Breastfeeding, Jaundice and Hyperbilirubinemia in the Newborn

Jeremy Jones, DO

Oklahoma State University

Center for Health Sciences

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Learning Objectives – Breastfeeding

1. Understand the qualitative and quantitative differences between human milk and various infant formulas
2. Recognize the presence and importance of various antibodies (including secretory IgA) in human milk and colostrum
3. Delineate the advantages to the baby of breastfeeding
4. Recognize when breast-feeding should be interrupted because of maternal infection

Learning Objectives – Hyperbilirubinemia

1. Plan the appropriate diagnostic evaluation of jaundice in a full-term infant
2. Understand the differences between physiologic jaundice in pre-term and full-term infants
3. Recognize the association between breast-feeding and physiologic jaundice in the neonatal period
4. Recognize the clinical features and sequelae of acute bilirubin encephalopathy in newborn infants, and manage appropriately
5. Understand strategies to prevent the development of severe hyperbilirubinemia in newborn infants

Practice Gaps

- Human milk provides substantial nutritional, cognitive, emotional, and immunologic benefits for the infant.
- Scientific study and research have accumulated and now constitute a large body of evidence documenting the actual benefits of breastfeeding for the infant and the mother.
- Jaundice occurs in most newborn infants.
- Most jaundice is benign, but because of the potential toxicity of bilirubin, newborn infants must be monitored to identify those who might develop severe hyperbilirubinemia and, in rare cases, acute bilirubin encephalopathy or kernicterus.

Disclosures

I have nothing to disclose.

The Newborn Baby and Breast Milk

aka “Your Baby Isn’t Perfect!”

Developmental Defects in Newborns

- Phagocytes:
  - Poor production, adhesion, migration for first 6 months of life
- Cell-mediated immunity:
  - Limited numbers of memory T-cells
  - Decreased cytokine production: IFN-alpha, IL-2, IL-4, IL-10
  - Poor stimulation of B-cells
- B-Lymphocytes and Immunoglobulins:
  - Limited quantity, quality antibody production
  - Poor Isotype switching
  - IgG production is limited, delayed (matures at 1–7 years of age)
- B-lymphocytes and immunoglobulins:
  - Serum IgA levels are low (less than adult levels through 6–8 years of age)
  - Poor response to T-cell independent antigens (matures at 2–3 years of age)
- Complement cascade:
  - Decreased function in both the classical and the alternative pathways

Robert M Lawrence and Camille A Pane, MD. Human Breast Milk: Current Concepts of Immunology and Infectious Diseases. Curr Probl Pediatr Adolesc Health Care 2007;37:7-36. 1538-5442

Selected Beneficial Properties of Human Milk

Component	Property
Secretory IgA	Specific antigen-targeted anti-infective action
Lactoferrin	Immunomodulation, iron chelation, antimicrobial action, anti-adhesive, trophic for intestinal growth
κ-Casein	Antiadhesive, bacterial flora
Oligosaccharides	Prevention of bacterial attachment
Cytokines	Anti-inflammatory, epithelial barrier function

Adapted from Hamosh M: Bioactive factors in human milk, Pediatr Clin North Am *48:69–86, 2001.*

Selected Beneficial Properties of Human Milk

Growth Factors

Component	Property
Epidermal growth factor	Luminal surveillance, repair of intestine
Transforming growth factor (TGF)	• Promotes epithelial cell growth • Suppresses lymphocyte function
Nerve growth factor	Promotes neural growth

Enzymes

Component	Property
Platelet-activating factor-acetylhydrolase	Blocks action of platelet-activating factor
Glutathione peroxidase	Prevents lipid oxidation
Nucleotides	Enhance antibody responses, bacterial flora

Adapted from Hamosh M: Bioactive factors in human milk, Pediatr Clin North Am *48:69–86, 2001.*

A Few Benefits of Breastfeeding

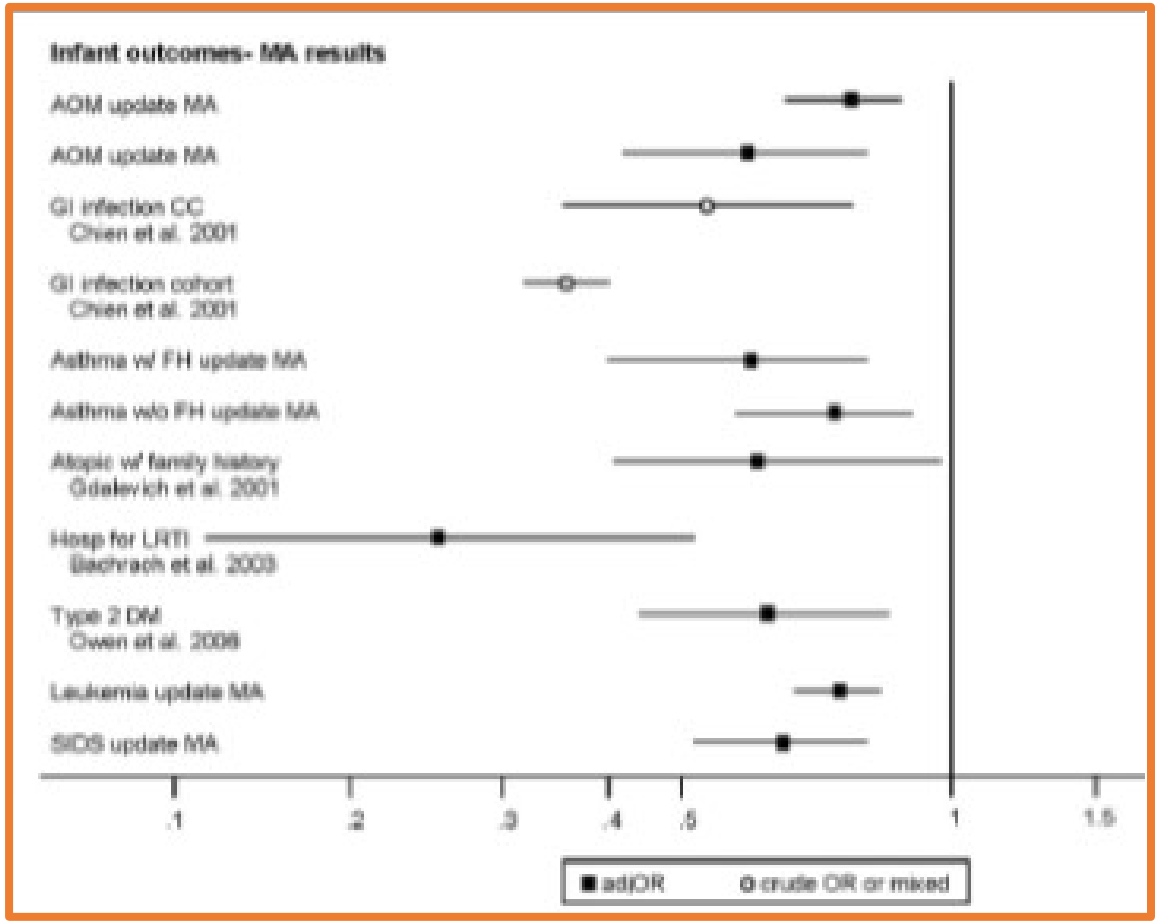
“Breast Milk is the Evidence”

Infant Outcomes with Human Milk

Table 45-2 Conditions for Which Human Milk Has Been Suggested to Possibly Have a Protective Effect

Acute disorders	Crohn disease
Diarrhea	Childhood cancer
Otitis media	Lymphoma
Urinary tract infection	Leukemia
Necrotizing enterocolitis	Recurrent otitis media
Septicemia	Allergy
Infant botulism	Obesity and overweight
Insulin-dependent diabetes mellitus	Hospitalizations
Celiac disease	Infant mortality

Adapted from Ip S, Chung M, Raman G, et al. A summary of the Agency for Healthcare Research and Quality's Evidence Report on Breastfeeding in Developed Countries. Breastfeed Med. 2009;4:S17–S30



Comparison of Human Milk, Cow Milk, and Infant Formula

Component	Human Milk	Similac®/Enfamil® Formulas	Cow Milk
Calories (kcal/L)	747	700	701
Protein (g/100 mL)	1.1	1.5	2.8
Casein	3.7		25.0
Taurine (mM/100 mL)	25 to 30	Added artificially	<1.0
Phenylalanine (mg/100 mL)	48	390 mM/100 mL	172
Tyrosine	61		179
Fat (g/1,000 mL)	4.5	2.6	4.4
Cholesterol (mg/L)	139	0	120
Carbohydrate (g/1,000 mL)	6.8	7.2	4.7
Minerals ash (weight %)	0.2	0.33	0.7
Calcium (mg/dL)	34	55	118
Phosphorus (mg/dL)	14	44	93
Calcium/phosphorus ratio	2.4:1	1.2:1	1.3:1
Sodium (g/L)	0.512 (7 mL Eq/L)	1.1 (6 mL Eq/L)	0.768 g/L
Vitamin D	4 to 40 IU/L	400 IU	47 to 100 IU
Vitamin K	0.9 to 6.9 mg/L	4 mg/100 kcal	19 mg/L

Similac® is a product of Abbot Laboratories, North Chicago, IL, Enfamil® is a product of Mead Johnson & Co, Evansville, IN.
Data from American Academy of Pediatrics. *Pediatric Nutrition Handbook*. 6th ed. Elk Grove Village, IL: American Academy of Pediatrics; 2009; Walker WA, Watkins JB. *Nutrition in Pediatrics*. Boston, MA: Little, Brown and Co; 1985; and Jensen RG. *Handbook of Milk Composition*. New York, NY: Academic Press; 1995.

Clinical Reports

Relevant Steps in the US Surgeon General's Call to Action to Support Breastfeeding

1. Give mothers the support they need to breastfeed their infants.
8. Develop systems to guarantee continuity of skilled support for lactation between hospitals and health care settings in the community.
9. Provide education and training in breastfeeding for all health professionals who care for women and children.
10. Include basic support for breastfeeding as a standard of care for midwives, obstetricians, family physicians, nurse practitioners, and pediatricians.

