PROBLEMS of the NEONATAL PERIOD

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* ... except appreciation to Colin Partridge, MD, MPH for help with slides
Common Neonatal Problems

* Hypoglycemia
* Respiratory conditions
* Infections
* Polycythemia
* Bilirubin metabolism/neonatal jaundice
* Bowel obstruction
* Birth injuries
* Rashes
* Murmurs
* Feeding difficulties
Abbreviations

- CCAM—congenital cystic adenomatoid malformation
- CF—cystic fibrosis
- CMV—cytomegalovirus
- DFA—Direct Fluorescent Antibody
- DOL—days of life
- ECMO—extracorporeal membrane oxygenation (“bypass”)
- HFOV—high-flow oxygen ventilation
- iNO—inhaled nitrous oxide
- PDA—patent ductus arteriosus
Hypoglycemia Causes

* Inadequate glycogenolysis
  * cold stress, asphyxia
* Inadequate glycogen stores
  * prematurity, postdates, intrauterine growth restriction (IUGR), small for gestational age (SGA)
* Increased glucose consumption
  * asphyxia, sepsis
* Hyperinsulinism
  * Infant of Diabetic Mother (IDM)
Early feeding when possible (breastfeeding, formula, oral glucose)

Depending on severity of hypoglycemia and clinical findings, may need to give intravenous glucose bolus (D10 @ 2-3 ml/kg)

Following bolus infusion, a continuous intravenous infusion of D10 is often required to maintain normal glucose levels
* Decrease D10 using the GIR (glucose infusion rate), dropping no more than by 1-2 mg/kg/min every 4 to 8 hours (as tolerated).
Respiratory Distress in the Neonate

* Pulmonary causes
  * Respiratory Distress Syndrome: surfactant deficiency
  * Transient Tachypnea of the Newborn: retained fetal lung fluid
  * Meconium Aspiration Syndrome
  * Congenital pneumonia
  * Persistent pulmonary hypertension
  * Space occupying lesions: pneumothorax, chylothorax, pleural effusion, congenital diaphragmatic hernia, CCAM
Respiratory Distress Syndrome (RDS)

- Surfactant insufficiency and pulmonary immaturity
  - 33% in infants between 28-34 wks
  - <5% in infants > 34 wks
- Incidence increased
  - male infants
  - 6-fold ↑ in infants of diabetic mom (IDM)
  - multiple births, second-born twin
- Severity of illness improved by antenatal steroids & surfactant
Strategies for Prevention of RDS

- Prevention of premature delivery
- Decrease antenatal inflammation/infection
  - Increased risk for preterm labor
- Antenatal glucocorticoids
  - Does not prevent all RDS or bronchopulmonary dysplasia
  - No increased risk to mother of death, chorioamnionitis, or puerperal sepsis
RDS X-ray Findings

- Hypoexpanded lungs
- Reticulogranular opacification
- Air bronchograms
- → white-out lungs
Incidence of meconium staining

- associated with fetal distress and increasing gestational age
- 20% of all deliveries
- 30% in infants \( \geq 42 \) weeks

Hypoxia, acidosis lead to fetal gasping (\( \rightarrow \) aspiration)

Meconium Aspiration Syndrome (MAS) found in 2-20% of infants with meconium-stained fluid

Most common cause of respiratory distress in term newborns, typically presenting in first few hours of life

Disease range: mild to severe disease with air leaks, pulmonary hypertension, respiratory failure, and death (iNO, HFOV, and ECMO improve survival)
Meconium Aspiration Syndrome (MAS)

- Patchy, streaky infiltrates
- Hyperexpansion
Complications of MAS

- Pneumothorax
- Air leaks
  - Pneumomediastinum
  - Pneumothorax
  - Pneumopericardium

http://circ.ahajournals.org/content/114/1/e7/F1.large.jpg
Transient Tachypnea of Newborn (TTN)

