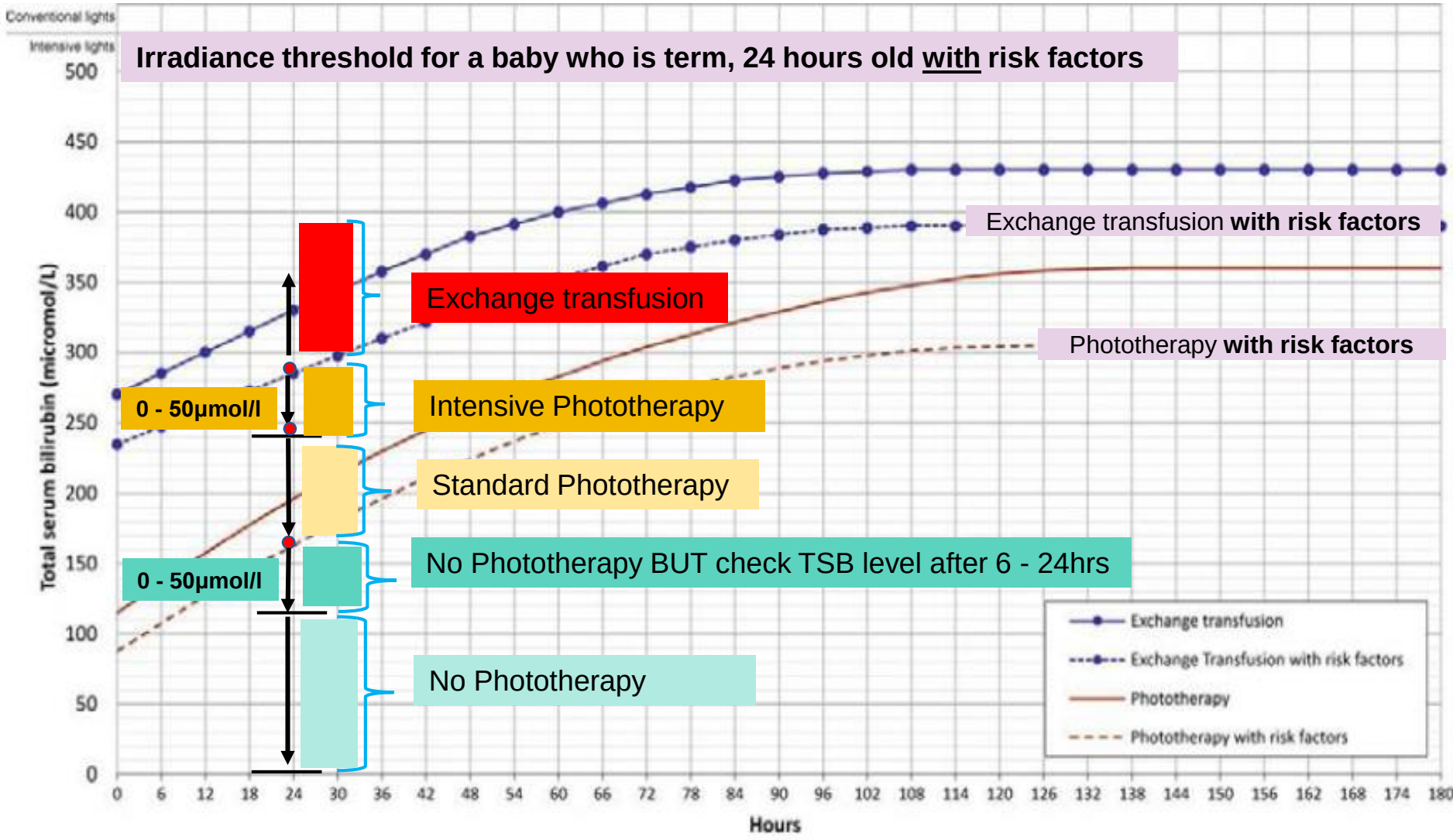
Questions to ask when using Nomograms

1. What is the baby's gestation? If the baby is less than 35 weeks, what is the weight? – To decide on which nomogram to use (A, B, C, D, E, F)
2. Are there risk factors for kernicterus? – To decide which curves (thresholds) to use. Continuous curve for no risk factors or broken curve with risk factors
3. What is the TSB level? What is the baby's age in hours?
4. Where on the curve does the TSB and age in hours meet?
   - Is it below the phototherapy curve?
   - Is it on the phototherapy curve?
   - Is it above the phototherapy curve and below the exchange transfusion curve?
   - Is it on or above the exchange transfusion curve?
5. What is the correct intervention to give?

