Almost There: Exploring the Hidden Risks of the Late Preterm Infant

Leann Baker, DNP, APRN, NNP-BC, C-ONQS. Neonatal Nurse Practitioner, University of Louisville/Norton Children's Hospital, Louisville, KY
Toni Dobson, MSN, APRN, FNP-C, ENP-C. Family and Emergency Nurse Practitioner, Erlanger Medical Center, Chattanooga, TN

Objectives

- Differentiate patients who are late preterm infants and identify common complications of this population.
- Using PediTools, assess your patient's level of hyperbilirubinemia and develop a treatment plan.
- Develop a management plan for an acutely hypoglycemic late preterm infant.
- Distinguish between non-emergent and emergent feeding difficulties of the late preterm infant.

Statistics

- Prematurity up 12% since 2014
- **70% of preterm births are LPI**
- Most LPIs look mature, but remain structurally and physiologically immature
- LPIs account for 8% of neonatal deaths
- 2-3 times the risk of complications and readmission

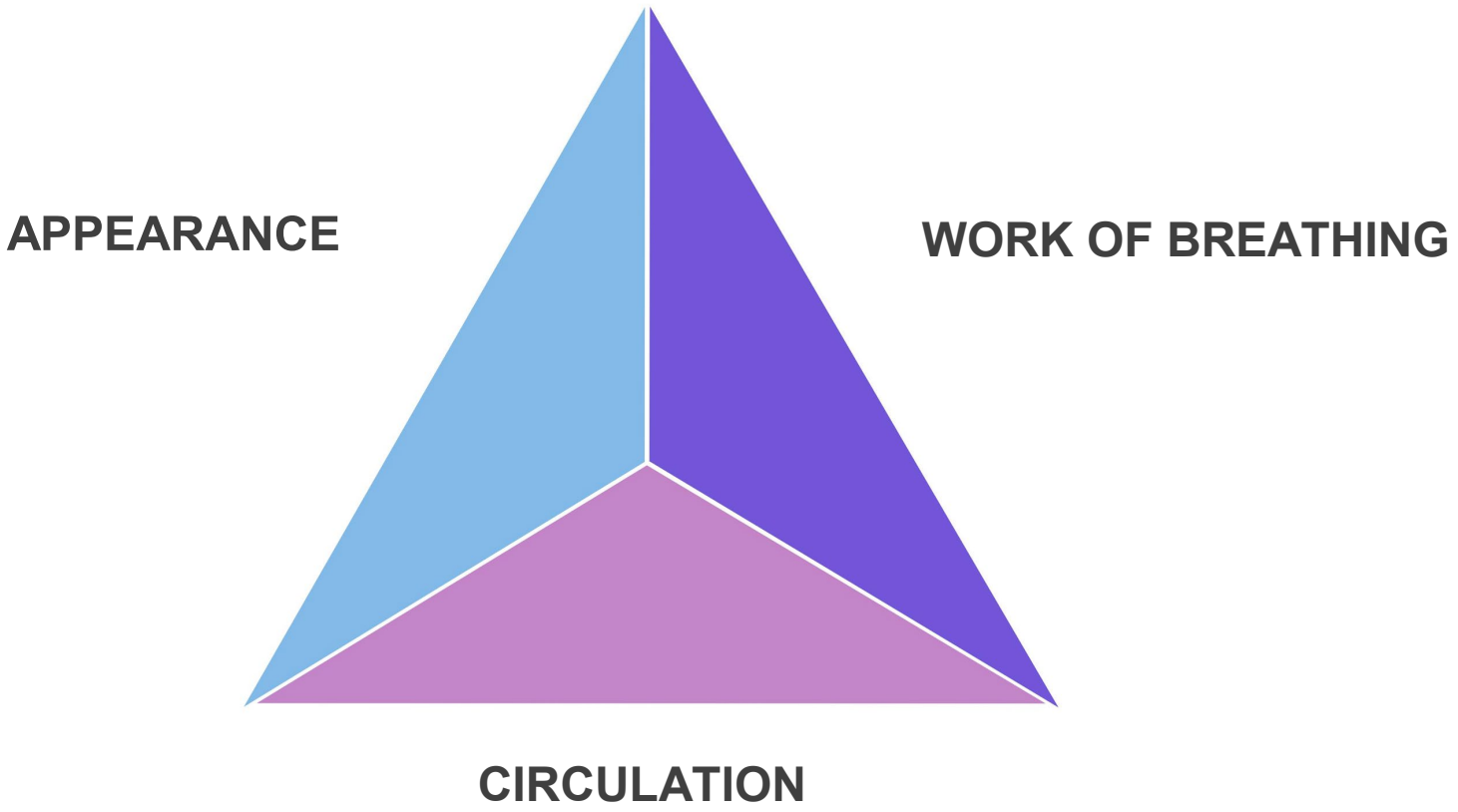
Risk Factors for Preterm Delivery

- PPROM
- Maternal hx of PTB
- Infections
- Maternal stress
- Chronic maternal disease
- Uterine, placental and fetal anomalies
- Shortened cervix
- Extremes of maternal age
- Assisted reproductive technology
- Obesity
- Inaccurate pregnancy dating
- Spontaneous preterm labor
- Smoking
- Multiple gestation

Common Complications of the LPI

- **Late preterm infant (LPI): Birth at 34w0d to 36w6d gestation**
- Greatest risk for readmission is in the first week of life.
- 2-3 times higher risk of complications and readmission.
- These children have increased healthcare needs during infancy and childhood.
  - Hyperbilirubinemia (58.9%)
  - Infection/Sepsis (10.8%)
  - Thermoregulation Problems (4.7%)
  - Hypoglycemia
  - Feeding Difficulties