- Delayed clearance of fetal lung fluid
- Term or near-term infants
- Delivered via c-section and/or no/little labor
- Chest Xrays: lung hyperaeration, prominent pulmonary vascular markings, interstitial fluid, pleural effusion
- Transient respiratory symptoms (tachypnea, occasional hypoxia, rare dyspnea) resolve within 2-5 days
TTN X-ray Findings

- Slightly hyperexpanded lungs
- “Sunburst” hilar streaks
- Fluid in minor fissure
- Prominent pulmonary vascular markings
- → CXR normalizes in 1st 24 hrs
Radiologic Finding

www.medicine.cmu.ac.th/dept/radiology/pedrad/normal.html
Extra-Pulmonary Causes of Respiratory Distress in the Neonate

- Hyperthermia, hypothermia
- Polycythemia
- Hypovolemia, shock, metabolic acidosis
- Cardiac disease
  - Cyanotic congenital heart disease
  - Left-sided obstructive lesions (coarctation)
  - Congestive heart failure
- Myocardopathy
- Myocarditis
- Sepsis
Perinatal Infections

* Bacterial infections
  * Group B Streptococcus
  * E. coli
  * Listeria monocytogenes

* Viral infections
  * Herpes simplex
  * Hepatitis B and C

* TORCH infections:
  Incidence is 0.5-2.5%; many infants are asymptomatic at delivery
  * Toxoplasma gondii, treponema pallidum
  * “Other”: syphilis
  * Rubella
  * Cytomegalovirus (most common)
  * Herpes
Risk Factors for Early-Onset Sepsis

* Prematurity < 37 weeks gestation
* Chorioamnionitis
* Prolonged ruptured membranes > 24 hours
* GBS positive mother
* Male infant
Prevention of GBS neonatal sepsis

* Routine antenatal cultures at 35-36 weeks
* Treat women
  * with positive cultures with onset of labor
  * with previously infected infants
  * with GBS UTI

**Strategy misses women who deliver prematurely and women with no prenatal care**
Management of Neonatal Infections

* Septic work-up for infection
  * CBC with differential including bands and platelets
  * Blood culture
  * +/- C-reactive Protein
  * +/- Lumbar Puncture
  * Specific workup for viral infection
Management of Neonatal Infections

* **Treatment**
  
  * **Symptomatic:** treat with ampicillin and gentamycin (or ampicillin and 2nd/3rd generation cephalosporin for bacterial meningitis). Acyclovir if concerned for herpes.
  
  * Length of treatment depends on clinical findings, CBC, LP, & culture results
  
  * **Asymptomatic infant at risk** (e.g., a non-reassuring CBC): treat for 48 (-72 hrs) until bacterial cultures negative
Prevention of Transmission of Perinatal Hepatitis B

* Hepatitis B vaccine prior to hospital discharge for all infants (<12 hr if Mom HBsAg positive)
* HBIG (hepatitis B immunoglobulin) plus vaccine for infants born to HBsAg positive mother <12 hours of life
* All infants should receive routine Hepatitis B vaccine during infancy (1 month and 6 months)
* Breastfeeding safe with HBsAg positive mother with vaccine plus HBIG treatment for the infant
High-risk mothers screened during pregnancy

- Vertical transmission rate is 5-10%
- Hepatitis C antibody titers obtained on infant at 6 and 12 months (even 18 months), or Hepatitis C PCR at 4 mos

What about breastfeeding with Hepatitis C+ mother?

