Neonatal Hyperbilirubinemia and Home Phototherapy

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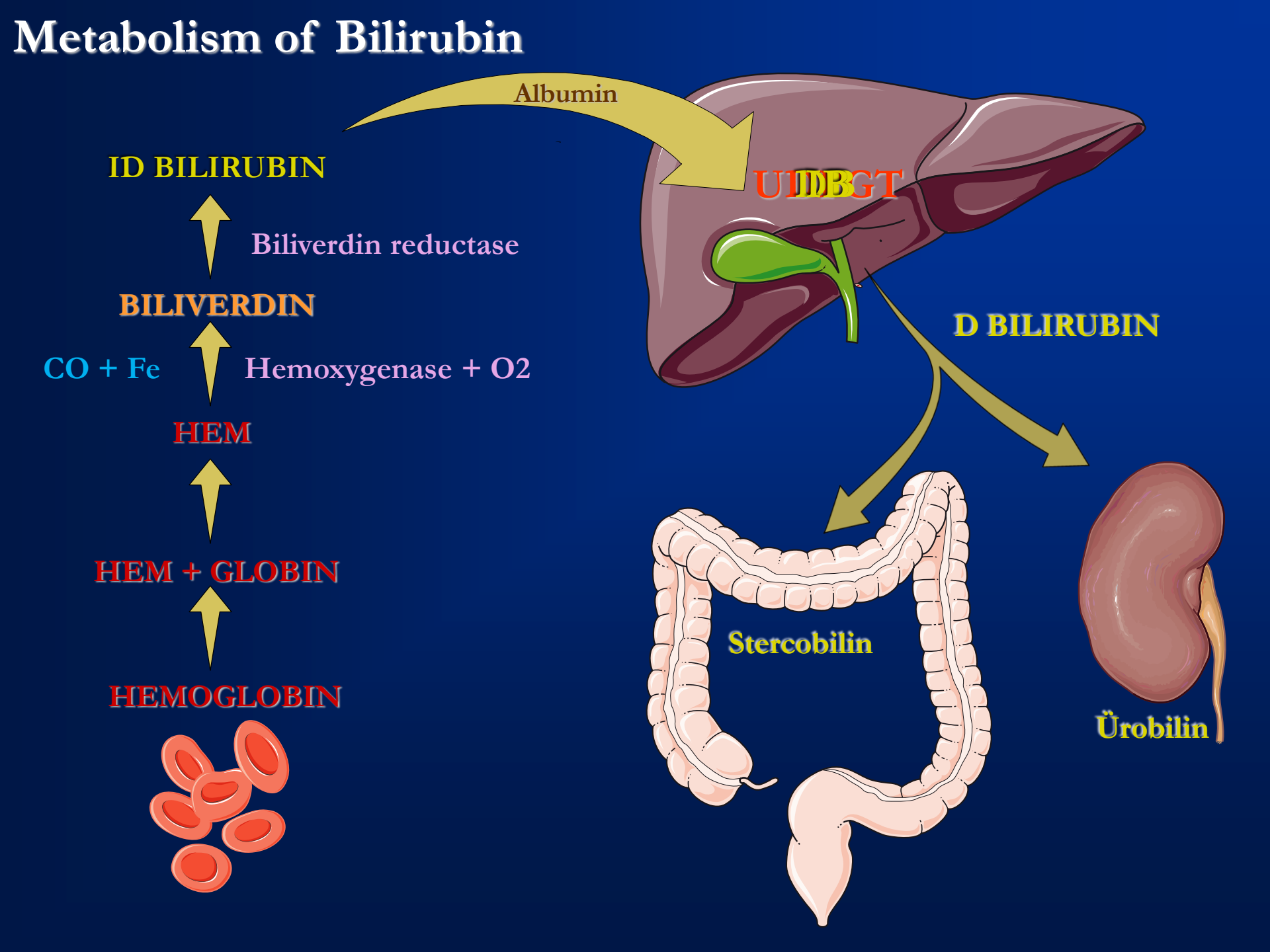
Neonatal Hyperbilirubinemia

Hyperbilirubinemia, or neonatal jaundice, is a condition in which there is a higher-than-normal level of bilirubin in the blood.

It is estimated to occur in up to 60 percent of term and 80 percent of preterm infants within the first week of life.

Bilirubin is a byproduct of the normal breakdown of hemoglobin. Hemoglobin is broken down into heme and globin, and the heme is converted to bilirubin.

Metabolism of Bilirubin



Neonatal Hyperbilirubinemia

Neonatal hyperbilirubinemia classified as either physiologic or pathologic.

Physiologic jaundice; most newborns develop transient, mild unconjugated hyperbilirubinemia during the first week of life as their hepatic conjugating and excreting mechanisms reach full maturity.

Pathologic jaundice; occurs in the first 24 hours of life and is often associated with anemia or hepatosplenomegaly.