Pediatric Assessment Triangle



Detailed Assessment

- History: Prematurity, feeding hx, weight gain, bowel and bladder function, NICU admission, pregnancy hx, maternal drug or ETOH use, maternal GBS and HSV status, abn fetal US or neonatal screening, FMHx of congenital disease
- General observation of infant: color, work of breathing, abnormal physical or facial appearance
- Tone
- Primitive reflexes: Moro, grasp, suck, root
- Femoral pulses
- Weight
- Vital signs including a rectal temperature
- Consider pre- and postductal SpO2 and BP in all 4 extremities when assessing for CHD

Normal VS Range for the LPI	
Heart Rate	129-139
Respiratory Rate	35-42
Blood Pressure	60/31-77/49
MAP	41-58
Temperature	36.5-37.5 C (97.7-99.5 F)
SpO2	98-100

Building a DDx: THE MISFITS

T	Trauma	Accidental and non-accidental
H	Heart Disease, Hypovolemia	Acquired and congenital heart disease
E	Endocrine	Salt-wasting crisis in undiagnosed congenital adrenal hyperplasia
M	Metabolic	Electrolyte abnormalities
I	Inborn Errors of Metabolism	Profound anion gap metabolic acidosis and hypoglycemia
S	Sepsis	Leading cause of critical illness in newborns
F	Formula Problems	Mixing errors: under or over diluting
I	Intestinal Emergencies	Malrotation with volvulus, NEC, intussusception, Hirschspring's, diaphragmatic hernia
T	Toxins and Poisons	Homeopathic medicines, prescription drugs, illicit drugs
S	Seizures	High risk for CNS and metabolic involvement

Hyperbilirubinemia

- Late preterm infants are 2-4 x more likely to develop significant hyperbilirubinemia
- Bilirubin levels peak later than those of term infants at ~ 5 days of life
- Increased risk of acute bilirubin encephalopathy and kernicterus at levels < or = to those of term infants
- Most common cause of LPI rehospitalization