Meek JY, Hatcher AJ, AAP SECTION ON BREASTFEEDING. The Breastfeeding-Friendly Pediatric Office Practice. *Pediatrics.* 2017;139(5):e20170647

Summary of Breastfeeding Supportive Office Practices

2. Train staff in breastfeeding support skills
3. Discuss breastfeeding during prenatal visits and at well-child visits
4. Encourage exclusive breastfeeding for ~6 months
7. Educate mothers on breast-milk expression and return to work
8. Provide noncommercial breastfeeding educational resources for parents
13. Link with breastfeeding community resources
14. Monitor breastfeeding rates in your practice

Meek JY, Hatcher AJ, AAP SECTION ON BREASTFEEDING. The Breastfeeding-Friendly Pediatric Office Practice. *Pediatrics.* 2017;139(5):e20170647

Jaundice Associated with Breastfeeding

Patterns of Milk Supply

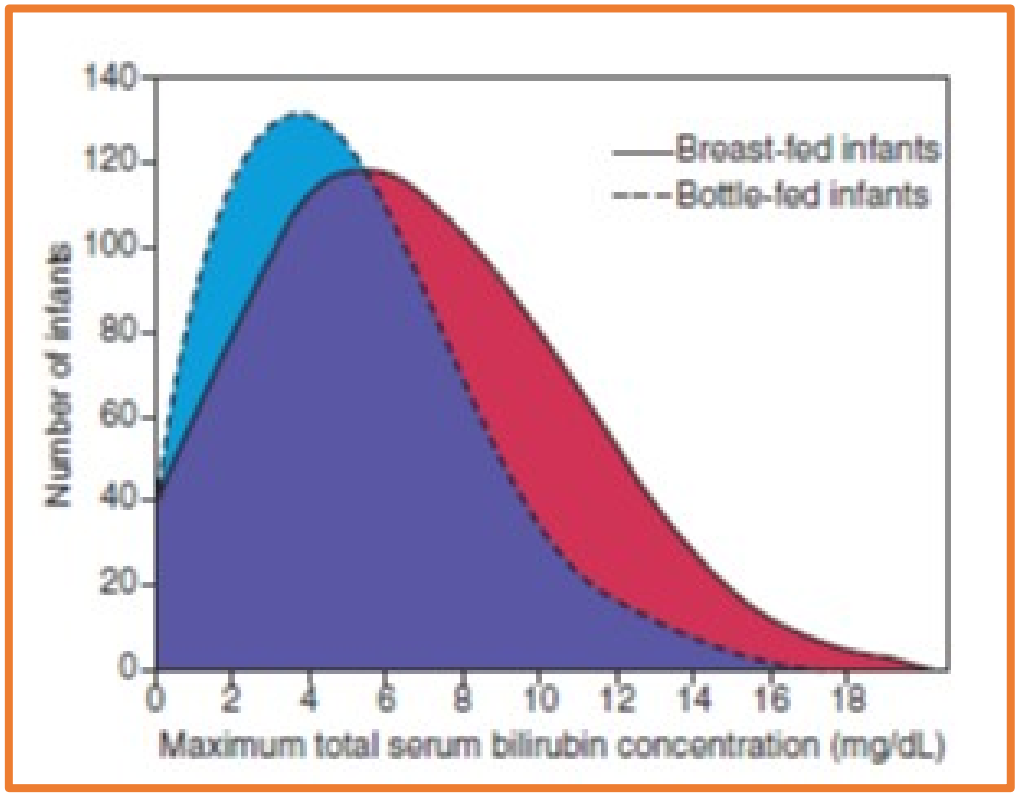
Day of Life	Milk Supply
Day 1	Some milk (~5 mL) may be expressed
Days 2-4	Lactogenesis, milk production increases
Day 5	Milk present, fullness, leaking felt
Day 6 onward	Breasts should feel “empty” after feeding

Adapted from Neifert MR: Clinical aspects of lactation: promoting breastfeeding success, Clin Perinatol *26:281–306, 1999.*

Breastfeeding Jaundice

- Early-onset, indirect hyperbilirubinemia in breastfed infants
  - Hyperbilirubinemia (>12 mg/dL) develops in 13% of breastfed infants
  - Decreased milk intake with dehydration and/or reduced caloric intake.
  - Frequent breastfeeding (>10/24 hr), rooming-in with night feeding, and ongoing lactation support may reduce the incidence
- Even when breastfeeding jaundice develops, breastfeeding should be continued if possible.
  - It is an option to hold breast-feedings and substitute formula for a day or two.
  - Frequent breastfeeding and supplementation with formula is appropriate if intake seems inadequate, weight loss is excessive, or signs of dehydration.

Maximum Bilirubin Levels



Maisels MJ, Gifford K: Normal serum bilirubin levels in the newborn and the effect of breast-feeding, Pediatrics *78:837–843, 1986.*

- Breast-fed infants typically will have higher maximum bilirubin levels
  - They will typically clear their bilirubin more quickly
- Bottle-fed infants typically will have lower maximum bilirubin levels
  - They will typically clear their bilirubin more slowly

Breast Milk Jaundice

- Significant elevation in unconjugated bilirubin in 2% of breastfed term infants after the 7th day
  - Maximal concentrations: 10-30 mg/dL, reached during the 2nd-3rd wk.
  - If breastfeeding is continued, bilirubin gradually decreases but may persist for 3-10 wk at lower levels.
  - If nursing is discontinued, the serum bilirubin level falls rapidly, reaching normal range within a few days.
  - Resumed breastfeeding seldom returns bilirubin to previously high levels.
- The etiology of breast milk jaundice is not entirely clear
  - Presence of glucuronidase in some breast milk

A Few Contraindications to Breastfeeding

“Breast Feeding Really Isn’t for Everybody!”

Contraindications to Breastfeeding

- **Infant Conditions**
  - **Classic galactosemia (galactose 1-phosphate uridyltransferase deficiency)**
  - **Maple syrup urine disease**
  - **Phenylketonuria (partial breastfeeding is possible with careful monitoring)**

Contraindications to Breastfeeding

- **Maternal Conditions**
  - **Human immunodeficiency virus 1 infection (if replacement feeding is acceptable, feasible, affordable, sustainable, and safe)**
  - **Human T-lymphotropic virus 1 and 2 infection (varies by country; in Japan, breastfeeding is initiated)**
  - **Tuberculosis (active, untreated pulmonary tuberculosis, until effective maternal treatment for the initial 2 weeks or the infant is receiving isoniazid)**
  - **Herpes simplex virus infection on a breast (until the lesions on the breast are cleared)**
  - **Medications (those of concern)**

Introduction to Hyperbilirubinemia

Introduction

- Jaundice is observed during the 1st wk after birth in approximately 60% of term infants and 80% of preterm infants.
  - Usually from accumulation of unconjugated, nonpolar, lipid-soluble bilirubin pigment in the skin
  - End product of heme-protein catabolism in the reticuloendothelial cells
  - Elevations of indirect, unconjugated bilirubin are potentially neurotoxic.
- The conjugated form is not neurotoxic.
- Direct hyperbilirubinemia indicates a potentially serious hepatic disorder or a systemic illness.

The Reason is Prevention of Kernicterus

- Develops in 30% of infants with untreated hemolytic disease and bilirubin levels >25-30 mg/dL.
- Overt neurologic signs have a grave prognosis
  - More than 75% of infants die
  - 80% of affected survivors have bilateral choreoathetosis with involuntary muscle spasms
  - Mental retardation, deafness, and spastic quadriplegia are common.

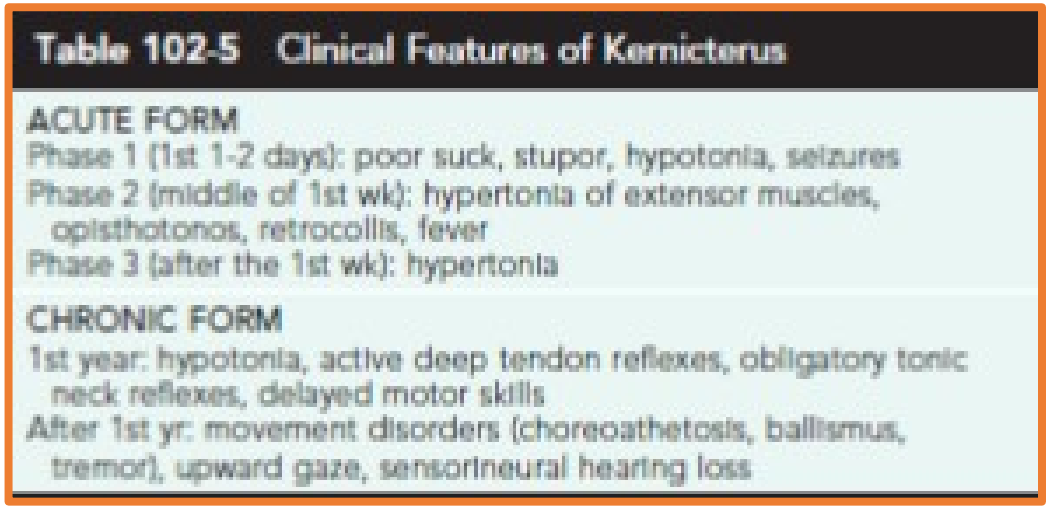


Table 102-5 Clinical Features of Kernicterus

ACUTE FORM

Phase 1 (1st 1-2 days): poor suck, stupor, hypotonia, seizures

Phase 2 (middle of 1st wk): hypertonia of extensor muscles, opisthotonos, retrocollis, fever

Phase 3 (after the 1st wk): hypertonia

CHRONIC FORM

1st year: hypotonia, active deep tendon reflexes, obligatory tonic neck reflexes, delayed motor skills

After 1st yr: movement disorders (choreoathetosis, ballismus, tremor), upward gaze, sensorineural hearing loss

Dennery PA, Seidman DS, Stevenson DK: Neonatal hyperbilirubinemia, N Engl J Med 344:581–590, 2001