- Variable amounts of virus in milk
- Studies have not shown increase risk of transmission of Hepatitis C with breastfeeding
- Recommend pump/dump if cracked/bleeding nipples
Perinatal TORCH Infections—Non-Specific Findings

- SGA, IUGR, postnatal growth failure
- Microcephaly, hydrocephalus, intracranial calcifications
- Hepatosplenomegaly, hepatitis, jaundice (elevated direct component)
- Anemia (hemolytic), thrombocytopenia
- Skin rashes, petechiae
- Abnormalities of long bones
- Chorioretinitis, cataracts, glaucoma
- Nonimmune hydrops
- Developmental and learning disabilities
* Toxoplasmosis: hydrocephalus, chorioretinitis, generalized intracranial calcifications (random distribution)
* Syphilis: osteochondritis, periosteal new bone formation, rash, snuffles
* Rubella: cataracts, “blueberry muffin” rash, patent ductus arteriosus, pulmonary stenosis, deafness
* Cytomegalovirus: microcephaly, periventricular calcifications, hydrocephalus, chorioretinitis, petechiae, thrombocytopenia, hearing loss (progressive)
“Blueberry muffin” rash (cutaneous hematopoeisis)
Ocular Findings

chorioretinitis

cataracts
Neonatal Herpes Simplex

- HSV-1 (15 to 20%) and HSV-2 (80 to 85%)
- Neonatal infections with primary HSV is 35-50%
- Neonatal infections with recurrent HSV is 0-5%
- Increased risk of transmission with prolonged rupture of membranes, forceps or vacuum delivery, fetal scalp monitoring, preterm infants
- 75% of cases have no history of maternal infection, nor evidence of skin lesions
  - One may need to start treatment based on clinical presentation and suspicion of infection
Disseminated (systemic) disease:
- Early onset (1st week of life), 25% of cases
- Sepsis syndrome, liver dysfunction, pneumonia

CNS disease: meningoencephalitis
- 2nd-3rd week of life, 35% of cases
- Fever, irritability, abnormal CSF, seizures
- Early treatment improves outcome, but 40-50% infants have residual neurodevelopmental disability

Localized disease: skin, eyes, mouth, 40% of cases
Cutaneous HSV: clustered vesicular eruption → ulceration
Toxoplasmosis
- maternal antibody titer and neonatal IGM antibody

Syphilis
- RPR or VDRL positive, obtain titers, order treponemal-specific test (FTA or MHA-TP)

CMV
- urine culture

Herpes simplex
- Surveillance: conjunctival, nasopharyngeal, and rectal swabs for Direct Fluorescent Antibody (DFA) 24-48 hours after birth if suspect exposure
- Culture of vesicle scrapings when lesions are present
- DFA of vesicle scrapings
- PCR: detect HSV-DNA in CSF
Polycythemia
(Hct > 65% on a spun, central venous blood sample)

- Complications associated with hyperviscosity
  - Plethora, slow capillary fill time
  - Respiratory distress
  - Hypoglycemia
  - Irritability, lethargy, poor feeding
  - Cyanosis, heart murmur, and cardiomegaly
  - Seizures and strokes
  - Necrotizing enterocolitis
  - Renal vein thrombosis
  - Hyperbilirubinemia
If symptomatic neonate with polycythemia, or an infant with excessively high hematocrit ($>70\%$)--by dilutional exchange, correcting Hct to approx 55%:

$$\text{Volume of blood} = \frac{\text{Wt (kg)} \times 80 \text{ cc/kg} \times (\text{Hct}_{\text{obs}} - \text{Hct}_{\text{desired}})}{\text{Hct}_{\text{obs}}}$$

- Blood is removed through umbilical artery or umbilical venous catheter and normal saline is infused for blood volume replacement.
Hyperbilirubinemia

* Types
  * Physiologic vs Pathologic
  * Conjugated/Direct vs Unconjugated/Indirect

* Causes
  * Increased red cell mass
  * Increased red cell breakdown
  * Delayed/abnormal conjugation
  * Abnormal excretion
  * Increased enterohepatic circulation
Increased RBC Mass

- Elevated hemoglobin level, RBC mass
  - Polycythemia
- Increased rate of RBC degradation with shorter half-life of RBC
  - 70 days in preterm infants, 70-90 days in term infants, 120 days in adults
- Extravasated blood: cephalohematoma, caput/bruises, swallowed blood, intracranial or intra-abdominal hemorrhage
- Effects of plasma albumin-bilirubin binding
  - Newborns have lower albumin levels → lower bilirubin-binding capacity
* Incompatibility: Rh, ABO, minor blood groups (Kell, Duffy [aka Fy])
* Enzyme defects: G6PD, pyruvate kinase
* Sepsis
* RBC membrane defects: hereditary spherocytosis
* Extravascular blood

