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## Prematurity: Diagnosis and Related Conditions

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# Prematurity

THE DIAGNOSIS AND RELATED CONDITIONS

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## Disclosures

- The presenter receives a salary for her work as an Associate Professor and Director of Clinical Education at the University of Louisville. She also received a stipend from SpeechPathology.com to present this course.

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## Learner Outcomes

1. Participants will be able to describe 3 short-term complications associated with prematurity.
2. Participants will be able to describe 3 long-term complications associated with prematurity.
3. Participants will be able to identify 3 ways that early experiences of the premature infant impact development.

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## At-Risk Populations for Prematurity

- ▶ Low income
- ▶ Women of color
- ▶ Women younger than 20; older than 40
- ▶ Women who were born premature
- ▶ Women with a h/o a previous premature delivery
- ▶ Women with multiple pregnancies
- ▶ Women with uterine/cervical abnormalities

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## Additional Risk Factors for Prematurity

- ▶ Smoking, alcohol, substance use
- ▶ Infection
- ▶ Stress
- ▶ Trauma
- ▶ Unintended pregnancy
- ▶ Chronic health conditions
- ▶ In-vitro conception
- ▶ H/o repeated miscarriages/spontaneous abortions

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## Incidence

- ▶ Estimated to be 11 percent of births (average) worldwide
- ▶ Translates to 15 million preterm infants born per year
- ▶ 84 % (32-36 weeks ega) 10 % (28-<32 weeks ega), 5% (<28 weeks)

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## Additional Statistics

- ▶ Associated with approximately 1/3 infant deaths in U.S.
- ▶ Accounts for ~ 45 % of children diagnosed with CP
- ▶ Accounts for ~ 35 % of children with vision impairment
- ▶ Accounts for ~ 25% of children with cognitive & hearing problem

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## Classification

### **Gestational Age**

- ▶ Late Preterm Birth – Between 34 (0/7) and 36 (6/7) Weeks GA
- ▶ Very Preterm Birth – Less than 32 Weeks GA
- ▶ Extremely Preterm Birth – At or Below 28 Weeks

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## Classification

### Birth Weight

- ▶ Low Birth Weight – birth weight is less than 2500 g
- ▶ Very Low Birth Weight – birth weight is less than 1500 g
- ▶ Extremely Low Birth Weight – birth weight less than 1000 g



5  
Pounds



3  
Pounds



2  
Pounds

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## Survival Rate Changes

- ▶ Survival rates increased:
  - ▶ 22 weeks 6% (1993) to 9% (2012)
  - ▶ 23 weeks 28% (1993) to 33% (2012)
  - ▶ 24 weeks 52% (1993) to 65% (2012)
  - ▶ 25 weeks 68% (1993) to 81% (2012)
  - ▶ 26 weeks 83% (1993) to 87% (2012)
  - ▶ 27 weeks 84% (1993) to 94% (2012)
  - ▶ 28 weeks 91% (1993) to 94% (2012) (Journal of American Medical Association)
- ▶ Late preterm births from 7.5 to 17.3 % from 1990-2006



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## Adjusting for Prematurity

- ▶ Determine gestational age in weeks
- ▶ Subtract the gestational age from 40 weeks
- ▶ Subtract the weeks of prematurity
- ▶ Example:
  - ▶ Olivia – born at 30 weeks gestation
  - ▶  $40 \text{ weeks} - 30 \text{ weeks} = 10 \text{ weeks premature}$
  - ▶ Olivia – currently 16 weeks chronologically
  - ▶  $16 \text{ weeks (chronological age)} - 10 \text{ weeks premature} = 6 \text{ weeks adjusted}$

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## **Associated Diagnoses**

**Impact on feeding development**

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## Short-Term Complications of Prematurity

- ▶ Hypothermia
- ▶ Respiratory complications
- ▶ Cardiovascular abnormalities
- ▶ Intraventricular hemorrhage (IVH)
- ▶ Necrotizing enterocolitis (NEC)
- ▶ Infection
- ▶ Retinopathy of prematurity (RoP)

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## Hypothermia

- ▶ Rapid heat loss
- ▶ May contribute to metabolic disorders
- ▶ Associated with increased mortality in preterm infants
- ▶ Associated with IVH and pulmonary insufficiency

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## Respiratory Complications

- ▶ Respiratory distress syndrome
- ▶ Bronchopulmonary dysplasia
- ▶ Apnea of prematurity