Kernicterus

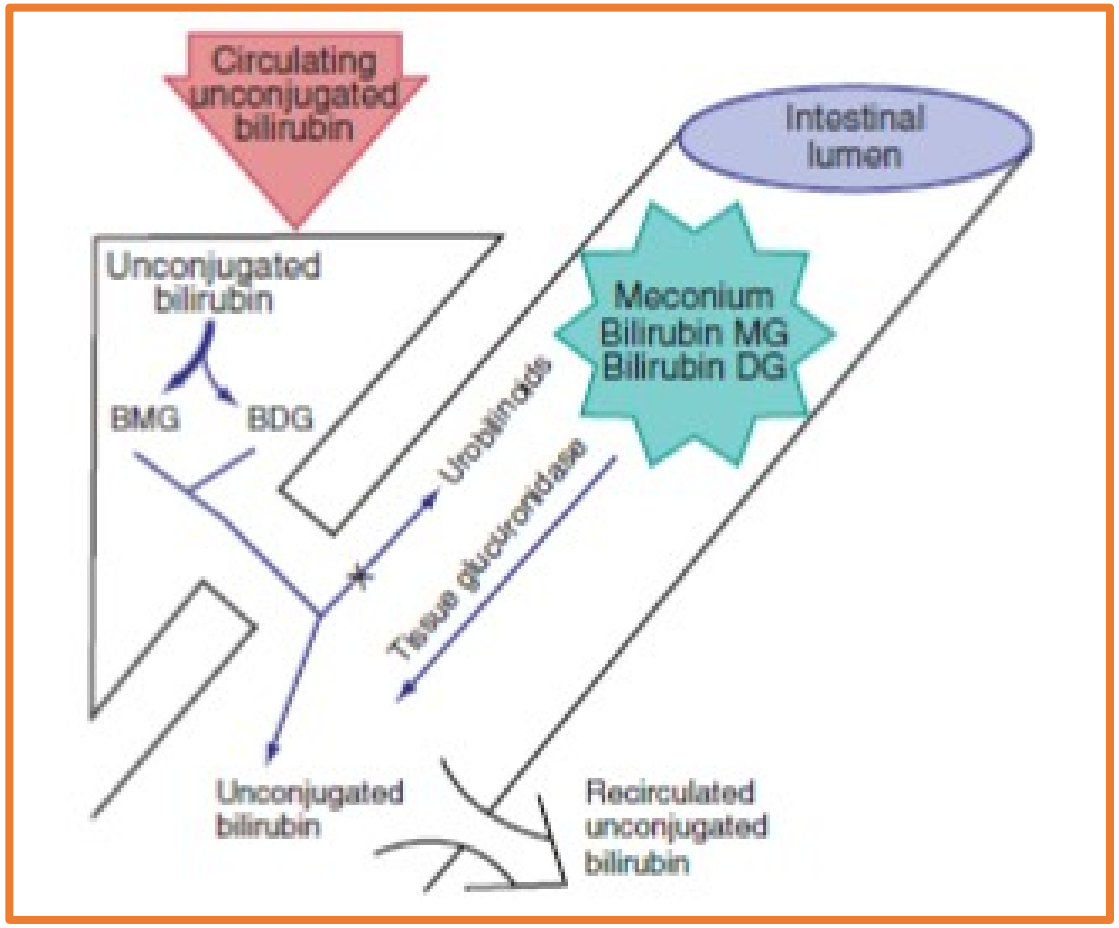
- Neurologic syndrome resulting from the deposition of unconjugated (indirect) bilirubin in the basal ganglia and brainstem nuclei.
- The pathogenesis of kernicterus is multifactorial
  - Unconjugated bilirubin levels
  - Albumin binding and unbound bilirubin levels
  - Passage across the blood-brain barrier
  - Neuronal susceptibility to injury.
- Disruption of the blood–brain barrier and maturational changes in blood–brain barrier permeability affect risk.

Etiology

Etiology

- Metabolism of bilirubin
  - Fetal stage, the placenta
  - Adult stage, conjugated form excreted from hepatic cells into the biliary system and gastrointestinal tract
- Unconjugated hyperbilirubinemia may be caused or increased by
  1. Increased load of bilirubin
  2. Damaged or reduced activity of the transferase enzyme
  3. Competing or blocking enzyme
  4. Absence or decreased amount of enzyme

Bilirubin Production in Neonates



- Neonatal production rate of bilirubin
  - 6-8 mg/kg/24 hr
  - 3-4 mg/kg/24 hr in adults
- Intestinal or milk-containing glucuronidases
  - Enterohepatic recirculation of bilirubin
  - Can lead to hyperbilirubinemia

Major Risk Factors for Severe Hyperbilirubinemia

In Approximate Order of Importance
Predischarge TSB level in the high-risk zone
Jaundice observed in the 1st 24 hr
Blood group incompatibility with positive direct antiglobulin test
Gestational age 35-36 wk
Previous sibling received phototherapy
Cephalohematoma or significant bruising
Exclusive breastfeeding, i.e., poor nursing, excessive weight loss
East Asian race

Minor Risk Factors for Severe Hyperbilirubinemia

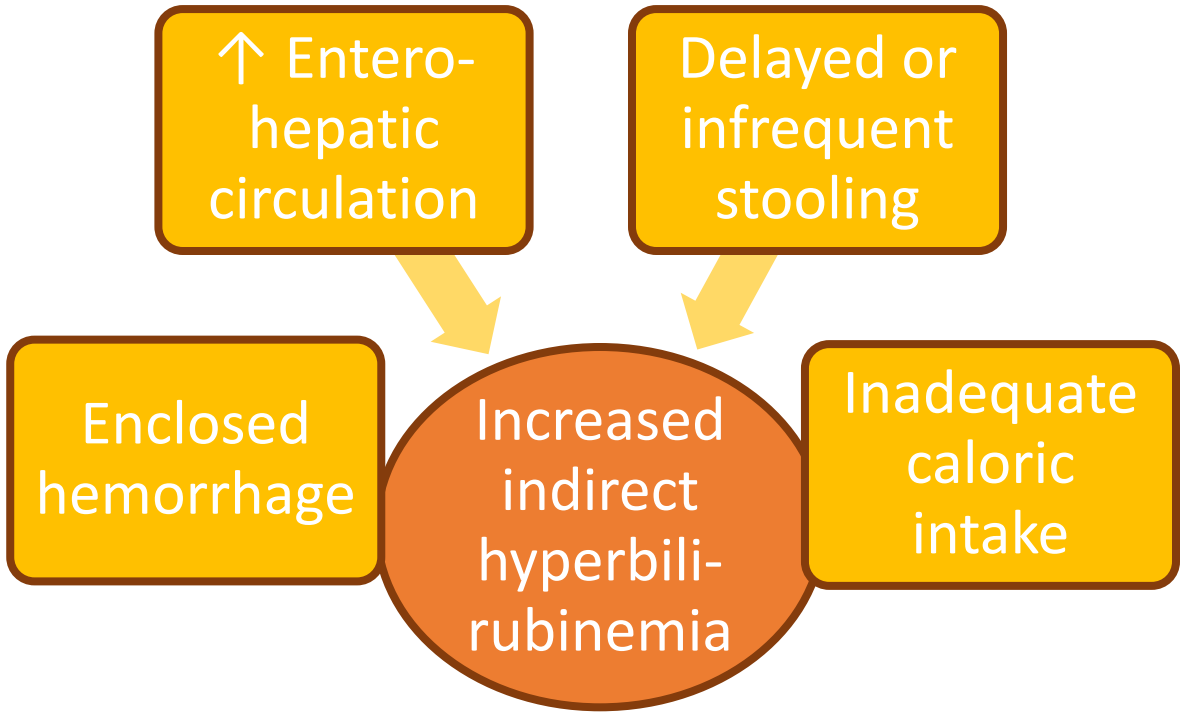
In Approximate Order of Importance
Predischarge TSB level in the high intermediate-risk zone
Gestational age 37-38 wk
Jaundice observed before discharge
Previous sibling with jaundice
Macrosomic infant of a diabetic mother
Maternal age ≥25 yr
Male gender

Additional Risk Factors

- Neurotoxic effect risk factors
  - Permeability of the blood–brain barrier
  - Asphyxia
  - Prematurity
  - Hyperosmolality
  - Infection
- Breastfeeding and dehydration increase serum levels of bilirubin
- Meconium contains 1 mg bilirubin/dL
  - Delayed passage is a risk via enterohepatic recirculation
- Risk factors for unconjugated hyperbilirubinemia
  - Polycythemia
  - Infection
  - Prematurity
  - Infant of a diabetic mother