Neonatal Hyperbilirubinemia

Determination of Nonphysiologic (Pathologic) Jaundice:

- Jaundice occurring less than 24 hours after birth

- Rate of rise of bilirubin greater than 0.5 mg/dl/hour or greater than 5 mg/dl/day

- Jaundice persisting for more than 7 to 10 days

- Total bilirubin greater than 10-12 mg/dl in low birth weight newborns

- Total bilirubin greater than 12-15 mg/dl in term newborns

- Increased bilirubin levels in the presence of hemolysis or other risk factors

Neonatal Hyperbilirubinemia

The etiologies of physiologic and pathologic hyperbilirubinemia generally fall into 3 categories or mechanisms:

(1) increased bilirubin production,

(2) decreased bilirubin conjugation, and

(3) increased enterohepatic circulation (jaundice related to breast-feeding).

Neonatal Hyperbilirubinemia

Increased Bilirubin Production

-Hemolytic diseases of the newborn *(blood group incompatibilities; Rh, ABO, minor blood groups),*

-Red cell membrane defects *(hereditary spherocytosis, elliptocytosis),*

-Enzyme deficiencies,

-Hemoglobinopathies,

-Glucose-6-phosphate dehydrogenase (G6PD) deficiency.

-Other causes; sepsis, DIC, blood extravasation associated with birth trauma, polycythemia.

Neonatal Hyperbilirubinemia

Decreased Bilirubin Conjugation

Decreased bilirubin conjugation is related to abnormalites of the conjugating enzyme UGT (Crigler-Najar syndrome, congenital hypothyroidism).

Neonatal Hyperbilirubinemia

Increased enterohepatic circulation

- Intestinal obstruction
- Poor or absent bowel motility (poor feeding and constipation)
- Breastfeeding or breast milk
- Prematurity.

Neonatal Hyperbilirubinemia

The clinical importance of hyperbilirubinemia derives primarily from its potential to cause acute bilirubin encephalopathy or kernicterus, a form of brain damage that can cause death or long-term sequelae, including cerebral palsy and hearing loss.

Therefore, the presence of neonatal jaundice frequently requires diagnostic evaluation and treatment.

Neonatal Hyperbilirubinemia

Neonatal Hyperbilirubinemia

Acute and Chronic Manifestations of Kernicterus

Acute Kernicterus	Chronic Kernicterus
Phase 1 (first 1–2 days): poor sucking, stupor, hypotonia, seizures	*First year:* hypotonia, active deep-tendon reflexes, obligatory tonic neck reflexes, delayed motor skills
Phase 2 (middle of first week): hypertonia of extensor muscles, opisthotonos, retrocollis, fever	*After first year:* movement disorders (choreoathetosis, ballismus, tremor), upward gaze, sensorineural hearing loss
Phase 3 (after first week): hypertonia	

Neonatal Hyperbilirubinemia

As plasma levels of bilirubin increase, jaundice becomes clinically evident.

Jaundice is assessed through blanching the skin with digital pressure, revealing the underlying color of the skin and subcutaneous tissue. Jaundice in term and preterm infants follows a cephalocaudal progression.