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## Respiratory Diagnoses

### **Impact**

- ▶ BPD associated with adverse neurodevelopmental outcomes at 9-12 months and more prominent in preterm infants with the diagnosis vs those without (Lin, et al, 2017)
- ▶ Well documented feeding difficulties (Mizuno, et al, 2007)
- ▶ Pre-term infants with BPD compared to healthy pre-term infants without BPD had higher respiratory rates with larger decreases in  $O_2$  sats and lower performance on sucking measures (Barlow, 2009)

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## Cardiovascular Abnormalities

- ▶ Patent ductus arteriosus (PDA)
- ▶ Systemic hypotension
- ▶ Population based study revealed premature infants 2x as likely to present with congenital heart defect (higher for anomalies of ventricular outflow tract) (Laas, et. Al, 2012)

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## Cardiovascular Diagnoses

### **Impact**

- ▶ Children with CHD have increased incidence of deficits in intelligence, VMI, and psychosocial functioning (Sterken, et al, 2016)
- ▶ 1 in 5 children with CHD had delays in multiple domains (Mussatto, et al, 2015)
- ▶ Predictors of poorer developmental outcomes in CHD population-longer hospital stay, poorer linear growth, feeding problems, & socioeconomic risks (Mussatto, et al, 2015)
- ▶ Children with CHD have increased risk of neurodevelopmental impairments but intelligence appears to be WNL (Massaro, et al, 2008)

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## Intraventricular Hemorrhage (IVH)

- ▶ Most common neuropathological lesion of preterm infant
- ▶ Rarely occurs at birth – typically within first 3 days of life
- ▶ Occurs more frequently in infants born before 32 weeks ega

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## Intraventricular Hemorrhage (IVH)

- ▶ Grade I (Mild) Bleeding confined to germinal matrix
- ▶ Grade II (Moderate) IVH occupies 50 percent or less of lateral ventricle volume
- ▶ Grade III (Severe) IVH occupies more than 50 percent of lateral ventricle volume
- ▶ Grade IV (Severe) Hemorrhagic infarction in periventricular white matter ipsilateral to large IVH

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## Intraventricular Hemorrhage

### Impact

- ▶ IVH diagnosis associated with significantly lower mean psychomotor and mental development indices and increased incidence of CP and visual impairment
  - ▶ IVH diagnosis born less than 28 weeks gestational age poorer outcomes than those born 28 weeks gestational age or later
  - ▶ Outcomes worse with grade of IVH
  - ▶ Lower grades of IVH associated with higher percentages of negative outcomes compared to controls without IVH
- (Klebermass-Schrehof, et al., 2012)

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## Necrotizing Enterocolitis (NEC)

- ▶ One of the most common GI emergencies in newborn
- ▶ Occurs 1 in 3 per 1000 live births
- ▶ Ischemic necrosis of intestinal mucosa

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## Necrotizing Enterocolitis (NEC)

### Clinical Characteristics

#### Systemic Signs

- ▶ Apnea
- ▶ Respiratory failure
- ▶ Lethargy
- ▶ Poor feeding
- ▶ Temperature instability
- ▶ Hypotension
- ▶ Bacteremia

#### Abdominal Signs

- ▶ Distention
- ▶ Gastric retention
- ▶ Tenderness
- ▶ Vomiting
- ▶ Diarrhea
- ▶ Rectal Bleeding
- ▶ Bilious drainage

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## Severity of NEC

(Nino, Sodhi, & Hackman, 2016)

Complications/Outcomes	Incidence	Associated Factors
• Recurrence	• 4-10%	• Nonoperative management; congenital heart disease
• Mortality	• 15-63%	• Main predictor is gestational age • Patients managed surgically have the highest mortality
• Intestinal Strictures	• 12-35%	• Most frequent in patients managed medically • Affects colon in up to 80%
• Stoma Complications	• 50%	• Most common include: prolapse, stricture, and retraction • Proximal jejunostomies can cause substantial electrolyte and fluid losses, impaired weight gain, and peristomal skin complications
• Short Bowel Syndrome	• 20-35%	• Relative risk up to 85.9 (95% CI 45.8-160.9)
• Neurodevelopmental Impairment	• 30-50%	• NEC vs no NEC (OR: 1.82), Surgical NEC vs medical (OR: 2.34)
• Growth Delay	• 10%	• Affected children fall below 50 <sup>th</sup> %ile for weight/height • More severe in patients w/short bowel syndrome after NEC compared with age-matched controls without NEC