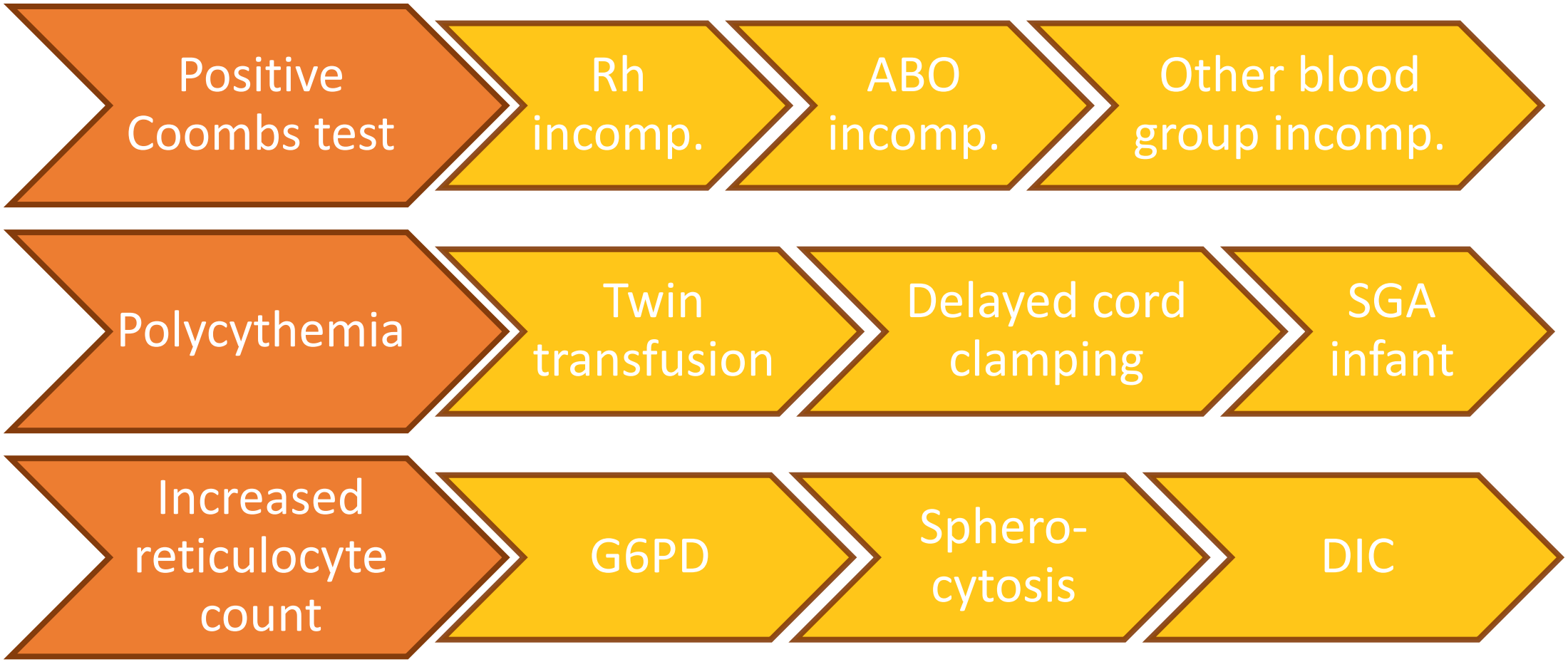
Differential Diagnosis

Reasoning Behind Lack of Workup…

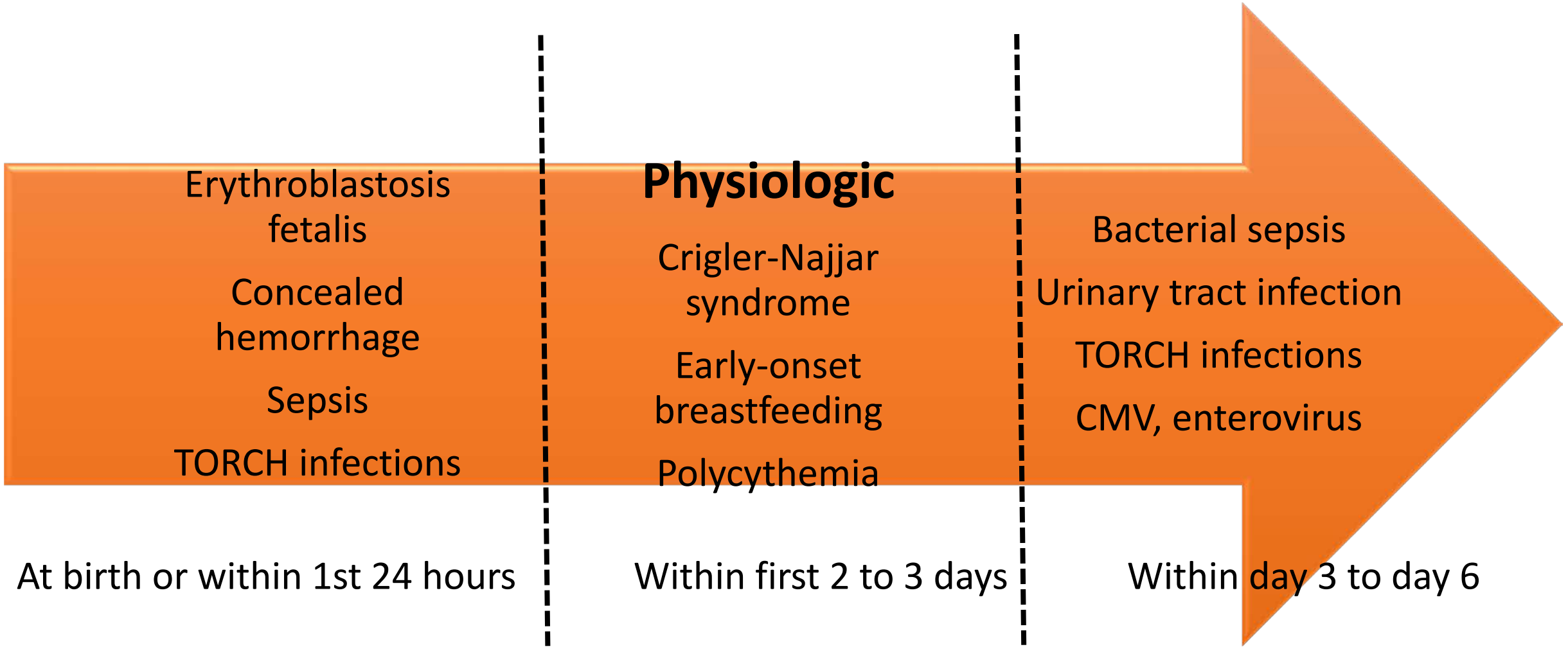


- ALL of these common reasons for jaundice:
  - Have a negative Coombs test
  - Have a normal hemoglobin
  - Have a normal reticulocyte count
  - Have normal red cell morphology
  - Do NOT cause jaundice in 1st 24 hours
  - Do NOT cause prolonged hyperbilirubinemia

Diagnosis of Neonatal Jaundice: **Increased Indirect Bilirubin**



Timeline Considerations for Jaundice



Laboratory Evaluation Recommendation

- *RECOMMENDATION 3.0: A TSB measurement should be performed on every infant who is jaundiced in the first 24 hours after birth. The need for and timing of a repeat TSB measurement will depend on the zone in which the TSB falls, the age of the infant, and the evolution of the hyper-bilirubinemia.*

American Academy of Pediatrics Subcommittee on Hyperbilirubinemia: Management of hyperbilirubinemia in the newborn infant 35 or more weeks of gestation, Pediatrics 114:297–316, 2004

Laboratory Evaluation of the Jaundiced Infant ≥35 Wk of Gestation

Indications	Assessment
Jaundice in 1st 24 hours	Measure TSB
Jaundice appears excessive for patient's age	Measure TSB

Laboratory Evaluation of the Jaundiced Infant ≥35 Wk of Gestation

Indications	Assessment
Infant receiving phototherapy or TSB rising rapidly and unexplained by history and physical examination	• Blood type and Coombs test, if not obtained with cord blood • Complete blood count and smear • Measure direct or conjugated bilirubin • It is an option to perform reticulocyte count, G6PD, and ETCO, if available • Repeat TSB in 4-24 hr depending on infant's age and TSB level

Jaundice that Appears from Day 2 to Day 6

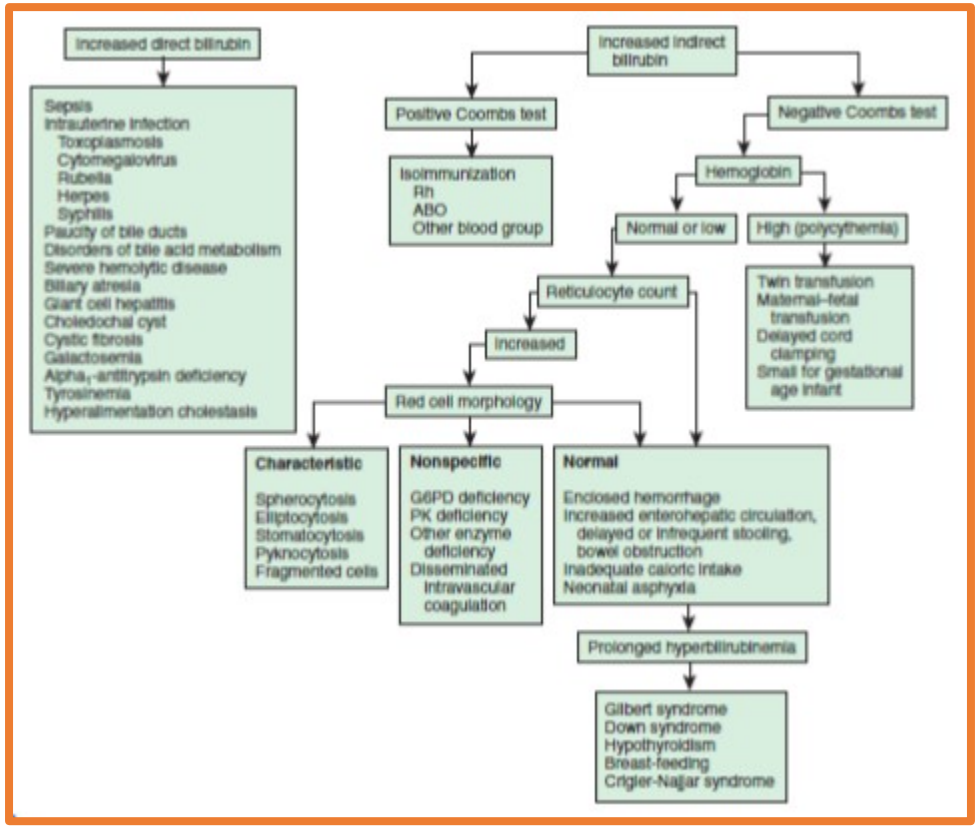
- **Jaundice that first appears on the 2nd or 3rd day is usually physiologic.**
- Jaundice secondary to extensive ecchymosis or blood extravasation (i.e., cephalohematoma) may occur during the 1st day or later, especially in premature infants.