Increased Breakdown/Hemolysis →
Increased Bilirubin
Impaired Conjugation

* Neonatal hepatitis
* Sepsis
* Prematurity
* Breast milk jaundice
* Hypothyroidism
* Sepsis
* Congenital enzyme deficiency eg Crigler-Najjar
* Metabolic diseases, e.g., galactosemia
Conjugated (Direct) Hyperbilirubinemia: Impaired Excretion

- Obstruction to biliary flow: biliary atresia, choledocal cyst, cystic fibrosis, stones
- Dark urine (urine + for bilirubin), light colored stools, persistent jaundice (> 3 weeks)
- Hepatic cell injury: syphilis, TORCH infections
- Hepatic dysfunction: E. coli (UTI)
- Toxic effects: hyperalimentation cholestasis
- Metabolic errors: galactosemia
- Chronic “overload”: erythroblastosis fetalis, G6PD, spherocytosis
Conjugated bilirubin—unconjugated, reabsorbed

Enterohepatic circulation and reabsorption is enhanced by:

- Gut sterility (urobilinogen and stercobilinogen)
- Bowel dysmotility (preterm infants, effects of magnesium or morphine)
- Ileus
- Obstruction: atresia, pyloric stenosis, meconium plugs, cystic fibrosis
- Delayed feeding (“breast-feeding jaundice”)
Causes Suggested by Clinical Findings

* **Hemolysis**
  * Onset of jaundice in 1st 24 hours
  * Rapid rate of rise of bili (>0.5mg/dL per hour)
  * Hepatosplenomegaly, pallor
  * Family history (G6PD, spherocytosis)
  * “Set-up” with incompatibility, Coombs (+DAT), elevated reticulocytes, abnormal hemolytic smear

* **Sepsis or inborn error**
  * Emesis, lethargy, poor feeding
  * Hepatosplenomegaly, tachypnea, temperature instability
Management of Indirect Hyperbilirubinemia

* Increased susceptibility to neurotoxicity seen with asphyxia, sepsis, acidosis, prematurity, and hemolysis
  * Consider treatment at lower levels of unconjugated bilirubin in these cases

* When to worry
  * Visible jaundice in the first 24 hours of life
  * Serum bilirubin rising rapidly > 5 mg/dl/24 hrs
  * Prolonged hyperbilirubinemia > 1 week term infant and > 2 weeks in the preterm
  * Direct bilirubin > 2mg/dl

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Decision to treat depends on clinical risk status (well vs ill infant), unconjugated bilirubin level, chronologic age (hours of life), and gestational age.

More conservative treatment of preterm infants (< 37 wks with more immature blood-brain barrier), or infants with sepsis or acidosis.

bilitool.org
Emesis: Bilious emesis suggests a lesion distal to ampulla of Vater; sporadic emesis suggests partial obstruction, malrotation, duplications, or annular pancreas

Failure to pass meconium (although some infants with “high” lesions will pass meconium)

**at birth DOESN’T COUNT**

Symptoms start soon after birth with high lesions or with complete obstruction, delayed in lower lesions of partial obstruction

Fetal diagnosis: polyhydramnios and fetal u/s
Atresia: complete obstruction of the lumen
  * 30% occur in duodenum (distal to ampulla)

Stenosis: narrowing of the lumen
  * intrinsic cause or compression by extrinsic lesions (annular pancreas, peritoneal bands)
  * plain films not diagnostic
  * emesis (amount and onset) depends on degree of obstruction
## Causes of Obstruction in the Newborn