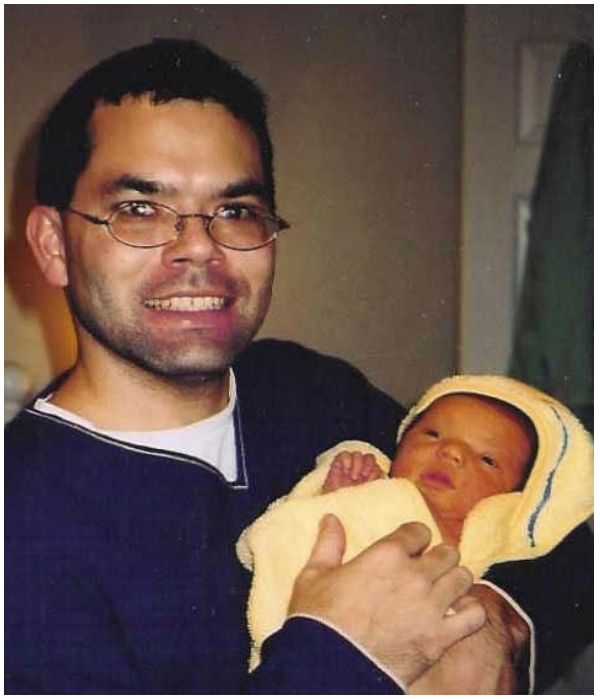


Image: Stanford Medicine Professional Education photo Gallery: https://med.stanford.edu/newborns/professional-education/photo-gallery/general.html#jaundice

Hyperbilirubinemia Pathophysiology

- Higher H/H at birth
- Shorter RBC lifespan
- Increased enterohepatic circulation
- Immature liver enzymes
  - glucuronyltransferase 1A1
- Poor feeding, Inadequate BM's, Sepsis

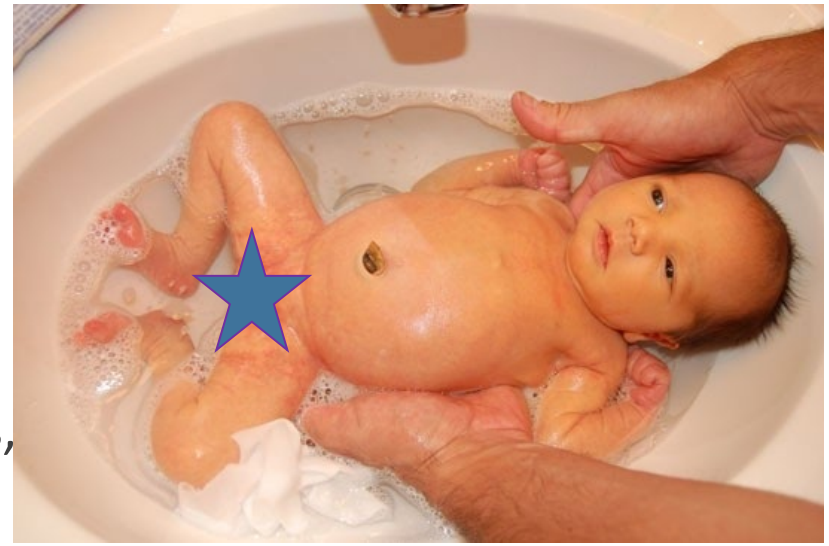


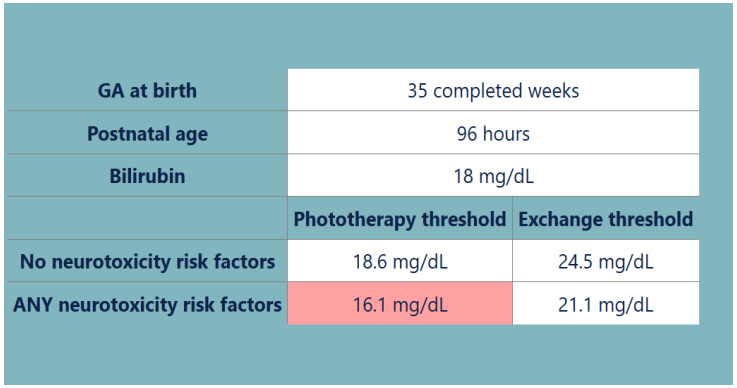
Image: Stanford Medicine Professional Education photo Gallery: https://med.stanford.edu/newborns/professional-education/photo-gallery/general.html#jaundice