Cause of Jaundice Recommendation

- *RECOMMENDATION 4.1: The possible cause of jaundice should be sought in an infant receiving phototherapy or whose TSB level is rising rapidly (i.e., crossing percentiles) and is not explained by the history and physical examination.*

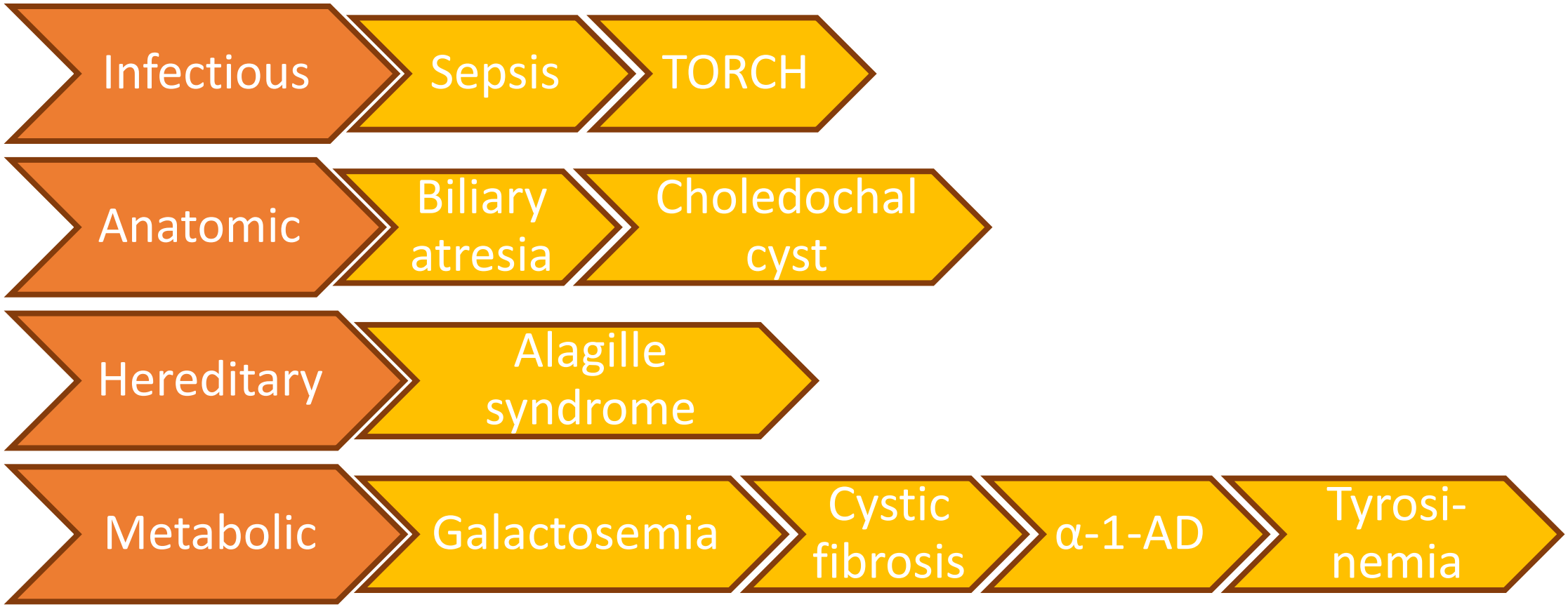
American Academy of Pediatrics Subcommittee on Hyperbilirubinemia: Management of hyperbilirubinemia in the newborn infant 35 or more weeks of gestation, Pediatrics 114:297–316, 2004

A Small Graphic on the Schematic Approach to the Diagnosis of Neonatal Jaundice



- Blood type and Coombs test, if not obtained with cord blood
- Complete blood count and smear
- Measure direct bilirubin
- Optional: reticulocyte count, G6PD, and ETCO, if available
- Repeat TSB in 4-24 hr depending on infant's age and TSB level

Diagnosis of Neonatal Jaundice: **Increased Direct Bilirubin**



Percentage of Cases of Cholestasis

Major Diagnostic Categories of Prolonged Neonatal Cholestasis	
Disorder	Cases, %
Idiopathic neonatal hepatitis	15
Extrahepatic biliary atresia (BA)	25
α_1-Antitrypsin deficiency	10
Genetic syndromes • Progressive familial intrahepatic cholestasis • Alagille syndrome • Bile acid secretory defects	25
TORCH syndrome	5
Metabolic disorders	20

Laboratory Evaluation of the Jaundiced Infant ≥35 Wk of Gestation

Indications	Assessment
TSB concentration approaching exchange levels or not responding to phototherapy	Perform reticulocyte count, G6PD, albumin, ETCO if available
Elevated direct (or conjugated) bilirubin level	• Do urinalysis and urine culture • Evaluate for sepsis if indicated by history and physical examination

Laboratory Evaluation of the Jaundiced Infant ≥35 Wk of Gestation

Indications	Assessment
Jaundice present at or beyond age 3 wk, or sick infant	• Total and direct (or conjugated) bilirubin level • If direct bilirubin elevated, evaluate for causes of cholestasis • Check results of newborn thyroid and galactosemia screen, and evaluate infant for signs or symptoms of hypothyroidism

Extensive Evaluation for Cholestasis

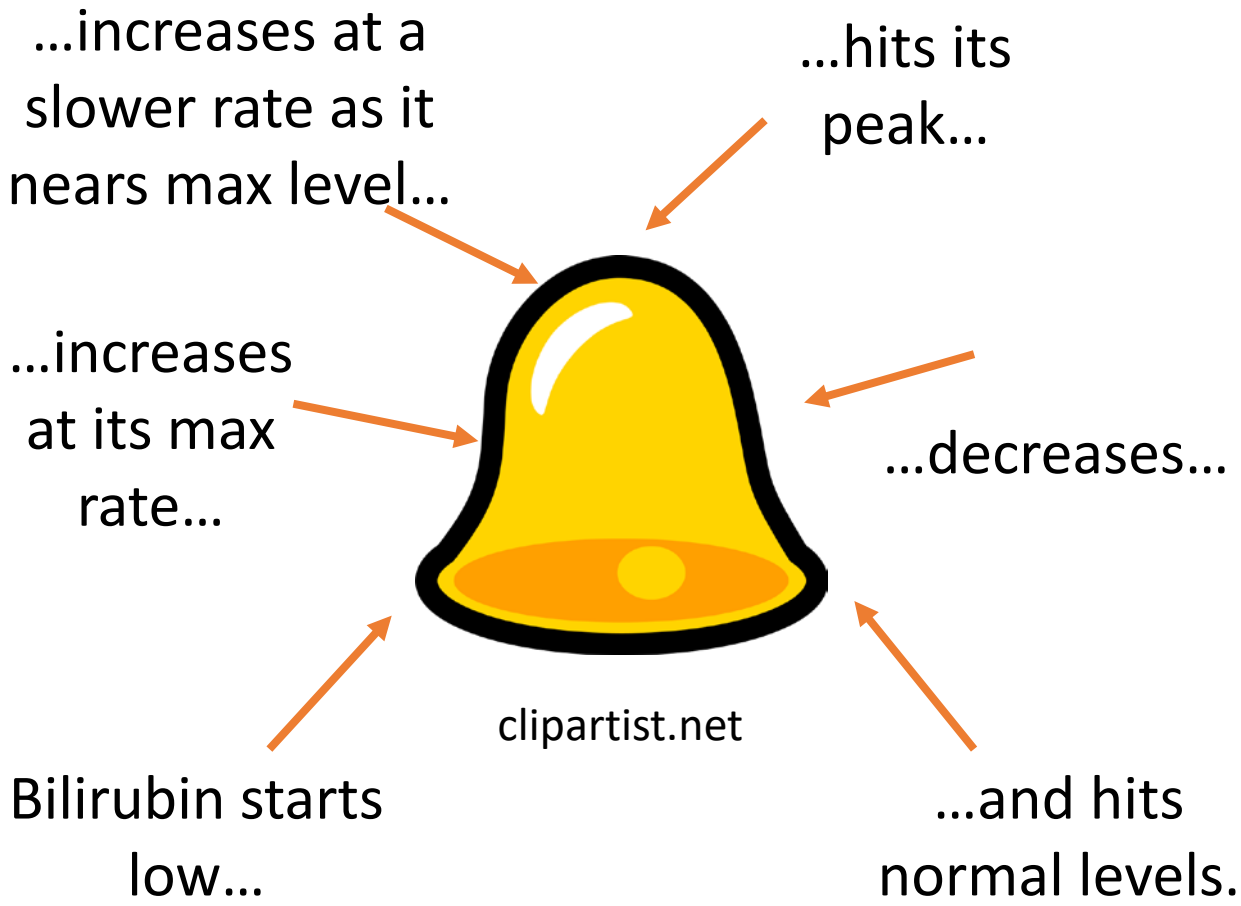
Initial Laboratory Evaluation of the Neonate with Cholestasis
Fractionated serum bilirubin concentration
Liver chemical tests: ALT, AST, alk phos, γ-glutamyl transferase
Tests of liver function: glucose, albumin, cholesterol, coagulation studies
Ammonia (if clinically indicated)
CBC
α_1-Antitrypsin level and phenotype

Physiologic Jaundice

Indirect Hyperbilirubinemia Incidence

- Under normal circumstances, the level of indirect bilirubin rises at a rate of <5 mg/dL/24 hr
  - Jaundice becomes visible on the 2nd or 3rd day
  - Bilirubin levels usually peak between the 2nd and 4th day
  - Decrease to <2 mg/dL between the 5th and 7th day
  - Decline to adult levels (1 mg/dL) by 10th to 14th day
- Overall, 6-7% of full-term infants have indirect bilirubin levels >13 mg/dL and less than 3% have levels >15 mg/dL.
- Predicting risk for exaggerated physiologic jaundice is based on hour-specific bilirubin levels in the 1st 24-72 hr of life.