<table>
<thead>
<tr>
<th>Intrinsic:</th>
<th>Functional:</th>
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<tbody>
<tr>
<td>Atresia</td>
<td>Hirschsprung</td>
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<td>Meconium ileus</td>
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<td>Annular pancreas</td>
<td>Parents awareness of diapers</td>
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<td>Peritoneal bands</td>
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70% of neonates have other anomalies: Down syndrome, annular pancreas, cardiac malformation, multiple atresias

- Clinical findings: dehydration with metabolic alkalosis
- Xray findings: “double-bubble” (dilated stomach and dilated proximal duodenum)
- Management: NG tube, correct electrolytes and surgical consultation
Malrotation with Volvulus

- Malrotation (8\textsuperscript{th}-10\textsuperscript{th} week) can lead to volvulus
  - Complete obstruction
  - Vascular compromise
    - Gangrene of the gut, peritonitis, sepsis, and shock.
- Infants present with emesis, bowel distention. Intermittent emesis with incomplete obstruction
- Xrays: dilated stomach and duodenum, little air in distal bowel, diagnosis by UGI (barium enema)
- \textit{Surgical emergency}
Hirschprung’s Disease

- Lower bowel obstruction: agenesis of ganglion cells (Auerbach and Meissner plexuses)
  - Rectal lesion extending in varying degree; in 80-90% patients no extension beyond sigmoid colon
  - Associated w/ Downs (15%), Waardenburg syndrome
  - Delayed meconium passage (>24-48 hrs) in 90% of patients
  - Clinical findings: Abdominal distention, emesis, obstipation
  - Barium enema: narrowing segment, “corkscrew” appearance of colon, delayed clearing of barium
  - Diagnosis: rectal sectional biopsy

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Meconium Ileus (inspissated meconium)

- 90% of patients have cystic fibrosis (CF), 10-15% of CF patients have meconium ileus
- Family history may be helpful
- Abdominal distention and emesis within 48 hrs
- Delayed meconium passage
- 1/3 of patients have volvulus, atresia, meconium peritonitis, pseudocyst, and present earlier
- Xrays: dilated bowel loops, intra-abdominal calcification (peritonitis), no air-fluid levels seen
Meconium Plug Syndrome

- Etiology: colonic dysmotility
- Hirschsprung’s disease in 50% of these patients
- Clinical findings:
  - Delayed meconium passage: (24-48 hrs)
  - Abdominal distention, emesis
  - Barium enema diagnostic and therapeutic
Birth Injuries

* Cephalhematoma
* Caput succedaneum
* Subgaleal hematoma
* Erb’s palsy
* Klumpke’s palsy
* Clavicular fracture
* Phrenic nerve injury with diaphragmatic paralysis
Injuries to the Head

**Caput:** vaguely demarcated, pitting edema on presenting part of scalp, w/ ecchymosis. Hemorrhagic edema is superficial to the periosteum, often crossing sutures.

**Cephalohematoma:** subperiosteal bleeding from rupture of vessels that traverse from the skull to periosteum. Bleeding limited by periosteal attachments, thus swelling does not cross sutures (*tight water balloon to palpation*).

**Subgaleal hemorrhage:** superficial bleed into loose connective tissue. Bleeding not limited → enlarging, mobile hematoma can lead to shock (*loose water balloon with fluid wave to palpation*).

**Cephalohematoma and subgaleal** can be associated with skull fracture and hyperbilirubinemia.
Subgaleal

http://www.pediatriconcall.com/fordoctor/casereports/subgaleal_hematoma.asp
Abnormal Arm Position in a Newborn

- Erb’s palsy C-5 and C-6
  - Decreased spontaneous movement and absent biceps reflex on affected side, abnormal Moro, "waiter's tip" appearance
- Klumpke's paralysis C-7, C-8, T-1
  - Hand paralysis, absent grasp reflex, Horner syndrome usually seen (ipsilateral ptosis, miosis, anhidrosis)
- Fractured clavicle
  - Crepitus felt, decreased spontaneous movements, pseudoparalysis, asymmetric Moro, biceps reflex normal
- Fractured humerus
Incidence of brachial plexus injuries: 1.6 - 2.9 per 1,000 live births

45% of brachial nerve injuries associated with shoulder dystocia.