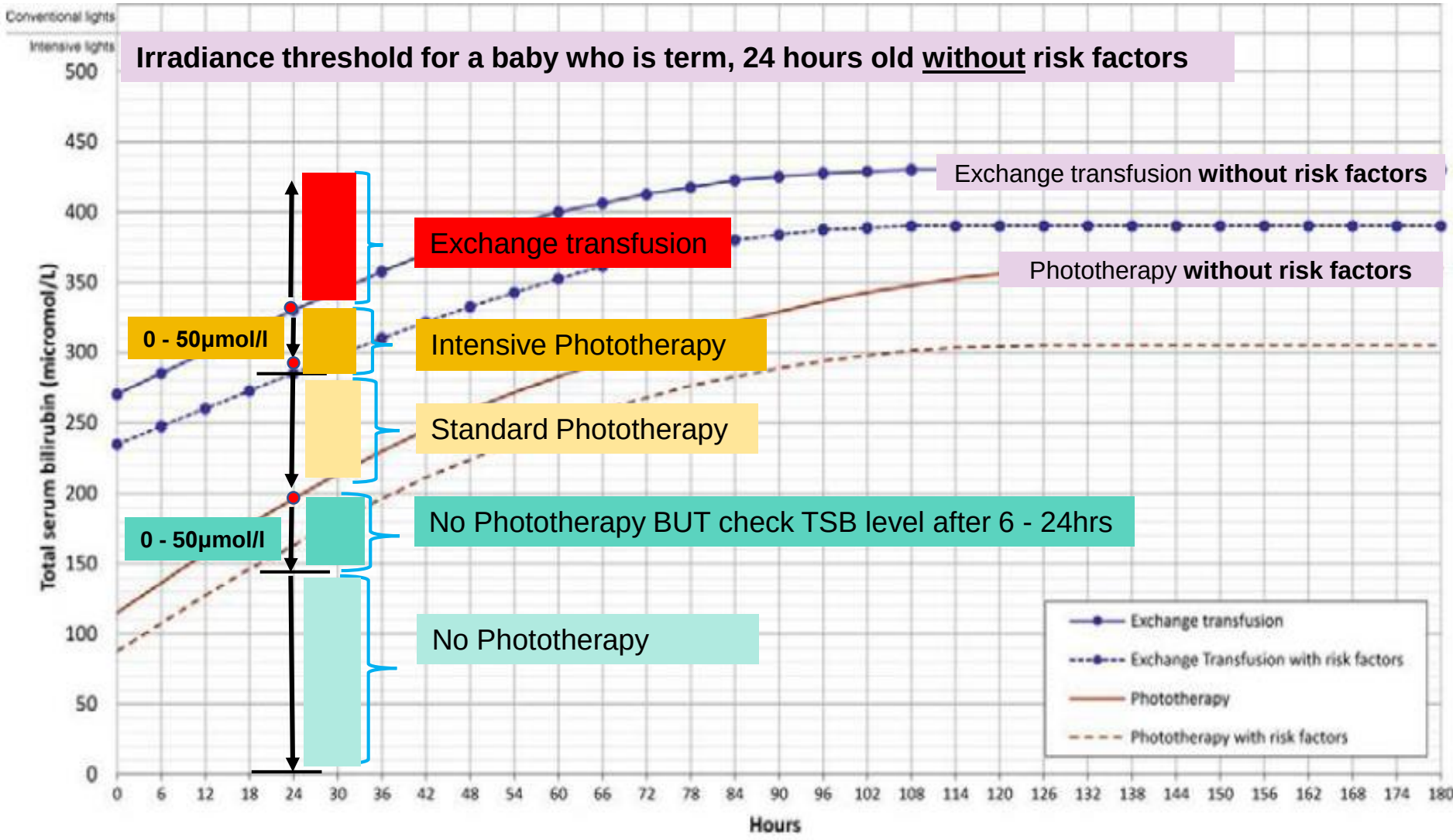
Using Nomograms

Nomogram A: Jaundice Management for a baby greater than 38 weeks gestation



Using Nomograms

Nomogram A: Jaundice Management for a baby greater than 38 weeks gestation



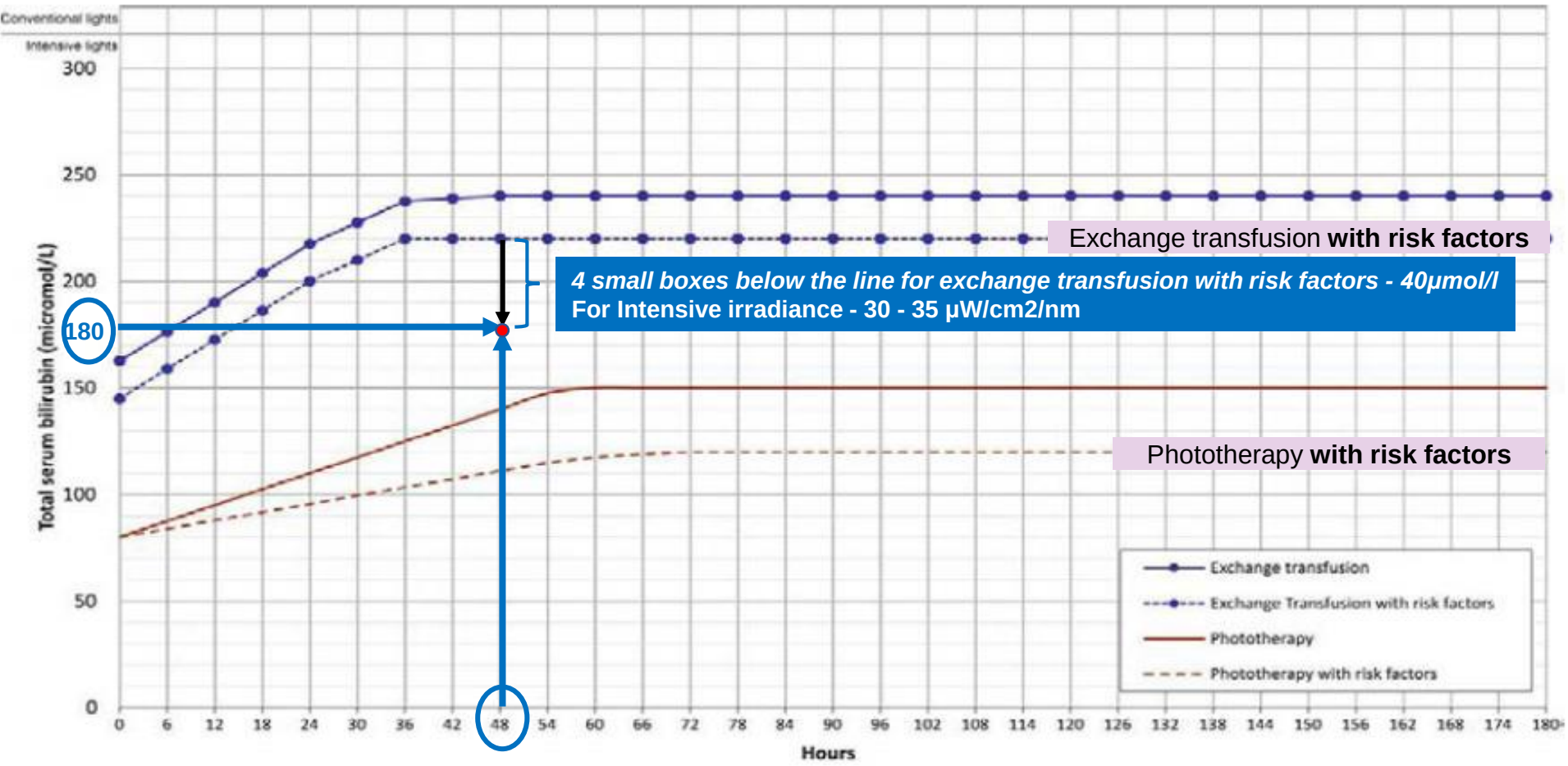
Using TSB to determine treatment

>50umol/l below phototherapy level	Observe the baby. There is no likely risk of developing kernicterus
<50umol/l below phototherapy level	Repeat TSB levels within 6 - 24 hours.
At phototherapy level	Initiate Standard phototherapy
<50umol/l below exchange level	Commence intensive phototherapy to lower TSB level and avoid exchange transfusion
At & above exchange transfusion level	Commence exchange transfusion. Initiate intensive phototherapy as you prepare