Expected Rate of Increase in Bilirubin and Maximum Bilirubin Levels



- **The maximum expected rate of increase of bilirubin in a term well newborn is:**
  - **0.2 mg/dL/h, OR**
  - **4.8 mg/dL/day**

Clinical Assessment Recommendation

- *RECOMMENDATION 2.2: Clinicians should ensure that all infants are routinely monitored for the development of jaundice. … Jaundice should be assessed whenever the infant's vital signs are measured…*
  - Jaundice can be detected by blanching the skin with digital pressure to reveal underlying color of skin and subcutaneous tissue.
  - You must be in a well-lit room preferably in daylight by a window.
  - Jaundice is usually seen first in the face and progresses caudally to trunk and extremities.

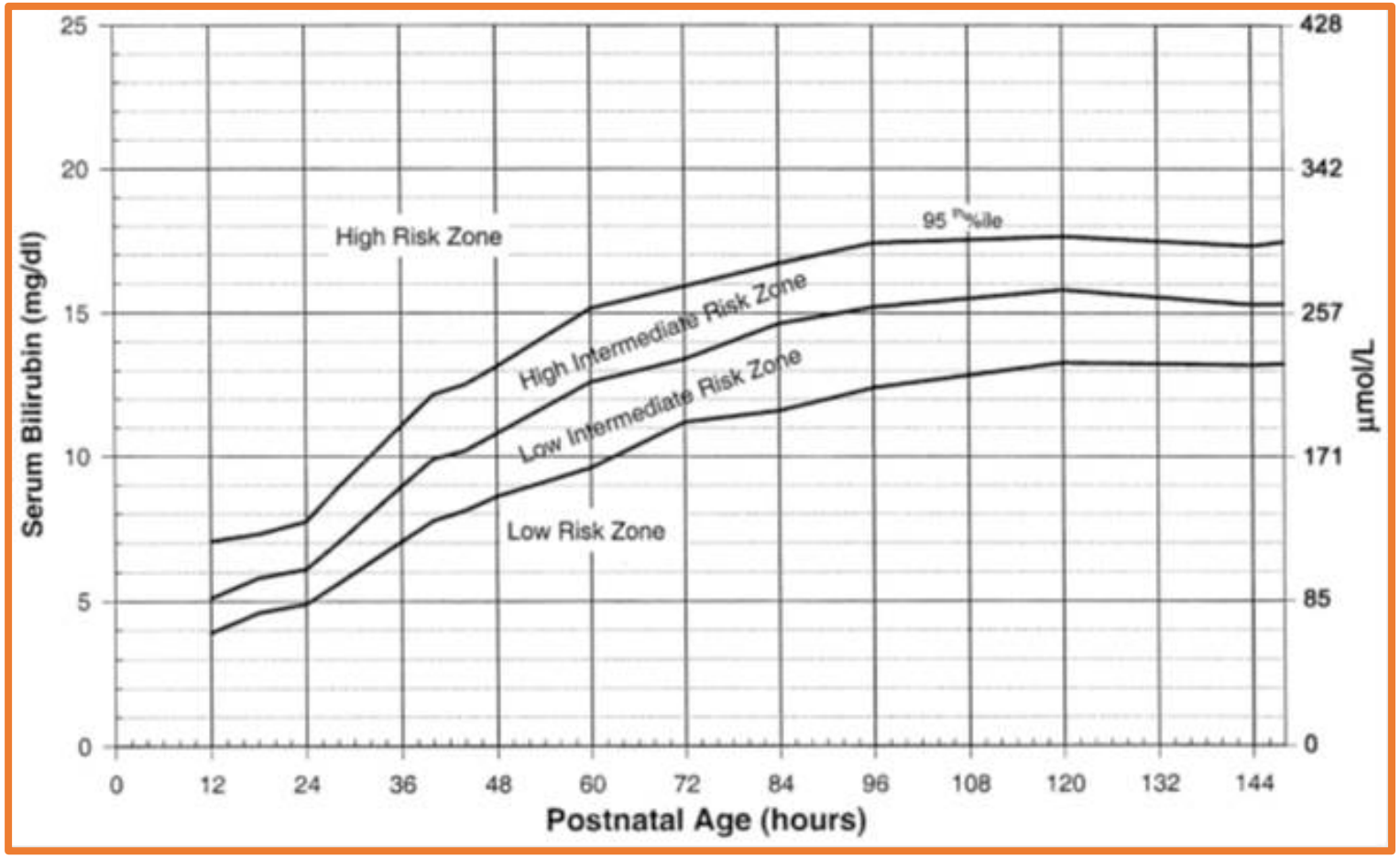
American Academy of Pediatrics Subcommittee on Hyperbilirubinemia: Management of hyperbilirubinemia in the newborn infant 35 or more weeks of gestation, Pediatrics 114:297–316, 2004

Risk Assessment Before Discharge Recommendations

- *RECOMMENDATION 5.1: Before discharge, every newborn should be assessed for the risk of developing severe hyperbilirubinemia, and all nurseries should establish protocols for assessing this risk. Such assessment is particularly important in infants who are discharged before the age of 72 hours.*

American Academy of Pediatrics Subcommittee on Hyperbilirubinemia: Management of hyperbilirubinemia in the newborn infant 35 or more weeks of gestation, Pediatrics 114:297–316, 2004

Risk Designation of Term Well Newborns



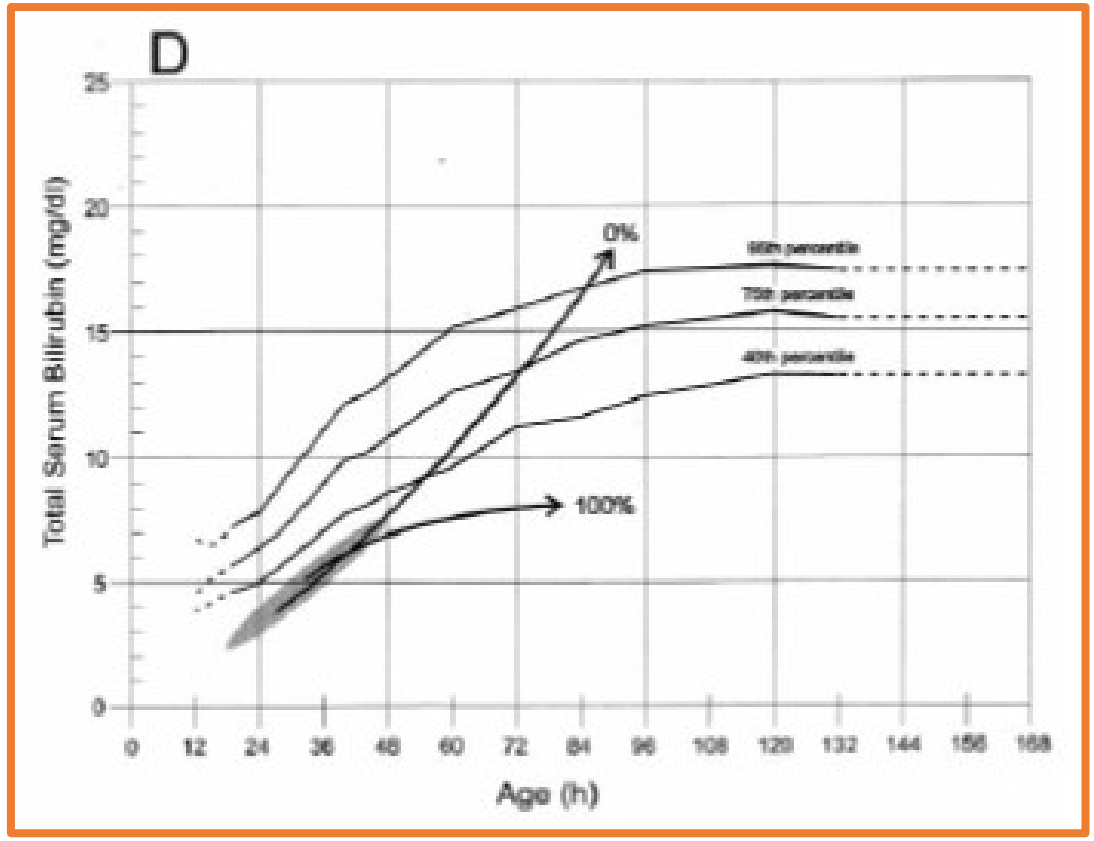
Risk Zone as a Predictor of Hyperbilirubinemia

TABLE 4. Risk Zone as a Predictor of Hyperbilirubinemia[39]

TSB Before Discharge	Newborns (Total = 2840), *n* (%)	Newborns Who Subsequently Developed a TSB Level >95th Percentile, *n* (%)
High-risk zone (>95th percentile)	172 (6.0)	68 (39.5)
High intermediate-risk zone	356 (12.5)	46 (12.9)
Low intermediate-risk zone	556 (19.6)	12 (2.26)
Low-risk zone	1756 (61.8)	0

Bhutani VK, Johnson L, Sivieri EM. Predictive ability of a predischarge hour-specific serum bilirubin for subsequent significant hyperbilirubinemia in healthy term and near-term newborns. Pediatrics. 1999;103: 6–14