Hyperbilirubinemia H&P

- ABO Incompatibility or Rh isoimmunization
  - Maternal BT (MBT)
  - Baby's BT (BBT)
  - Direct Antiglobulin Test (DAT) also called Coombs test
- Type of feeding
  - Frequency or amount
- Number of wet and soiled diapers
- Skin appearance
  - Jaundice progresses cephalocaudally
- LOC
- Mucous membranes

Hyperbilirubinemia Management

- Total and direct bilirubin levels
  - Enter results into hyperbilirubinemia tool for plan of care
  - https://peditools.org/bili2022/
  - **https://bilitool.org**
- Consider POC blood glucose and IVFB
- Consider other DDx
- Discharge home if well hydrated and levels are below phototherapy range
  - Tool will tell you when they need the next level assessed
- Admit to peds floor or transfer if phototherapy is indicated
- Admit to NICU or PICU or transfer if an exchange transfusion is indicated



GA at birth	35 completed weeks	
Postnatal age	96 hours	
Bilirubin	18 mg/dL	
	Phototherapy threshold	**Exchange threshold**
No neurotoxicity risk factors	18.6 mg/dL	24.5 mg/dL
ANY neurotoxicity risk factors	16.1 mg/dL	21.1 mg/dL

Infection/Sepsis

- **In the newborn**
  - Innate immune system is underdeveloped
  - Acquired immune system deficient
  - This places all newborns at risk for infection
- **LPI**
  - Immaturity of immune system
  - Inadequate transfer of maternal antibodies
  - Impaired skin integrity
  - Exposure to pathogenic microorganisms

Early onset sepsis (EOS) - birth to 72 hours of age

Late onset sepsis (LOS) - after 72 hours of age

Infection/Sepsis

- **Pathogens of concern**
  - **Gram + bacteria**
    - Coagulase negative staphylococcus
    - Staphylococcus aureus
    - Enterococcus
    - Group B Streptococcus
  - **Gram - bacteria**
    - Escherichia coli
    - Klebsiella
    - Pseudomonas
  - **Viral**
    - Herpes simplex virus
    - Enterovirus
    - Adenovirus
    - Other respiratory viruses

Infection/Sepsis

Signs and Sxs by system

- General: activity, tone
- Respiratory: breath sounds, rate (fast or slow), WOB
- Cardiovascular: HR, perfusion, pulses
- Gastrointestinal: stool output, abd exam, emesis
- Metabolic: hypoglycemia, temperature
  - **Hypothermia more common than hyperthermia**
- Genitourinary: UOP

Evaluation of Infection/Sepsis

- Neonates do not mount a large immune response and sxs can be vague. Have a high index of suspicion. LPIs are at increased risk.
- Sxs: Fever (rectal temp 100.4 in ED or measured fever reported by caregiver), hypothermia, irritability, poor feeding, apneaic spells, tachycardia, bradycardia, poor perfusion, respiratory distress.
- POC blood glucose
- CBC, CMP, CRP, Procalcitonin, BC
- Cath UA and UC
- CSF studies and culture, Meningitis/Encephalitis Panel if available
- RVP (resp panel)
- Consider HSV cultures (maternal HSV, lesions, xanthochromia, inc LFTs)
- Consider CXR
- Consider blood gas (iStat panel)
- Consider other DDx

Management of Sepsis

- **GOAL: start abx ASAP. Ideally after your cultures are collected and within 60 mins of arrival.**
  - Empiric coverage for EOS: ampicillin and gentamicin
  - Empiric coverage for LOS: ampicillin and cephalosporin (cefotaxime, cefepime)
  - Consider acyclovir (maternal HSV, lesions, xanthochromia, inc LFTs)
- Supportive care
- Admit to peds floor, NICU, PICU or transfer

Hypoglycemia

- **Risk associated with**
  - Prematurity
    - 3-4 times greater risk than term infants
  - LBW
  - SGA
  - LGA
  - IDM