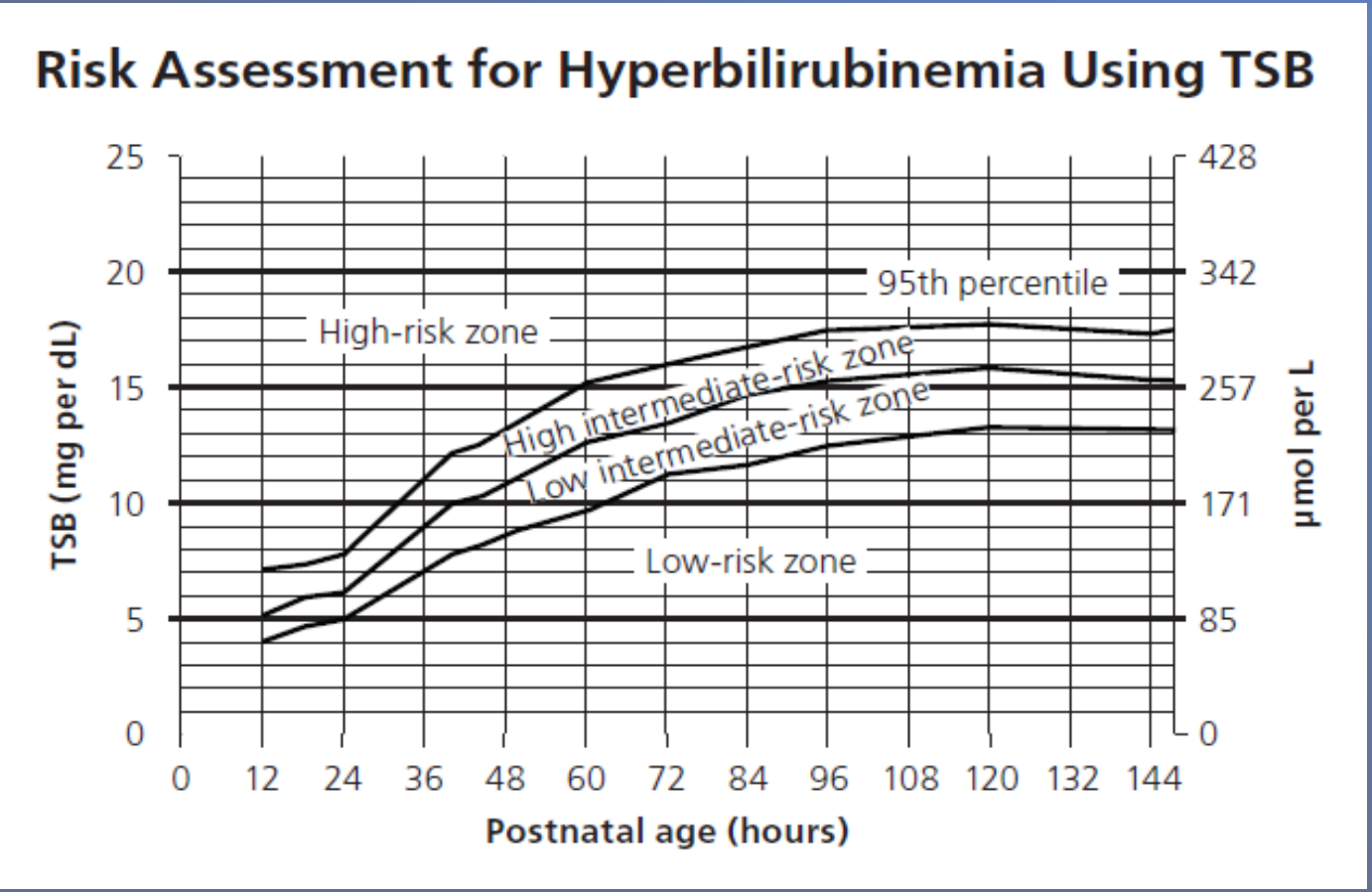
Neonatal Hyperbilirubinemia

If the indirect bilirubin exceeds the normal physiologic range or is increasing rapidly, a pathologic cause should be considered and these infants should be evaluated with a risk score or TSB/TcB measurement.

The bilirubin level should be interpreted according to the infants' age in hours.

Further testing may be indicated depending on the infant's risk.

Neonatal Hyperbilirubinemia



Neonatal Hyperbilirubinemia

The American Academy of Pediatrics recommends the following laboratory tests for all infants with jaundice who require phototherapy.

Table 4. Laboratory Evaluation of Neonatal Hyperbilirubinemia

Indication	*Assessments*
Jaundice in the first 24 hours	TSB or TcB level
Jaundice excessive for infant's age	TSB or TcB level
Receiving phototherapy or TSB level increasing rapidly	Blood type and Coombs' test
	CBC and peripheral blood smear
	Conjugated bilirubin level
	Consider reticulocyte count; G6PD and end-tide carbon monoxide (corrected) levels
	Repeat TSB measurement in four to 24 hours
TSB level approaching exchange transfusion threshold or not responding to phototherapy	Reticulocyte count; G6PD, albumin, and end-tide carbon monoxide (corrected) levels
Elevated conjugated bilirubin level	Urine culture, urinalysis
	Consider sepsis evaluation
Prolonged jaundice (more than 3 weeks) or sick infant	TSB and conjugated bilirubin levels
	Check results of newborn thyroid and galactosemia screen

CBC = complete blood count; G6PD = glucose-6-phosphate dehydrogenase; TcB = transcutaneous bilirubin; TSB = total serum bilirubin.

Adapted with permission from American Academy of Pediatrics Subcommittee on Hyperbilirubinemia. Management of hyperbilirubinemia in the newborn infant 35 or more weeks of gestation [published correction appears in Pediatrics. *2004;114(4):1138].* Pediatrics. *2004;114(1):300.*

Neonatal Hyperbilirubinemia

THERAPY

In ID hyperbilirubinemia, the ultimate goals are;

- Prevention of severe hyperbilirubinemia,
- Prevention of bilirubin encephalopathy and kernicterus,
- Prevention of its potentially devastating effects,

while minimizing the risks of unintentional harm such as increased family anxiety, interference with breast-feeding, and increased costs of unnecessary treatment and monitoring.

Neonatal Hyperbilirubinemia

Treatment options for hyperbilirubinemia include;

- Phototherapy,
- Exchange transfusion,
- Pharmacologic agents *(Phenobarbital, ursodeoxycholic acid, metalloporphyrins, high-dose IVIG, activated charcoal or agar),*
- and replacing breastfeeding with formula.