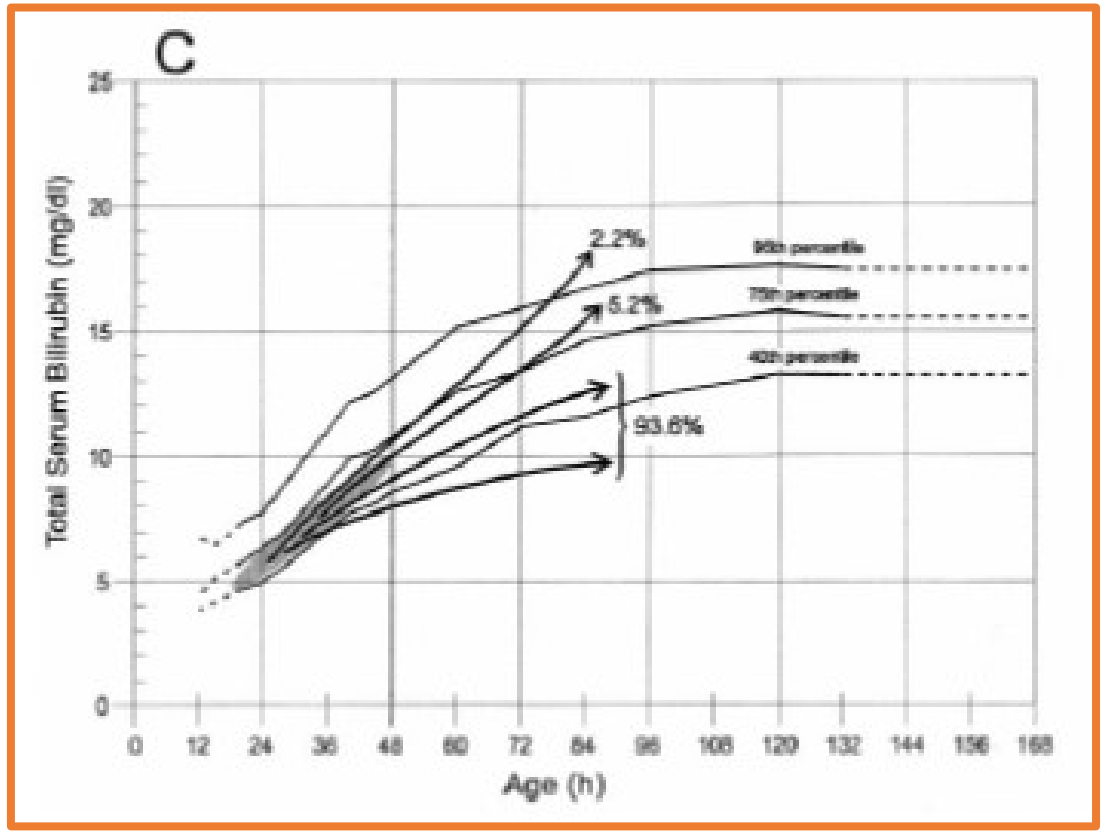
Outcomes of Newborns in the Low-risk Zone



Predictive Characteristics	
Value	**%**
Positive Predictive Value	11.6%
Negative Predictive Value	100%
Sensitivity	100%
Specificity	64.7%

Bhutani VK, Johnson L, Sivieri EM. Predictive ability of a predischarge hour-specific serum bilirubin for subsequent significant hyperbilirubinemia in healthy term and near-term newborns. Pediatrics. 1999;103: 6–14

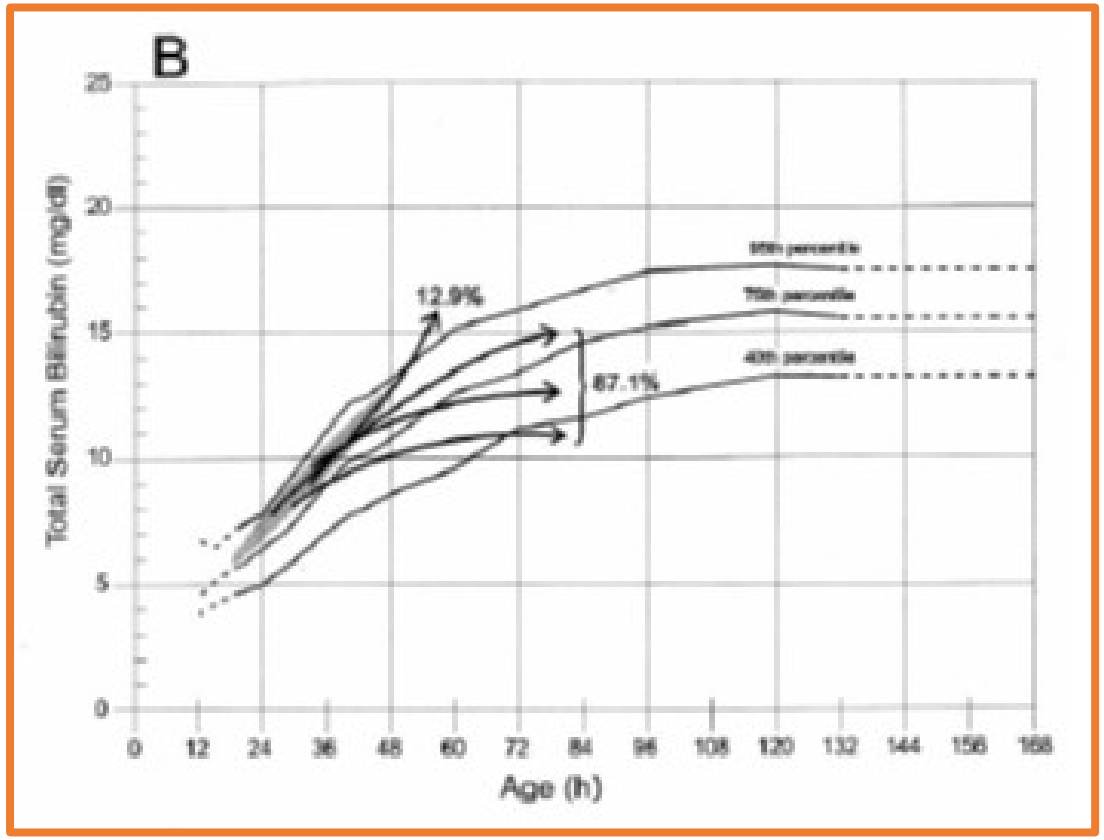
Outcomes of Newborns in the Low-intermediate-risk Zone



Predictive Characteristics	
Value	**%**
Positive Predictive Value	21.6%
Negative Predictive Value	99.5%
Sensitivity	90.5%
Specificity	84.7%

Bhutani VK, Johnson L, Sivieri EM. Predictive ability of a predischarge hour-specific serum bilirubin for subsequent significant hyperbilirubinemia in healthy term and near-term newborns. Pediatrics. 1999;103: 6–14

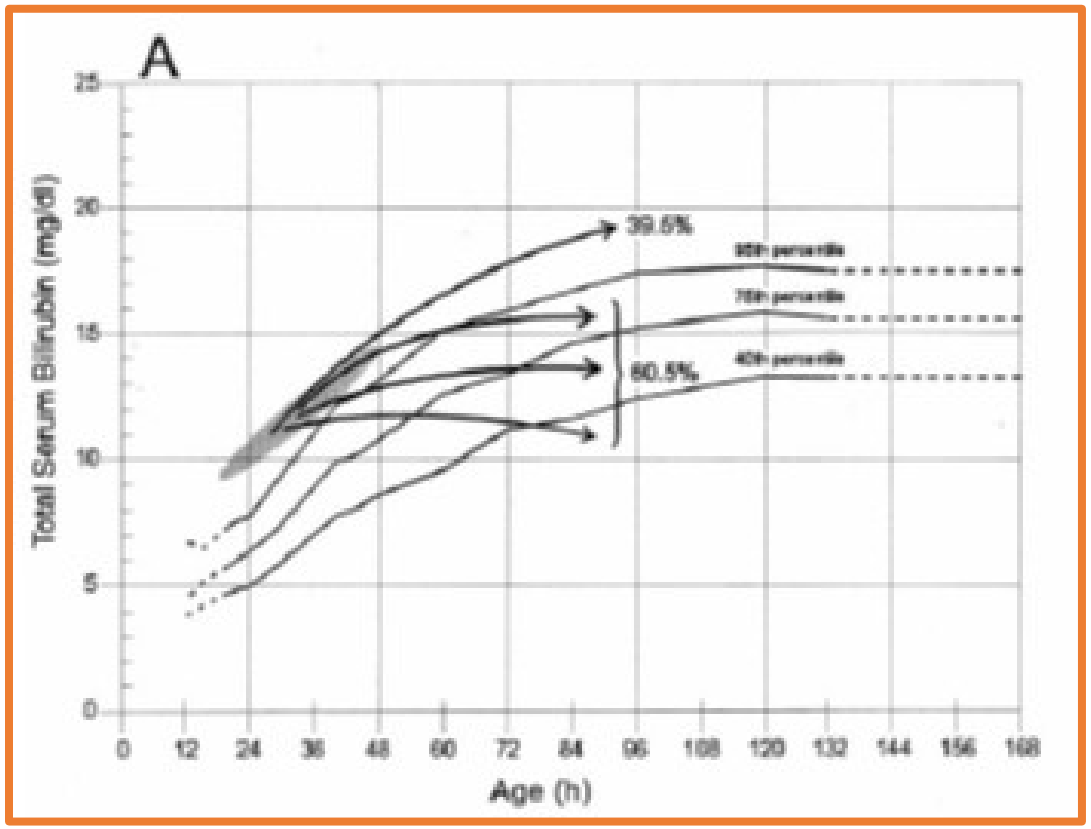
Outcomes of Newborns in the High-intermediate-risk Zone



Predictive Characteristics	
Value	**%**
Positive Predictive Value	21.6%
Negative Predictive Value	99.5%
Sensitivity	90.5%
Specificity	84.7%

Bhutani VK, Johnson L, Sivieri EM. Predictive ability of a predischarge hour-specific serum bilirubin for subsequent significant hyperbilirubinemia in healthy term and near-term newborns. Pediatrics. 1999;103: 6–14

Outcomes of Newborns in the High-risk Zone



Predictive Characteristics	
Value	**%**
Positive Predictive Value	39.5%
Negative Predictive Value	97.8%
Sensitivity	54.0%
Specificity	96.2%

Bhutani VK, Johnson L, Sivieri EM. Predictive ability of a predischarge hour-specific serum bilirubin for subsequent significant hyperbilirubinemia in healthy term and near-term newborns. Pediatrics. 1999;103: 6–14

Prevention

Primary Prevention Recommendation

- *RECOMMENDATION 1.0: Clinicians should advise mothers to nurse their infants at least 8 to 12 times per day for the first several days*
  - Poor caloric intake and/or dehydration may contribute to development of hyperbilirubinemia.
  - Baby should have 4-6 wet diapers in 24 hours and pass 3-4 stools a day by the 4th day of life.
  - Stools should be mustard yellow and no longer meconium like.