Hypoglycemia Pathophysiology

- Steady supply of glucose crosses the placenta
- At birth, this supply is cut off
- Primary cause
  - Poor feeding and/or low volume intake
- Secondary causes due to development immaturity
  - Inadequate glycogen stores in the liver
  - Immature hepatic enzymes necessary for gluconeogenesis and glycogenolysis
  - Hormonal dysregulation coupled with inadequate adipose tissue lipolysis
  - Rapid depletion of what glycogen stores that baby has
    - Exacerbated by respiratory distress, hypothermia, illness

Hypoglycemia H&P

- Birthweight (BW)
- Current weight (CW)
- Maternal history of diabetes
- Feeding type
- Feeding frequency/amounts
- Number of wet and soiled diapers
- Apnea
- Cyanosis
- Abnormal cry
- Hypotonia
- Poor feeding
- Hypothermia
- Tremors/jitteriness
- Irritability
- Lethargy
- Seizures
- Tachypnea

Hypoglycemia Evaluation

- Per AAP Committee on Fetus and Newborn, late preterm infants should have a pre-feeding glucose of > 45 mg/dL after 24 hours of life.
  - Many different opinions on glucose level, with range 40-60 mg/dL after 24 hours of life.
- **DO NOT delay treatment**
  - Glucose is the primary fuel for the brain

Hypoglycemia Management

- General hypoglycemia thresholds
  - 0-48 hours of age - BG <50 mg/dl
  - Over 48 hours of age - BG <60 mg/dl
- **DO NOT DELAY GLUCOSE.** If child is alert and can take PO safely, administer sweeties (sugar water) or glucose gel while getting IV access.
- Give a **D10** bolus of 2 mL/kg over 5-10 minutes
- Start a continuous infusion of **D10** without additives at a total fluid goal of 80 mL/kg/day**:** 2.5 kg x 80 mL/kg/day / 24 hours = 8.3 mL/hr
- Continue to monitor blood glucose levels every 30-45 minutes until normal
  - Additional **D10** bolus(es) may be needed
- Consider inborn errors of metabolism
- Consider other DDx
- Admit to peds floor, NICU, PICU, or transfer

Hypoglycemia Management

WARNINGS

- Boluses for neonatal hypoglycemia are only with D10
- Glucagon is not given to neonates
- The concentration of a continuous dextrose infusion that can be given via PIV is D12.5; concentrations higher must infuse via central access.
- Appropriate IVF rates and TF volumes are critical

Hypothermia

- LPI's at greater risk due to:
  - Prematurity
  - LBW
  - SGA
  - Excessive weight loss

Hypothermia Pathophysiology

- Nonshivering thermogenesis
- Larger body surface area
- Deficient in brown adipose fat stores
  - Brown fat is located: mediastinum, axillae, kidneys, adrenal glands, subscapular regions – highly vascular regions
  - At term accounts for ~ 2-7 % of total body weight
  - Norepinephrine is released which acts on brown fat to liberate FFA's which are oxidized and produce heat

Hypothermia H&P

- Core body temperature: between 36.5 and 37.5 ° C (97.7 and 99.5 °F) – rectal or esophageal
  - If not properly trained to take a rectal temp in a preterm infant, it is safer to monitor temperature axillary
- BW
- CW
- Type of dressing/swaddling
- Ambient temperature
- Feedings
- Wet and soiled diapers

Hypothermia Management

- Hypothermia: core temp less than 36.0 C/96.8 F (wide variability among ED providers)
- Consider environmental factors
- Monitor temperature every 30 mins for several hours
- **Consider sepsis!**
- Consider other DDx
- Rewarm with warm blankets, skin to skin, incubator if available
- Possible discharge?
- Admit to peds floor, NICU, PICU, or transfer

Feeding Difficulties (FD)

LPI's at risk due to:

- Prematurity
- Neurological immaturity
- Hypoglycemia
- Hypothermia
- Hyperbilirubinemia
- Illness
- Respiratory distress

FD Pathophysiology

- At 34 weeks gestation, the neonatal brain:
  - Has a weight that is ~ 65% of the weight at 40 weeks gestation
  - Has a cerebral cortex that is still smooth
  - Has incomplete myelination and intraneuronal connectivity
- Brain continues to grow and mature until age 2
- Can manifest as decreased tone, coordination, feeding skills, etc.