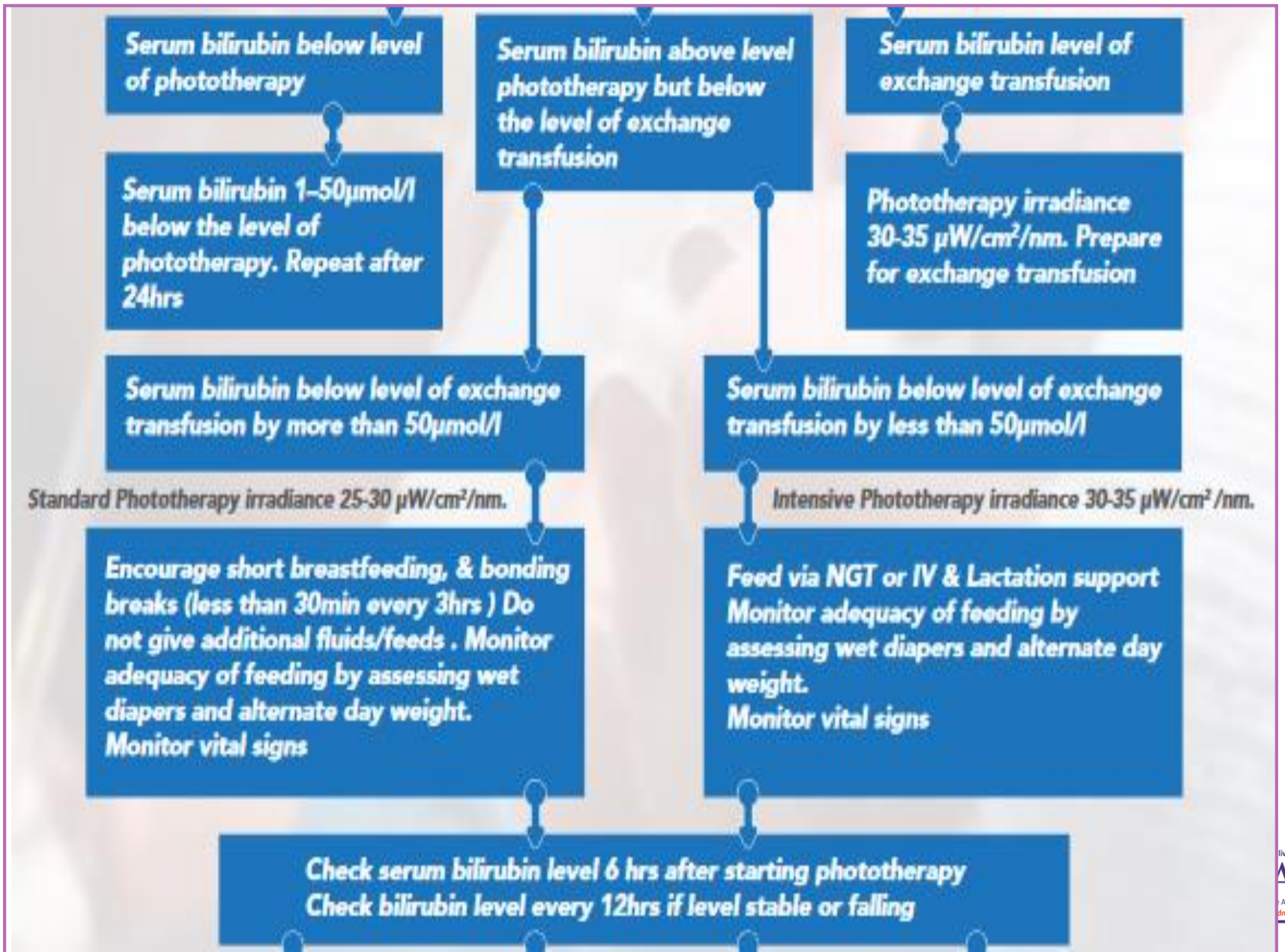
Using Nomograms – Scenario

Scenario: *Baby J, Birthweight - 1100gms, Gestation 30 weeks, Jaundiced, TSB - 180µmol/l at 48 hours of age. Has Respiratory Distress Syndrome*

Nomogram E: Jaundice Management for a baby less than 35 weeks gestation 1000 - 1499gm birth weight



Assess severity of jaundice and give correct treatment



Providing Phototherapy

Phototherapy – Light Sources

Fluorescent lights

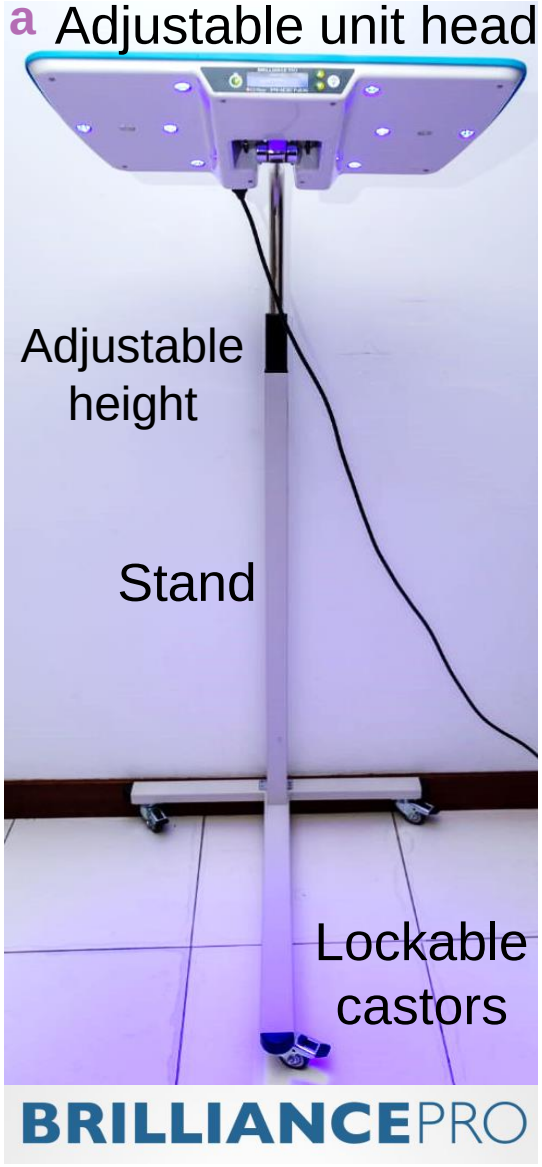
LED lights

	Fluorescent Lights	Light Emitting Diode (LED)
Heat Generated	More heat	Little heat
Durability	1000 -1500hrs	Longer than 3000hrs
Energy Consumption	High	Less by half