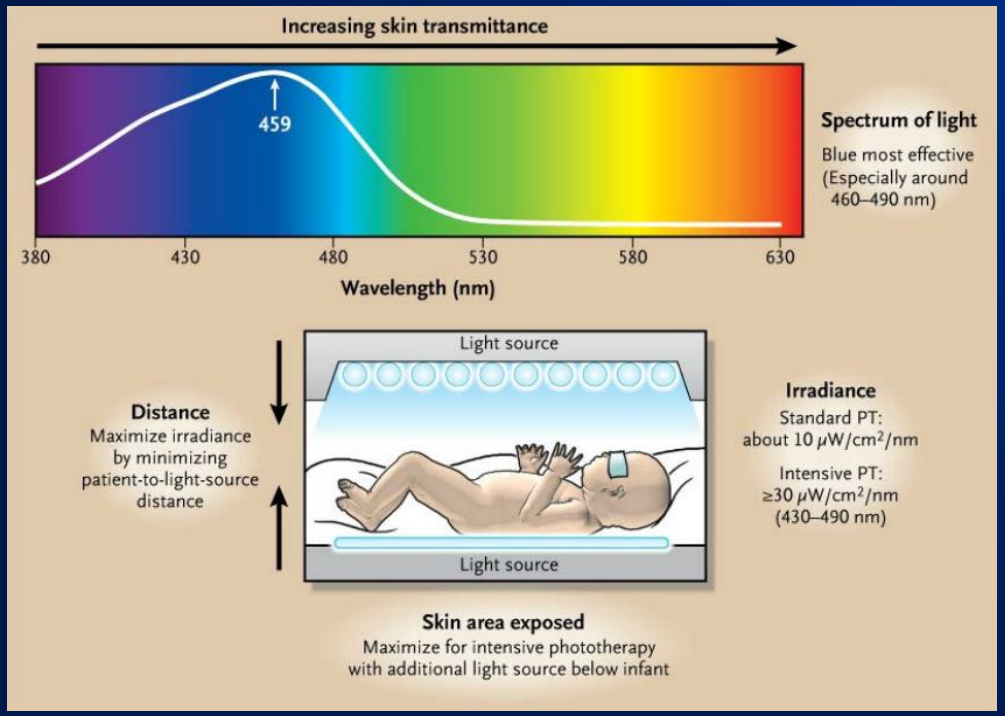
Phototherapy

First observation by Cremer in 1958; when newborn infants were exposed to sunlight or blue wavelengths of artificial light, bilirubin levels drop.

Since 1958, phototherapy has been extensively used to treat neonatal jaundice and became standart therapy for neonatal jaundice.

Cremer RJ, Perryman PW, Richards DH. Influence of light on the hyperbilirubinaemia of infants. Lancet. 1958 May 24;1(7030):1094-7.

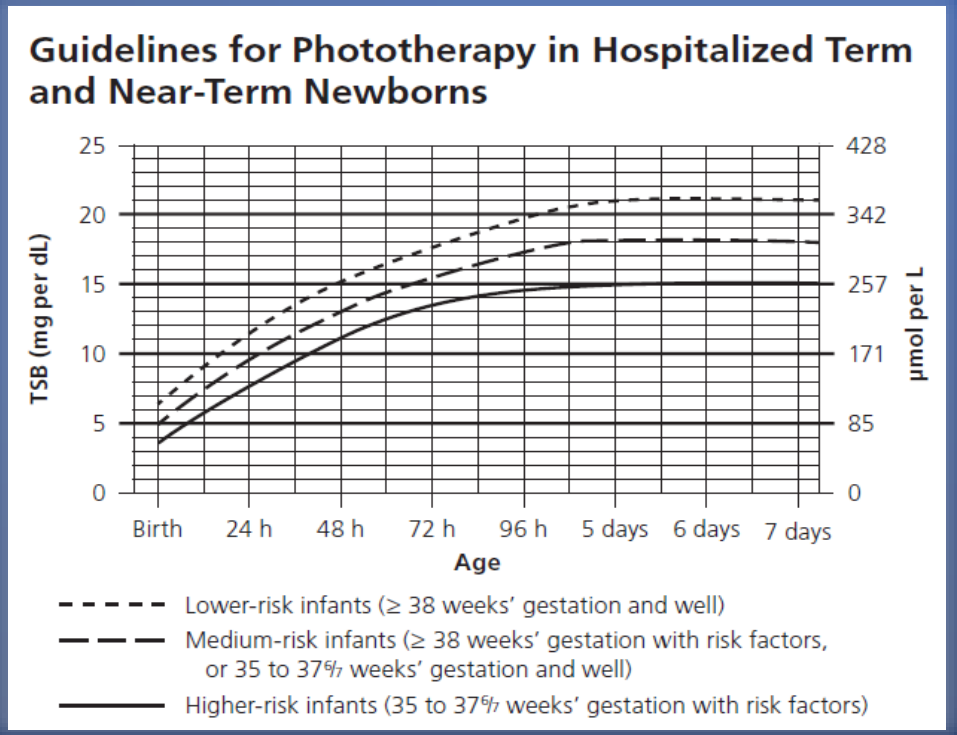
Phototherapy



Bilirubin absorbs the blue light provided by phototherapy and converts to a water-soluble compound, permitting more rapid excretion in the urine.

Phototherapy

The hour-specific nomogram recommended by the AAP provides guidelines for phototherapy in hospitalized infants of 35 or more weeks gestational age.



Phototherapy

American Academy of Pediatrics recommendations for phototherapy

	Total serum bilirubin (mg/dL)				
	Age (h)				
Risk category	24	36	48	72	96
High risk (35–37 weeks + risk factors[a])	8	9	11	13	14
Medium risk (≥38 weeks + risk factors or 35–37 weeks and well)	10	12	13	15	17
Low risk (>38 weeks and well)	12	13	15	18	20

[a] Risk factors are defined as isoimmune hemolytic disease, G6PD deficiency, asphyxia, significant lethargy, temperature instability, sepsis, acidosis.

Phototherapy

Phototherapy generally applied at hospital, and hospital-treatment of jaundice has some disadvantages;

- Causes parent-child separation at the first days of life,
- Can interfere with successful breastfeeding,
- Generate excessive tests and procedures,
- Exposes the newborns to hospital infection,
- Sometimes engender parental anxiety about the newborn's health, which can contribute to the vulnerable child syndrome,
- İncreases cost of medical care,
- Causes hospital bed occupation.