Image: https://www.boostbabiesaustin.com/blog/2017/11/17/in-honor-of-world-prematurity-day

FD Pathophysiology

- Poor oral-motor tone
- Uncoordinated suck-swallow-breathe
- Deglutition (act of swallowing), sphincter control and immature peristalsis
- Poor caloric intake and dehydration can exacerbate hyperbilirubinemia
- Frequent emesis – possible aspiration
- Hypoglycemia
- Using energy to stay warm steals calories for energy, etc.
- Exclusive breastfeeding

FD History and Assessment

- BW
- CW
  - Determine % of loss from BW
  - In preterm infant, > 10-15% concerning
- Type of feeding
- Frequency/amounts
  - If exclusive breastfeeding, has the mothers “milk come in”
- Wet and soiled diapers
  - Minimum of 4 urine and 4 stool in 24-hour period within first 4 days of life
  - Minimum of 6 urine and 2-3 stool in 24-hour period after 4 days of life
- Emesis
  - Frequency, amount, appearance

FD - Bilious Emesis

- Vomiting **BILIOUS EMESIS** is an emergency and requires emergency imaging to r/o malrotation with midgut volvulus
- Unstable neonate with concern for peritonitis - **Call peds surgery!**
- Imaging:
  - Gold standard for diagnosis - Upper GI series
  - Abdominal US -
  - 2V abd XR - Can be normal
- Labs: blood glucose, CBC, CMP
- NPO and start dextrose containing maintenance fluids
- NGT for decompression
- ABX (piperacillin-tazobactam or ceftriaxone and metronidazole)
- Imaging diagnostic or concerning for malrotation with midgut volvulus - Call a pediatric surgeon. Admit to peds surgery or transfer to facility with peds surgery.

FD Management

- Check blood glucose
- If stable, observe feeding - DO NOT force feed
- If unable to feed, consider IVFB and start dextrose containing maintenance fluids
- Consider other DDx
- **Consider sepsis and CHD**
- Respiratory sxs - concern for aspiration or PNA
  - Add CXR and VBG
- Labs: CBC, CMP, CRP and procalcitonin
- A neonate who cannot feed cannot be discharged home
- Admit to peds floor, NICU, PICU or transfer

Final Review

- LPIs are infants born between 34w0d - 36w6d and they are at increased risk for complications such as hyperbilirubinemia, infection, poor temperature regulation, hypoglycemia, and feeding difficulties.
- With the GA at birth, hours of age, and total bilirubin level, PediTools will help you to develop a POC for hyperbilirubinemia.
- Immediate treatment of hypoglycemia of the neonate includes oral glucose if alert and can tolerate PO. If not, IV bolus of D10: 2 mL/kg over 5-10 minutes.
- Bilious emesis in a newborn can represent a malrotation with midgut volvulus and is a surgical emergency.

Definitions/Abbreviations

- Preterm Birth (PTB): delivery before 37w0d
- **Late Preterm Infant (LPI): delivery at 34w0d - 36w6d**
- Term Birth: delivery at 37w0d to 41w6d
- Postterm Birth: delivery at 42w0d and greater
- Birthweight (BW) – use this for any calculation during first 7 days of life
- Current weight (CW)
- Infant of Diabetic Mother (IDM)
- Small for Gestational Age (SGA): BW < 10%
- Large for Gestational Age (LGA): BW > 10%
- Low Birth Weight (LBW): birthweight less than 2500 grams (5#, 8.2 oz.)

Calculations

- Percent of weight loss from birth
  - BW in grams – CW in grams/BW in grams
  - 1900 grams – 1700 grams = 200 grams/1900 grams = 10.5% below BW
- Glucose infusion rate (basal in LPI ~ 5-7 mg/kg/min)
  - Dextrose concentration x rate in mL/hr x 0.167/wt in kg
  - 1.9 kg baby, TF goal 100 mL/kg/day = 7.9 mL/hr of D10
  - 10 x 7.9 x 0.167/1.9 = 6.9 mg/kg/min

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