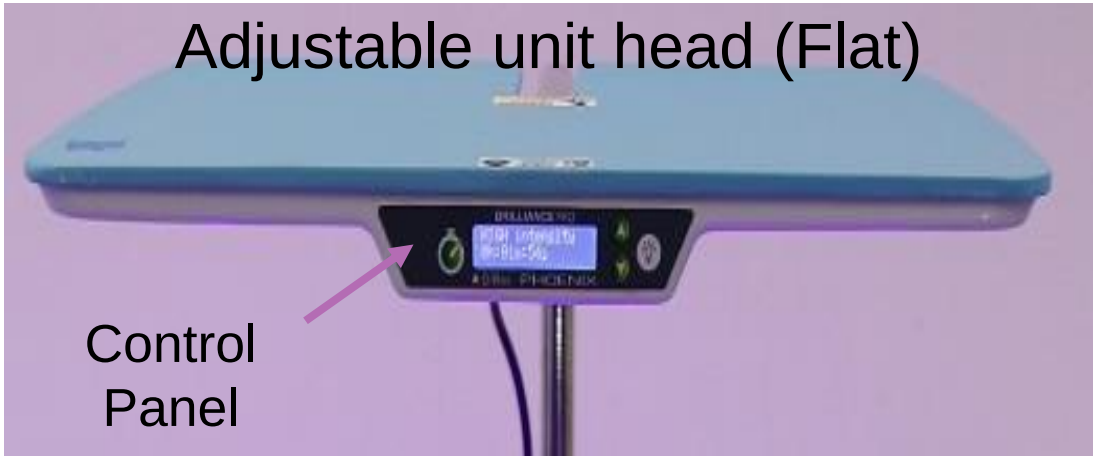
Vassilios F., Michele M., Antonio., Bo S., Dorret I. B., Gavino F., Antonio G. "Phototherapy in the newborn: what's new?" Journal of Pediatric and Neonatal Individualized Medicine 2015;4(2):e040255 doi: 10.7363/040255

Phototherapy – Lights

a Adjustable unit head



b Adjustable unit head (Flat)



c Adjustable unit head (Rotated)

Image source: NEST Clinical Modules [www.nest360⁰.org](http://www.nest360.org)

Phototherapy – Lights

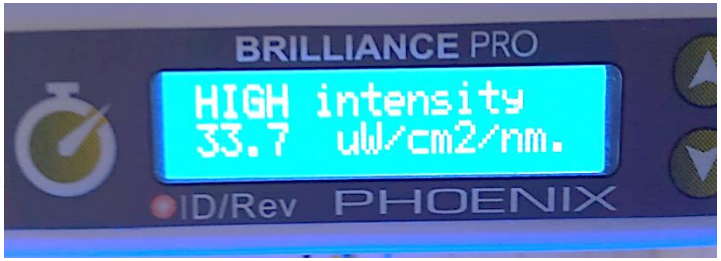
a

Reset Timer

Therapy mode buttons

b

c



d

Adjustable unit head (Back view)

Light meter port & cable

Power cable

Light meter & cable

Image source: NEST Clinical Modules www.nest360⁰.org

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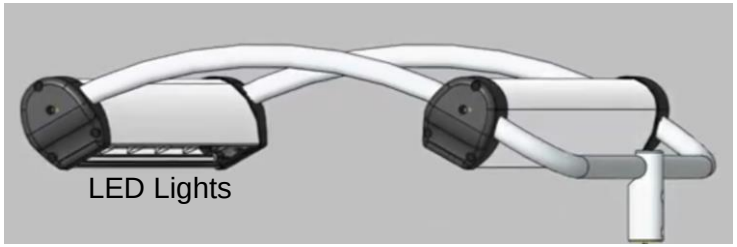
Phototherapy – Lights

a

Image source: NEST Clinical Modules www.nest360⁰.org

b



c

Control Panel

1	On/Off Button	Press this button to turn Colibri Phototherapy display and functions on and off.
2	Therapy Mode Button	Press this button to switch between standard and intensive therapy mode.
3	Display	Shows therapy mode and treatment time.

d

Light Meter

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Initiating Phototherapy

Phototherapy – Requirements

Phototherapy lamp

Light meter

Cot/Incubator/ Radiant warmer

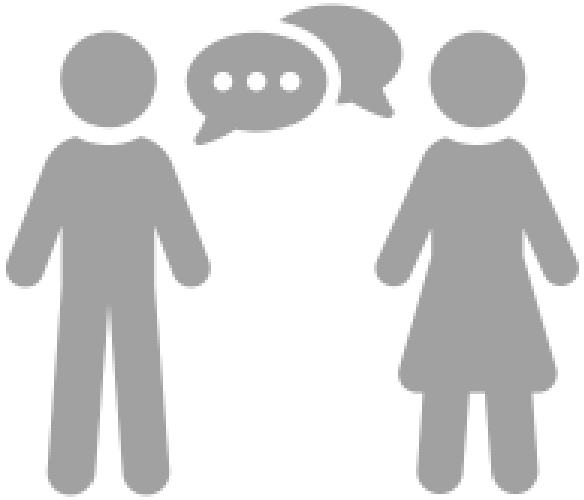
Room Thermometer

Eye shields

Linen

Images source: NEST Clinical Modules www.nest360⁰.org

Phototherapy – Family Centered Care



Discuss with the mother/caregiver the:

- Need for, action & outcomes of phototherapy
- Need to cover eyes
- Need to expose as much skin as possible
- Feeding plan
- Need for periodic assessment & blood sampling
- Potential complications

- Standard phototherapy - Short Breast feeding session (30min) 3hourly
- Intensive phototherapy - Nasal Gastric tube feeding with expressed breast milk

Eileen M., Eileen T., regina K. 2018.Phototherapy nursing guideline. Ret. From https://www.olchc.ie/Healthcare-Professionals/Nursing-Practice-Guidelines/Phototherapy-2018.pdf

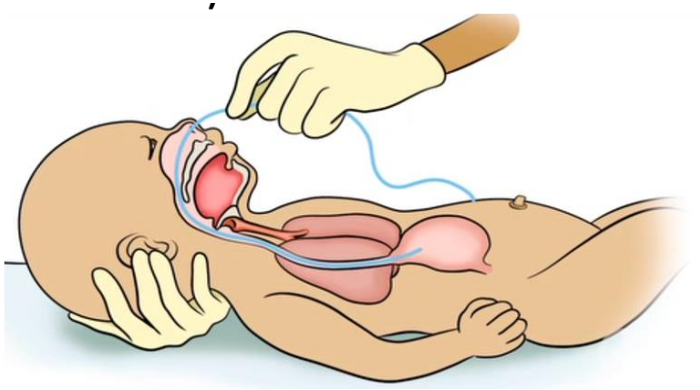
Phototherapy – Preparing the Baby

1. Ensure hand hygiene

2. Prepare cot & warm environment

3. Assess vitals & risk factors

4. Remove all the baby's clothes



5. Insert NG tube if Indicated

Phototherapy for neonatal jaundice (N.D.) Ret .From https://www.rch.org.au/rchcpg/hospital_clinical_guideline_index/Phototherapy_for_neonatal_jaundice/
Images source: NEST Clinical Modules www.nest360º.org

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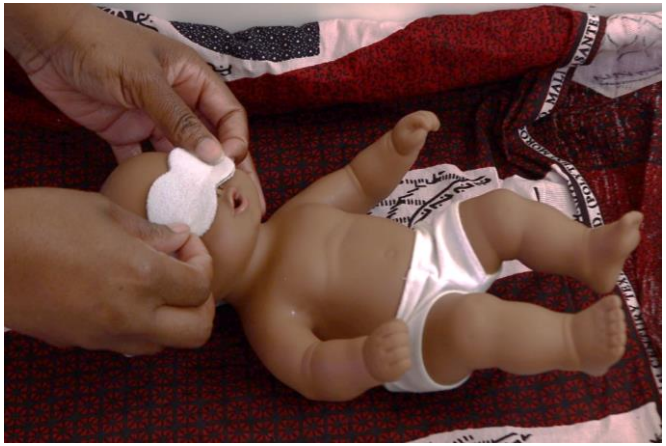
Phototherapy – Preparing the Baby

6. Cover the baby's eyes with an eye shield



7. Ensure the eye shield is snuggly fit and place baby in the center of the cot/incubator/radiant warmer

Phototherapy for neonatal jaundice (N.D.) Ret .From https://www.rch.org.au/rchcpg/hospital_clinical_guideline_index/Phototherapy_for_neonatal_jaundice/
Images source: NEST Clinical Modules www.nest360^{0}.org

Phototherapy – Preparing the Machine

1. **Position the LED phototherapy unit above the baby's cot/incubator/radiant warmer**
2. **Plug power cable on the machine and turn on the machine.**
3. **Ensure the lights cover the baby's entire body**

Phototherapy – Preparing the Machine

3. Select the irradiance mode (standard or intensive)
4. Adjust the height of the lamp to desired irradiance
5. Reset patient therapy time to zero and initiate phototherapy

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Images source: NEST Clinical Modules [www.nest360⁰.org](http://www.nest360.org)