Home Phototherapy

Home phototherapy for neonatal hyperbilirubinemia has been suggested as an alternative means of providing care for hyperbilirubinemic infants.

"Home phototherapy" is, applying of phototherapy at home with special devices to jaundiced infants that meets selection criterias.

Home phototherapy should be reserved for infants with TSB levels 2 to 3 mg/dL below the levels recommended for intensive phototherapy and for those without significant risk factors.

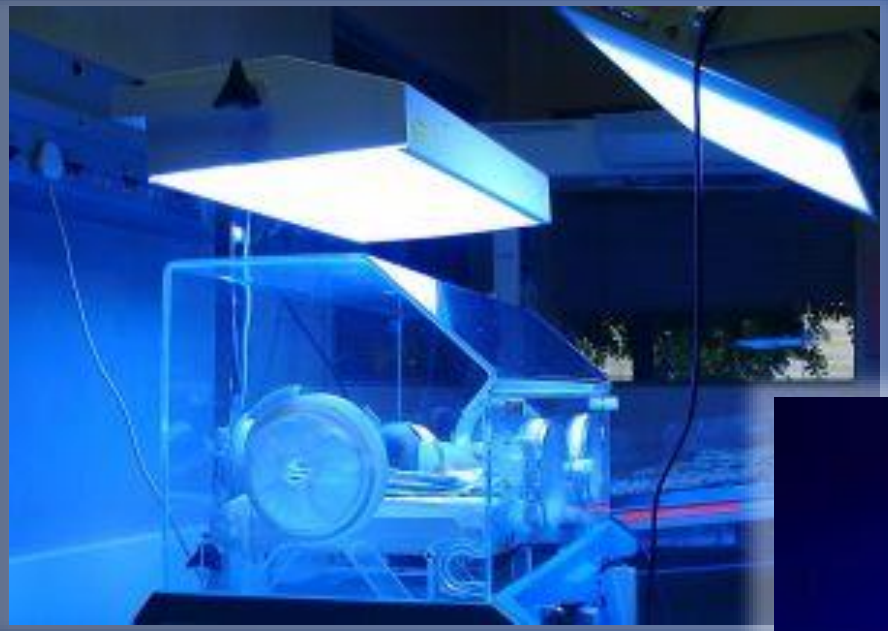
Home Phototherapy

In the hospital setting, phototherapy is delivered by exposing the infant to fluorescent light.

When this type of light source is used, the infant's eyes are protected from the lights with a mask.

The infant is positioned in an incubator wearing only a diaper, exposing as much of the infant's skin surface as possible.

Home Phototherapy



Home Phototherapy

In the home setting, phototherapy is accomplished by using a fiber optic blanket (biliblanket) or beds with light-emitting diode lamps (bilicot, bilibed).

In home phototherapy, light is not directed to the infant's face and therefore masking the infant's eyes is not necessary.

The infant can also be fed without interrupting therapy.

Home Phototherapy

Home Phototherapy

There are a variety of light sources on the market that are appropriate for home use, and the information below represents a sampling of these devices.

- Ohmeda Medical BiliBlanket® (Ohmeda Medical, Laurel, MD)
- Natus® Blue Light Phototherapy Unit (Natus Medical Inc., SanCarlos, CA)
- neoBlue cozy™ LED Phototherapy System (Natus Medical, Inc., San Carlos, CA)
- Wallaby™ Phototherapy System (Respironics GA Inc., Marietta, GA)
- BiliBed® Phototherapy Unit (Medela, Inc., McHenry, IL)

Home Phototherapy

Home phototherapy has been available to pediatricians in the USA and some European Countries for over 30 years.

In a study of home versus hospital phototherapy done by Slater and Brewer, the average decrease in serum bilirubin concentration was similar for the two groups after the first day of treatment and no phototherapy related complications were noted in the study infants.

Slater L, Brewer MF, Home versus Hospital Phototherapy for Term Infants with hyperbilirubinemia: a comparative study, Pediatrics 1984; 73: 515.

Home Phototherapy

In another study by Eggert et al, bilirubin levels decreased as rapidly in the home group as in the hospitalized control group, and duration of treatment averaged 2.8 days.

They found home phototherapy to be a feasible, safe and effective alternative to in-hospital phototherapy for otherwise healthy, jaundiced infants.

Eggert LD, Pollary RA, Folland DS, Jung AL, Home Phototherapy Treatment of Neonatal Jaundice, Pediatrics 1985; 76: 579.

Home Phototherapy in Turkiye

Coordinated and controlled home phototherapy is firstly applied by our hospital in our country to hyperbilirubinemic newborns that fulfills selection criterias.

The criteria for choosing the newborns were based on the Committee on Fetus and Newborn of the American Academy of Pediatrics (AAP) guidelines for Home Phototherapy with some modifications.