The arm is adducted, extended, and internally rotated. Absent biceps and Moro reflexes on affected side. Sensory function usually preserved.

Recovery is often spontaneous and may occur within 48 hours or up to six months.

Nerve laceration may result in a permanent palsy.
Common Neonatal Skin Conditions

* Erythema toxicum neonatorum (“E tox”)
* Benign pustular melanosis (“BPN”)
* Hemangiomata
  * Nevus flammeus
  * Capillary
  * Cavernous
  * Mixed
  * Port wine stain
Erythema Toxicum

- Yellow papules w/ erythematous macular base, evanescent and found over entire body
- Common in term infants
- Most seen 24-48 hours after delivery; can be seen up to 2 wks of age
- Eosinophil-filled papules
- Unknown etiology, benign, resolves spontaneously
Benign Pustular Melanosis

* Seen in 4.4% of African-American infants, 0.2% in white infants
* Lesion: superficial pustular lesions that easily rupture then leave a scaley “collar” around hyperpigmented macules. These fade within weeks to months.
* Lesions most in clusters under chin, nape of neck, forehead, and may be on trunk and extremities
* Lesions are sterile and transient. Not associated with systemic disease.
Pustules with scaling “collar”
Pustules
Post-inflamatory Hyperpigmentation
Strawberry hemangioma

- 2.6% of infants (higher incidence in preterm infants)
- May be seen at birth, but typically develop during first few weeks of life and 90% seen by 1 mo of life
- Start as small, discrete, well demarcated lesions. These grow rapidly during infancy, and eventually involute.
- Infants with large lesions, lesions on the face, eyelids, airway, mouth, or cavernous lesions should be referred

Nevus flammeus

- Very common, up to 40% of infants
- “Salmon patch” on nape of neck, on eyelids, between eyebrows
- Do not grow during infancy and do not completely disappear. Lesions fade and are less noticeable except during crying or exertion
Cavernous Hemangioma

- Difference is blood vessels—can be difficult dx
- Tumor vs vascular malformation vs hemangioma
- Will need propanolol or other interventions

Hemangiomata

Nevus flammeus

Hemangioma

Port-wine stain (Sturge-Weber)
Hemangiomas

Refer for:
- Eyes (upper lid)
- Nasal tip
- Mouth/midline (respiratory)
- Elbows/knees/heels
- Spine
- Diaper area
Cardiac/Murmurs

* What you hear when
  * Day of birth/1\textsuperscript{st} DOL—outflow stenoses
  * After 1\textsuperscript{st} day—coarctation
  * 1\textsuperscript{st} week—left-to-right shunts (PDA, VSD, etc)
  * “Tachycardia”/bradycardia of newborn (DOL ~3)

* How? Training ear to VSD vs patent ductus
  * Stanford’s newborn nursery site: http://newborns.stanford.edu/PhotoGallery/Heart.html
Cardiac/Murmurs, cont’d

* What else to see?
  * Congestive heart failure—sweating, poor feeding, failure to grow, HSM

* What else to do? Standard to check post-ductal saturation after 24 HOL
  * Post-ductal <95%, or gradient >3%
Breastfeeding

* Benefits
* Challenges
  * Who is your patient?
* Resources
  * Lactation
  * Public health nurses
  * Local groups/stores/insurance
Ankyloglossia

newborns.stanford.edu/PhotoGallery/Ankyloglossia1.html

www.ghorayeb.com/TongueTie.htm
Frenulectomy

http://www.tongue-o-rama.com/2010/05/ankyloglossia.html
Common Neonatal Problems

* Hypoglycemia
* Respiratory conditions
* Infections
* Polycythemia
* Bilirubin metabolism: neonatal jaundice
* Bowel obstruction
* Birth injuries
* Rashes
* Murmurs
* Feeding difficulties
Questions?

Thank you!

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