Phototherapy – Irradiance

Always use the light meter to measure desired Irradiance

Standard irradiance - 25 - 30 μW/cm²/nm

Intensive irradiance - 30 - 35 μW/cm²/nm

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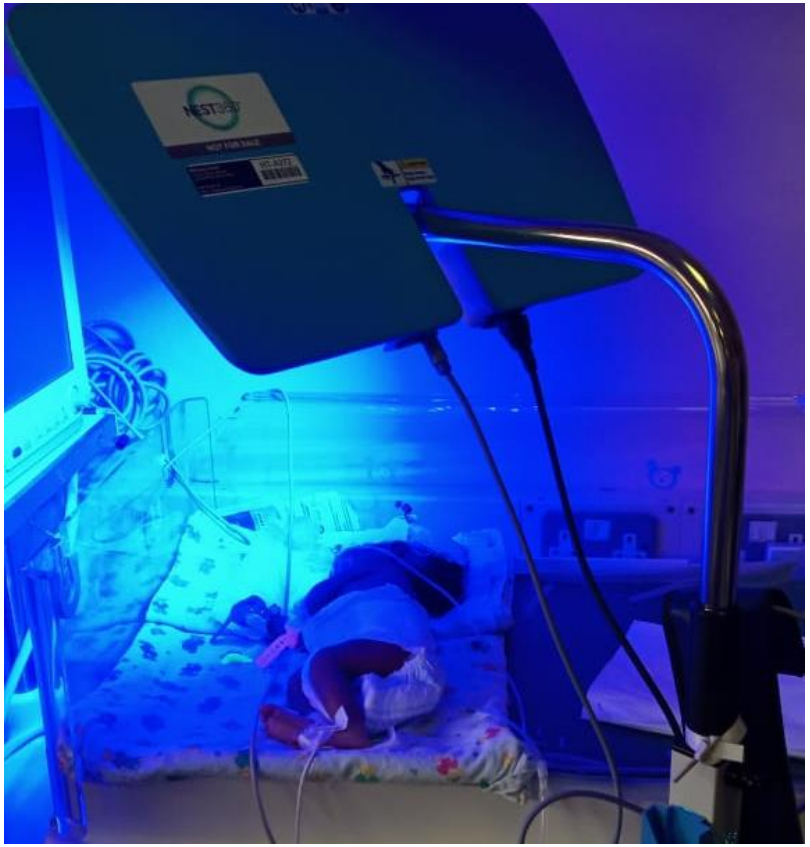
http://pediatrics.aappublications.org/content/128/4/e1046 & Image source: The Firefly phototherapy user manual

Phototherapy – Avoid incorrect practices at all times!



Phototherapy – Avoid incorrect practices at all times!

Monitoring during Phototherapy

Phototherapy – Monitoring

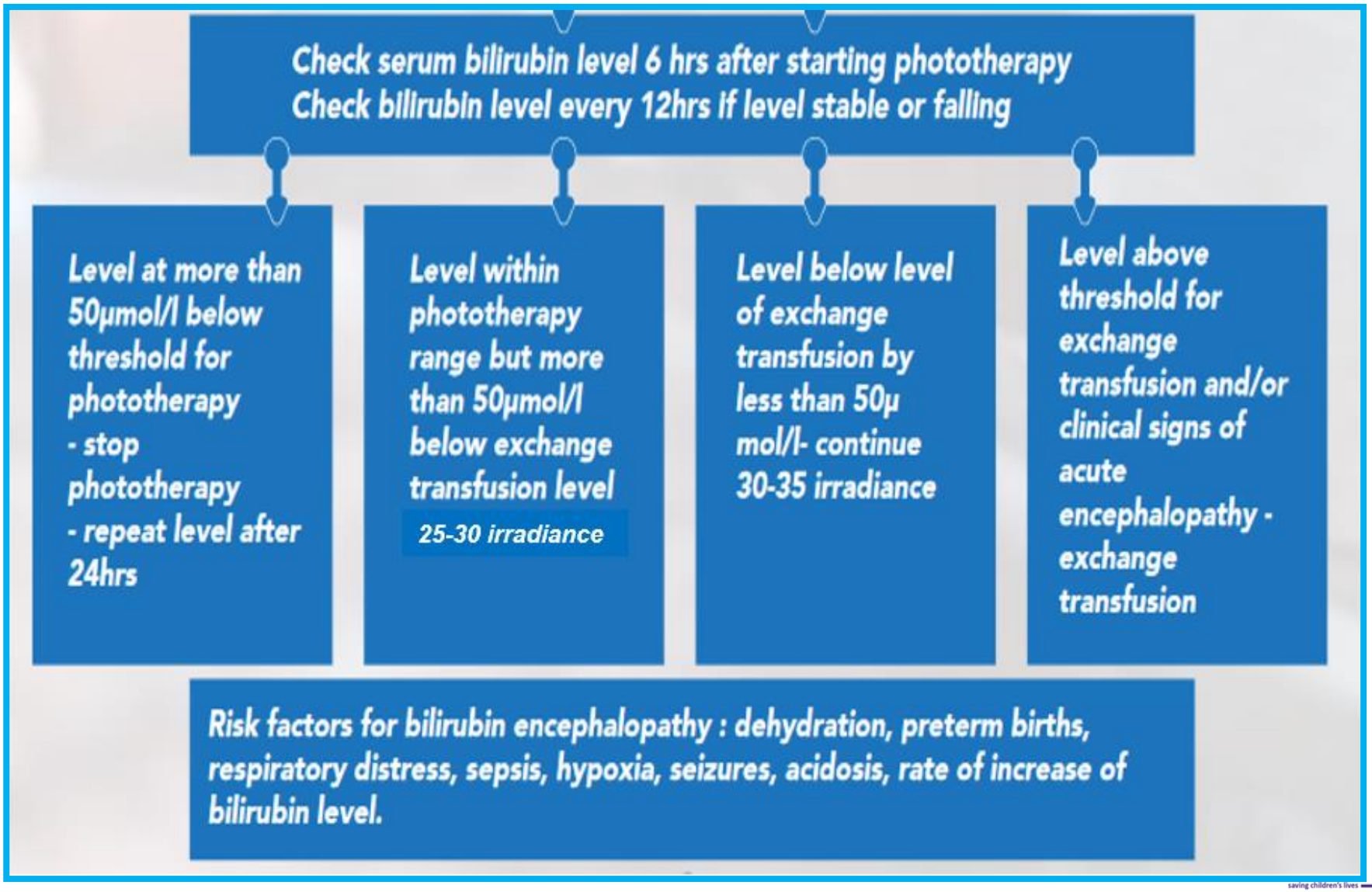
Skin Exposure
Expose as much skin as possible