Home Phototherapy in Turkiye

Home phototherapy for hyperbilirubinemia is considered medically necessary if ALL of the following criteria are met:

- *Full term infants (GA ≥ 37 week, BW 2.500-4.000 grams),*
- *The TSB is less than 20-22 mg/dL,*
- *The infant appears healthy, active, and is feeding well,*
- *A primary liver disorder is not the cause of the elevated serum bilirubin,*
- *Follow-up evaluations will be done by the physician or by a trained home health care nurse,*
- *No hemolytic disease (Coombs test (-), no G6PD deficiency, ABO or Rh incompatibility),*
- *Adequate home and parental environment (environment is clean, not too hot, adequate ventilation is available and there is always an adult to supervise the infant under the phototherapy unit) as evaluated by staff.*

Home Phototherapy in Turkiye

Risk factors;

- Prematurity,
- Isoimmun hemoliytic disease,
- Asphyxia,
- Sepsis,
- G6PDH deficiency,
- Lethargy,
- Temperature instability,
-Acidosis.

If the baby has this risk factors, the baby needs intensive phototherapy, and therapy must be applied at hospital.

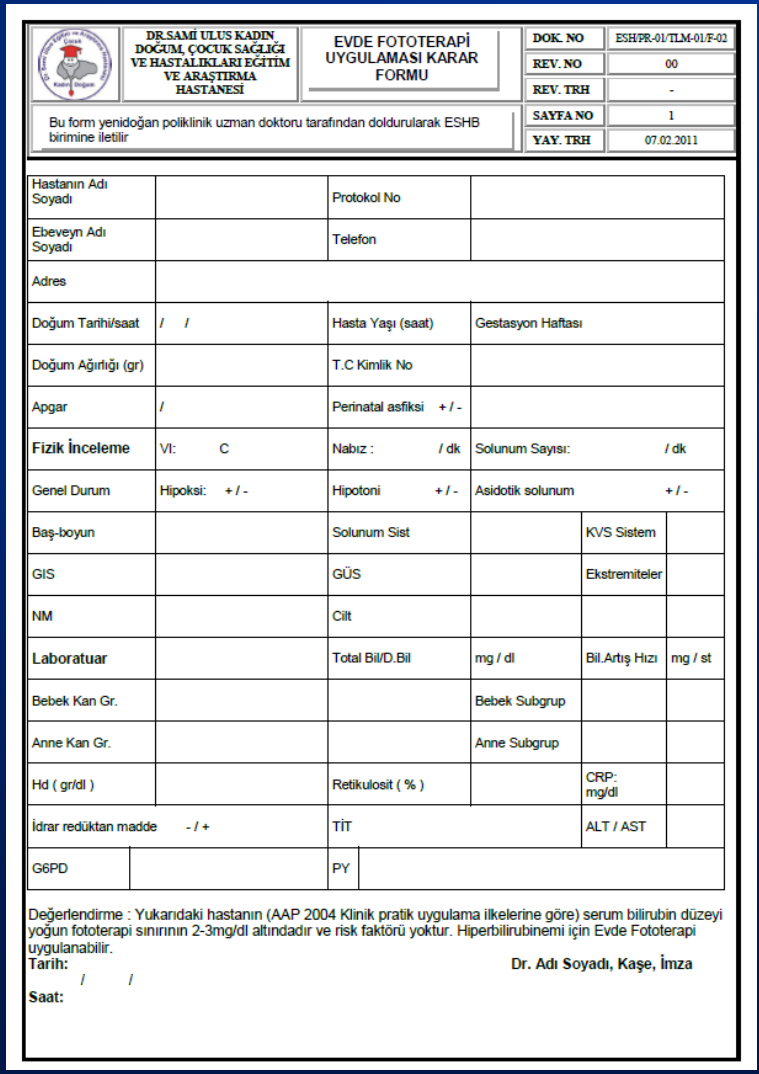
Home Phototherapy in Turkiye

In 5 years period (From February 2011 to September 2015), phototherapy applied at home to 201 jaundiced newborns fulfilling the selection criteria by our hospital's neonatology unit with the collaboration of our hospital's "Home Health Care Service (HHCS)".

Home Phototherapy in Turkiye

If the hyperbilirubinemic newborn fulfills the selection criterias, HHCS fills in a "Home phototherapy Follow-up Form".

And a signed consent was obtained from the parents.



DR.SAMİ ULUS KADIN DOĞUM, ÇOCUK SAĞLIĞI VE HASTALIKLARI EĞİTİM VE ARAŞTIRMA HASTANESİ	EVDE FOTOTERAPİ UYGULAMASI KARAR FORMU	DOK. NO	ESH/PR-01/TLM-01/F-02
		REV. NO	00
		REV. TRH	-
Bu form yenidoğan poliklinik uzman doktoru tarafından doldurularak ESHB birimine iletilir		SAYFA NO	1
		YAY. TRH	07.02.2011

Hastanın Adı Soyadı		Protokol No			
Ebeveyn Adı Soyadı		Telefon			
Adres					
Doğum Tarihi/saat	/ /	Hasta Yaşı (saat)	Gestasyon Haftası		
Doğum Ağırlığı (gr)		T.C Kimlik No			
Apgar	/	Perinatal asfiksi + / -			
Fizik İnceleme	VI: C	Nabız : / dk	Solunum Sayısı: / dk		
Genel Durum	Hipoksi: + / -	Hipotoni + / -	Asidotik solunum + / -		
Baş-boyun		Solunum Sist		KVS Sistem	
GIS		GÜS		Ekstremiteler	
NM		Cilt			
Laboratuar		Total Bil/D.Bil	mg / dl	Bil.Artış Hızı	mg / st
Bebek Kan Gr.			Bebek Subgrup		
Anne Kan Gr.			Anne Subgrup		
Hd (gr/dl)		Retikulosit (%)		CRP: mg/dl	
İdrar redüktan madde - / +		TİT		ALT / AST	
G6PD		PY			