American Academy of Pediatrics Subcommittee on Hyperbilirubinemia: Management of hyperbilirubinemia in the newborn infant 35 or more weeks of gestation, Pediatrics 114:297–316, 2004

Correlation of Breast-feeding Frequency and Incidence of Hyperbilirubinemia

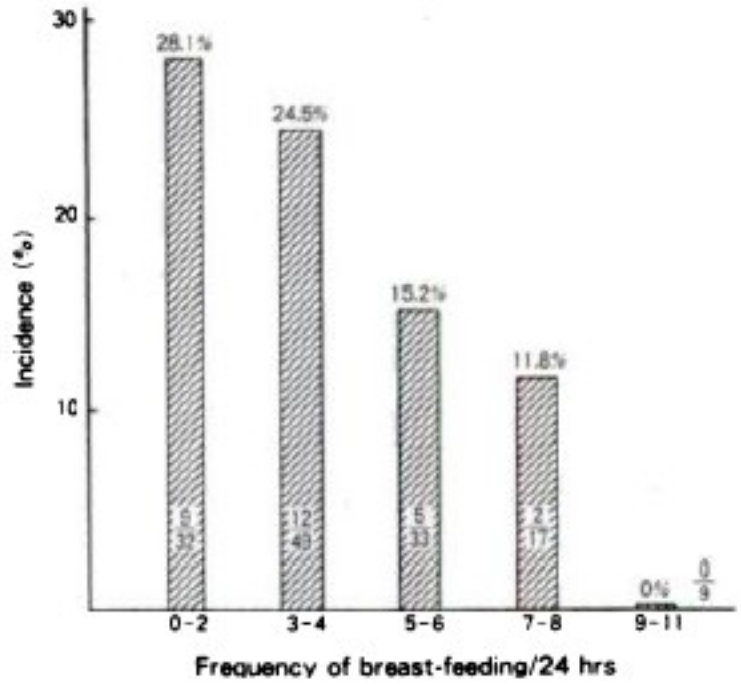


Fig 2. Correlation between breast-feeding frequency during the first 24 hours after birth and incidence of hyperbilirubinemia (transcutaneous bilirubin reading ≥23.5).

Frequency	Incidence
Every 2 hours	0%
Every 3 hours	12%
Every 4 hours	15%
Every 6 hours	25%
Every 12 hours	28%

Yamauchi Y, Yamanouchi I. Breast-feeding frequency during the first 24 hours after birth in full-term neonates. Pediatrics. 1990;86:171–175

Secondary Prevention Recommendations

- *RECOMMENDATION 2.0: Clinicians should perform ongoing systematic assessments during the neonatal period for the risk of an infant developing severe hyperbilirubinemia*.
  - Blood typing
  - Clinical assessment

American Academy of Pediatrics Subcommittee on Hyperbilirubinemia: Management of hyperbilirubinemia in the newborn infant 35 or more weeks of gestation, Pediatrics 114:297–316, 2004

Blood Typing Recommendation

- *RECOMMENDATION 2.1: All pregnant women should be tested for ABO and Rh (D) blood types and have a serum screen for unusual isoimmune antibodies.*
  - If no blood typing or mom is Rh -, then a DAT or Coombs' test on infant's cord blood is strongly recommended
  - If maternal blood type O+, it is an option to test cord blood for infant's blood type and DAT but not required provided appropriate surveillance and follow-up

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Hospital Policies and Procedures Recommendations

- *RECOMMENDATION 6.1: All hospitals should provide written and verbal information for parents at the time of discharge, which should include an explanation of jaundice, the need to monitor infants for jaundice, and advice on how monitoring should be done.*

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Timing of Follow-up

Timing of Follow-up

RECOMMENDATION 6.1.2: Follow-up should be provided as follows:

Infant Discharged	Should Be Seen by Age
Before age 24 h	72 h
Between 24 and 47.9 h	96 h
Between 48 and 72 h	120 h

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- All infants should be examined by qualified healthcare professional in first few days after discharge to assess infant well-being and presence of jaundice.
- Earlier follow-up visit may be necessary if patient has risk factors for hyperbilirubinemia; may need to see within 24 hours of discharge.

Treatment of Hyperbilirubinemia

Goals of Therapy

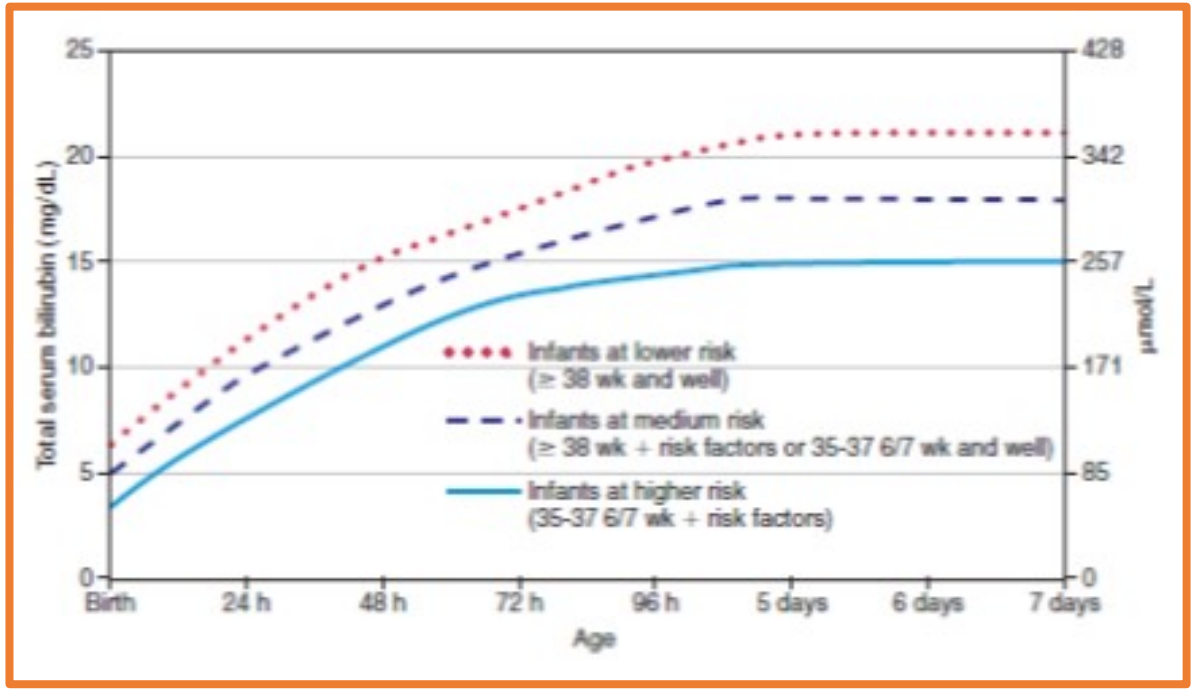
- Regardless of the cause, the goal of therapy is to prevent neurotoxicity related to indirect-reacting bilirubin while not causing undue harm.
- Phototherapy and, if it is unsuccessful, exchange transfusion remain the primary treatment modalities used to keep the maximal total serum bilirubin below pathologic levels.

Principles Behind Starting Phototherapy

- There is lack of consensus regarding the exact bilirubin level at which to initiate phototherapy.
- Because phototherapy may require 6-12 hr to have a measurable effect, it must be started at bilirubin levels below those indicated for exchange transfusion.
- Phototherapy is usually started at 50-70% of the maximal indirect level.
- If values greatly exceed this level, if phototherapy is unsuccessful in reducing the maximal bilirubin level, or if signs of kernicterus are evident, exchange transfusion is indicated.

Guidelines for Phototherapy

- Risk factors
  - Isoimmune hemolytic disease
  - G6PD deficiency
  - Asphyxia
  - Significant lethargy
  - Temperature instability
  - Sepsis
  - Acidosis
  - Albumin 3.0 g/dL (if measured)



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Suggested Maximal Indirect Serum Bilirubin Concentrations (mg/dL) in Preterm Infants

BIRTHWEIGHT (g)	UNCOMPLICATED*	COMPLICATED*
<1,000	12 – 13	10 – 12
1000 – 1,250	12 – 14	10 – 12
1,251 – 1,499	14 – 16	12 – 14
1,500 – 1,999	16 – 20	15 – 17
2,000 – 2,500	20 – 22	18 – 20

- *Complications include perinatal asphyxia, acidosis, hypoxia, hypothermia, hypoalbuminemia, meningitis, intraventricular hemorrhage, hemolysis, hypoglycemia, or signs of kernicterus.

How Phototherapy Works

- Clinical jaundice and indirect hyperbilirubinemia are reduced by exposure to a high intensity of light in the visible spectrum.
  - Bilirubin absorbs light maximally in the blue range (420-470 nm).
  - Broad-spectrum white, blue, and special narrow-spectrum (super) blue lights have been effective in reducing bilirubin levels.
- Bilirubin in the skin absorbs light energy, causing several photochemical reactions.
  - Major products from phototherapy are an isomer which can then be excreted in bile without conjugation and an isomer that can be excreted by the kidneys.

Phototherapy Effectiveness

- Dependent factors
  1. Light energy emitted in the effective range of wavelengths
  2. Distance between the lights and the infant
  3. Surface area of exposed skin
  4. Rate of hemolysis
  5. In vivo metabolism and excretion of bilirubin
- Increasing effectiveness
  1. Using “special blue” fluorescent tubes
  2. Placing the lamps within 15-20 cm of the infant
  3. Putting a fiberoptic phototherapy blanket under the infant’s back to increase the exposed surface area

Phototherapy Considerations

- Skin color cannot be relied on for evaluating the effectiveness of phototherapy
  - Skin exposed to phototherapy may appear to be almost without jaundice
- NOT necessary for all affected infants, but
  - Intravenous fluid supplementation added to oral feedings
  - Dehydrated patients
  - Infants with bilirubin levels nearing those requiring exchange transfusion

Questions

Resources

Pediatric Review Education Program

American Academy of Pediatrics

Nelson Textbook of Pediatrics