Eye Care
Ensure the eyes are well covered

1. Monitor vitals every 3 hours - Temp
2. Maintain 3 hourly breastfeeding (BF) for standard therapy or NGT feeding for intensive therapy
3. Reposition the baby every 3 hours
4. Monitor urine output - Four or more wet nappies per day
5. Weigh the baby on alternate days
6. Check for potential signs of bilirubin encephalopathy – lethargy, poor feeding, seizures, vomiting
7. Watch out for potential complications
8. Repeat total serum bilirubin level 6 hrs after starting phototherapy

Vassilios F., Michele M., Antonio., Bo S., Dorret I. B., Gavino F., Antonio G. "Phototherapy in the newborn: what's new?" Journal of Pediatric and Neonatal Individualized Medicine 2015;4(2):e040255 doi: 10.7363/040255 & Eileen M., Eileen T., regina K. 2018.Phototherapy nursing guideline. Ret. From https://www.olchc.ie/Healthcare-Professionals/Nursing-Practice-Guidelines/Phototherapy-2018.pdf
http://pediatrics.aappublications.org/content/128/4/e1046

Monitoring bilirubin levels



http://pediatrics.aappublications.org/content/128/4/e1046 & Queensland Clinical Guideline: Neonatal jaundice June 2019

Stopping phototherapy

Discontinue phototherapy when TSB reduces by

more than 50umol/l below treatment threshold .

1. Rebound hyperbilirubinaemia
   - Repeat TSB in 12-24 hours[4].
2. If baby had haemolytic jaundice or other early onset jaundice and is discharged before 3–4 days
   - Organize follow up TSB 24 hours after discharge

American Academy of Pediatrics. Management of hyperbilirubinaemia in the newborn infant 35 weeks or more of gestation. Pediatrics 2004;114(1):297-316.[1] Chang PW, Kuzniewicz MW, McCulloch CE, Newman TB. A clinical prediction rule for rebound hyperbilirubinemia following inpatient phototherapy. Pediatrics 2017;139(3)2 Wong R, Bhutani VK. Patient education: Jaundice in newborn infants (Beyond the Basics) 3http://guidance.nice.org.uk/CG98/treatmentthresholdgraph/xls/English[4]

Complications of phototherapy

Short term complications

Interference with maternal–infant bonding[1]

Skin rash

Diarrhea[1]

Hypothermia (LED light) if not in thermoneutral environment

Small increased risk for seizures (approximately 1-2 infants per 10,000 treated)

No increase in incidence of total cancer and type 1 DM,

Muchowski KE. Evaluation and treatment of neonatal hyperbilirubinemia. Am Fam Physician. 2014;89(11):873-878[1] Kahveci H, Phototherapy causes a transient DNA damage in jaundiced newborns. Drug ChemToxicol. 2013;36(1):88–92[2] Newman TB, Wickremasinghe AC, Walsh EM, Grimes BA, McCulloch CE, Kuzniewicz MW. Retrospective Cohort Study of Phototherapy and Childhood Cancer in Northern California. Pediatrics. 2016;. Phototherapy and Risk of Type 1 Diabetes. Pediatrics. 2016;138(5):e20160687. doi:10.1542/peds.2016-0687[4]

Questions

Summary

1. High bilirubin level can cause irreversible brain damage.
2. Chief rationale of treating newborn jaundice is the prevention of kernicterus
3. Screening and early recognition of risk factors for bilirubin encephalopathy is important in prevention of kernicterus
4. Adjust phototherapy irradiance depending on the serum bilirubin level