Değerlendirme : Yukarıdaki hastanın (AAP 2004 Klinik pratik uygulama ilkelerine göre) serum bilirubin düzeyi yoğun fototerapi sınırının 2-3mg/dl altındadır ve risk faktörü yoktur. Hiperbilirubinemi için Evde Fototerapi uygulanabilir.

Tarih: / /

Dr. Adı Soyadı, Kaşe, İmza

Saat:

Home Phototherapy in Turkiye

- Than our hospital's HHCS goes to home. If home and parental environment is adequate, our team sets up phototherapy unit.

- Parents were given a demonstration on the use of the equipment and the safety precautions that needed to be taken once the baby was placed in the unit.

- Continuous phototherapy was administered by the parents at home. Record of interruption of phototherapy for feeding, excessive crying, bathing and napkin changes was kept by the parents.

Home Phototherapy in Turkiye

- We use a special photherapy unit (Bilicot (Novos®)) that gives blue LED lights from bottom of bed to the back of baby.

- Baby lies down on the bed in a dress that is attached to bed to prevent fall down.

Home Phototherapy in Turkiye

Home Phototherapy in Turkiye

Home Phototherapy in Turkiye

Home Phototherapy in Turkiye

- Our HHCS nurse visits the baby twice a day and checks the parental records for adequate nutritional intake and urinary output.

- She also checks for signs of dehydration, such as weight loss or a sunken fontanelle.

- Our nurse also monitors the phototherapy unit, intensity of the lights with a photometer, and records of thermometer of unit.

Home Phototherapy in Turkiye

- Before leaving, she draws a blood sample and delivers it to the lab. Bilirubin level of the newborn also controlled with a noninvasive transcutaneous bilirubinometer.

- All recordings and findings (weight, temperature, etc.) are written in a daily visit form.

- Later, she notifies the physician this records at the end of day.

Home Phototherapy in Turkiye

	DR.SAMİ ULUS KADIN DOĞUM, ÇOCUK SAĞLIĞI VE HASTALIKLARI EĞİTİM VE ARAŞTIRMA HASTANESİ	FOTOTERAPİ İZLEM FORMU	DOK. NO	ESH/PR-01/TLM-01/F-01
			REV. NO	00
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			YAY. TRH	07.02.2011

pHastanın Adı Soyadı		Protokol No		T.C. Kimlik No		Ev Telefonu	
Baba Adı Soyadı				T.C. Kimlik No		Cep Telefonu	
Anne Adı Soyadı				T.C. Kimlik No		Cep Telefonu	
Adres							
Fototerapi Başlama Zamanı	/ /	Saat:	Hastanede Son Ölçüm - TB (Venöz):		TB (TCB):		
Tedavi Başlama Anındaki Lamba Saati				Tedavi Bitiş Anındaki Lamba Saati			

İZLEM														
Tarih ve Saat	Hasta Yaşı (saat)	Oda Isısı C	Lamba Saati	Vücut Ağırlığı (gr)	Tot.Bil Mg/dl	Vücut Isısı: C	Nabız / dk	Sol. Sayısı /dk	Bez değişme sayısı	İshal +/-	Döküntü +/-	Göbek Bakımı	Diğer/Kan Örneği: Alındı/Alınmadı	Takibi Yapan: Kaşe Adı Soyadı, İmza

BUNLARIN DIŞINDA:

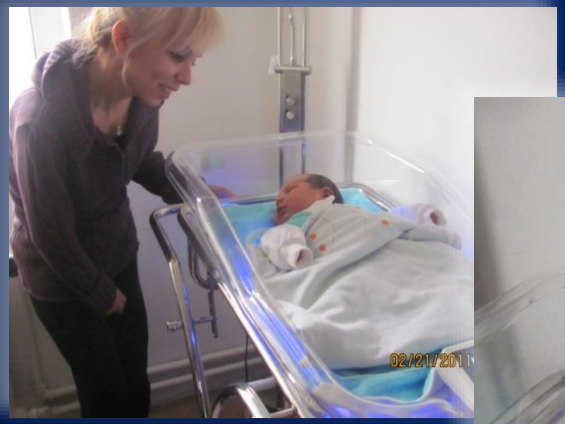
Home Phototherapy in Turkiye

- Decision of termination or continuation of phototherapy is made by pediatrician or neonatologist.

- In decision of termination of phototherapy, we use AAP criterias and we terminate phototherapy when the total bilirubin level fell below 13-14 mg/dl.

- After 24 hours of termination of phototherapy, HHCS team visits the baby again, and controls physical findings and bilirubin level again.

Home Phototherapy in Turkiye



Home Phototherapy in Turkiye

The results of our “home phototherapy” application in 5 years period are;

- The mean weight of newborns; 3206±466 grams

- The mean gestational age of newborns; 38,4±1,1 weeks

(min. 35, max. 41 weeks)

- Mean age at start of phototherapy; 4,9±2,5 days

(min. 2, max. 11 days)

- Mean Duration of phototherapy; 42±16 hours

(min. 1, max. 5 days)

Home Phototherapy in Turkiye

Mean Bilirubin at start; 16,8±1,7 mg/dl

(min. 10,2, max. 19,3).

Mean Bilirubin at termination of phototherapy; 12,6±1,9 mg/dl

(min. 7.4, max. 20.6).

Home Phototherapy in Turkiye

Causes of hyperbilirubinemia in newborns		
Diagnosis	n	%
Physiologic hyperbilirubinemia	191	95,2
ABO incompatibility	7	3,4
Rh isoimmunation	3	1.4

Home Phototherapy in Turkiye

Of the 201 infants, 164 successfully completed therapy at home. 37 newborns re-hospitalized because of rise of bilirubin levels or family maladaptiveness.

No major complications developed during our 5 year home phototherapy period except re-hospitalization (37 newborns), skin rash or diarrhea.

All the mothers found home phototherapy convenient.

The vast majority (95%) of mothers chose to breast-feed their infants during home phototherapy.

Home Phototherapy in Literature

Hospital treatment of jaundice can interfere with successful breastfeeding, therefore home phototherapy may be a viable alternative for breastfeeding mothers.

Mothers accessibility to washroom facilities is a big problem in hospitals. Because in the hospital they share a common area and common washroom facilities which is inconvenient to the mothers.

Home Phototherapy in Literature

A study by Meropol et al. found that 75% of parents were satisfied with home phototherapy.

79% felt that the major parental benefit from home phototherapy was less separation from their newborns.

Meropol SB, Luberti AA, De Jong AR, Weiss JC. Home phototherapy: use and attitudes among community pediatricians. Pediatrics. 1993 Jan;91(1):97-100.

Home Phototherapy in Literature

Another study by Jackson et al found that all the families were highly satisfied with the home program and recorded high levels of confidence in their therapeutic responsibilities.

Jackson CL, Tudehope D, Willis L, Law T, Venz J. Home Phototherapy for neonatal jaundice- technology and teamwork meeting consumer and service need, Aust Health Review, 2000; 23: 162.

Home Phototherapy in Literature

Comparison of our results and literature results

	Okumus et al (n:75)	Zainab & Adlina (n:18)	Eggert et al (n:62)	Slater & Brewer (n:25)
Mean age at start of phototherapy (days)	4.9	3.7	4.2	3.9
Mean Bilirubin Level at start of phototherapy (umol/L)	16.8	13.9	15.2	16.4
Mean Bilirubin Level at termination of phototherapy (umol/L)	12.6	10.2	11.3	11.7
Duration of Phototherapy (d)	1.75	1.17	2.8	2.8

Zainab K, Adlina S. Effectiveness of home versus hospital phototherapy for term infants with uncomplicated hyperbilirubinemia: a pilot study in Pahang, Malaysia. Med J Malaysia. 2004 Aug;59(3):395-401

Eggert LD, Pollary RA, Folland DS, Jung AL. Home phototherapy treatment of neonatal jaundice. Pediatrics. 1985 Oct;76(4):579-84.

Slater L, Brewer MF. Home versus hospital phototherapy for term infants with hyperbilirubinemia: a comparative study. Pediatrics. 1984 Apr;73(4):515-9.

Home Phototherapy in Literature

In a Malaysian study, they found home phototherapy as a feasible and safe alternative to in-hospital phototherapy for carefully selected, otherwise healthy infants.

They also did not see any major complications.

Zainab K, Adlina S. Effectiveness of home versus hospital phototherapy for term infants with uncomplicated hyperbilirubinemia: a pilot study in Pahang, Malaysia. Med J Malaysia. 2004 Aug;59(3):395-401.

Home Phototherapy in Literature

Costs should also be considered when evaluating home phototherapy to hospital phototherapy.

In the study of Eggert et al., about US $ 18,000 was saved by treating the 62 infants in the study at home compared to treatment of jaundiced infants in hospital.

Eggert LD, Pollary RA, Folland DS, Jung AL. Home phototherapy treatment of neonatal jaundice. Pediatrics. 1985 Oct;76(4):579-84.

Home Phototherapy in Literature

In the government hospitals, bed availability is always a problem.

If a selected jaundiced term infant can be treated at home, it would make available a bed in the pediatric unit for more deserving patients.

Home Phototherapy in Literature

One of major advantage of “Home Phototherapy” is prevention of hospital based infections to hyperbilirubinemic newborns.

Conclusion

Home phototherapy is a feasible and safe alternative to in-hospital phototherapy for carefully selected, otherwise healthy infants, with hyperbilirubinemia as their sole problem.

All cases of home phototherapy should be under a paediatrician's or neonatologist's care who would determine the initial level of bilirubin and suitability for home phototherapy.

Conclusion

Home phototherapy should not replace in-hospital phototherapy for infants with multiple problems, inadequate home facilities, or poorly motivated parents!

Teşekkürler…

Thanks…

Grazie…

شكْرًا جَزِيلً…