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## Necrotizing Enterocolitis

### Impact

- ▶ Premature infants with NEC hospitalized 60 days longer if surgery required and 20 days longer if no surgery than unaffected preterm infants (Neu & Walker, 2011)
- ▶ NEC associated with worse neurodevelopmental outcomes than preterm infants without the diagnosis (Rees, et al, 2007)
- ▶ Advanced NEC with need for surgery increase risk of neurological impairment (Rees, et al, 2007)
- ▶ Approximately 50 % of neonates with NEC have long-term neurodevelopmental problems (Rees, et al 2007)
- ▶ Infants with NEC at greater risk for motor impairment (Shah, et al, 2008)

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## Infection/Sepsis

- ▶ Late-onset sepsis (occurring after 3 days of life) – common complication
- ▶ Associated with longer hospital stays
- ▶ Complications associated with increased risk of infection (BPD, PDA, NEC, prolonged intravascular access)



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## Infection/Sepsis

### Impact

- ▶ Higher incidence of CP in children who had isolated episodes of early onset sepsis and for those who had isolated episodes of late onset sepsis when compared to those without either
- ▶ Higher incidence of CP in children who had both early and late onset sepsis when compared to those without either
- ▶ No association was found between infection and cognitive impairment

(Mitha, et al, 2013)

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## Retinopathy of Prematurity (RoP)

- ▶ Developmental vascular proliferative disorder that occurs in the incompletely vascularized retina of preterm infants
- ▶ Typically emerges around 34 weeks PMA
- ▶ Advances irregularly until 40-45 weeks PMA
- ▶ May resolve spontaneously
- ▶ May result in vision impairment

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## Vision Impairment (VI) **Impact**

- ▶ VI may result in delays/deficits in motor, linguistic, cognitive, and social-behavioral development (Bartlett, et al, 2002)
- ▶ VI interferes with gross and fine motor development (Prechti, et al, 2001).
- ▶ Delay of head control (Prechti, 2001)
- ▶ Postural instability until 12-14 months (Prechti, 2001)
- ▶ Delay in hands to midline (Prechti, 2001)
- ▶ Increased tactile defensiveness

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## Long-Term Complications **of Prematurity**

- ▶ Increased recurrent hospitalizations
- ▶ Increased long-term neurodevelopmental impairment
- ▶ Chronic health problems
- ▶ Growth impairment
- ▶ Impairment of lung function

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## Increased Recurrent Hospitalizations

- ▶ Most common causes
  - ▶ Respiratory disorders
  - ▶ Infection & asthma
  - ▶ Gastroesophageal reflux & gastroenteritis

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## Increased Recurrent Hospitalizations

### **Impact**

- ▶ Though weight gain/physical growth/medical stability achieved at time of discharge, child is vulnerable for developmental delays (Catlin, 2008; Pao, Ballard, & Rosenstein, 2007)
- ▶ Motor development may be impacted by restricted space
- ▶ Hospitalized child may be further limited by vent or feeding tube dependence and exposure to invasive procedures (Glader & Palfrey, 2009)
- ▶ Stress in early childhood, such as frequent hospitalizations, reduces potential for brain growth (Holt & Mikati, 2011)

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## Increased Recurrent Hospitalizations

### Impact

- ▶ Although children may not recall events of hospitalization accurately may display symptoms of PTSD up to 1 year post discharge (Rennick & Rashotte, 2009)
- ▶ Variation in parent involvement may exacerbate developmental delays/issues
- ▶ Disrupted/limited contact between primary caregiver/child impacts sense of attachment/security (Jaegermann & Klein, 2010)
- ▶ Longitudinal studies of institutionalized children reveal attention-seeking behaviors/increased risk of long-term social/behavior delays (Johnson, et al, 2006)

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## Neurodevelopmental Impairment

- ▶ Impaired cognitive skills
- ▶ Motor deficits
- ▶ Sensory impairment
- ▶ Behavioral & psychological problems

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## Neurodevelopmental Impairment

### Impact

- ▶ General motor movement at term (equivalent) predictive of feeding problems at 12 mths (Sanchez, et al, 2017)
- ▶ Feeding problems more common in children with lower cognitive, language, and motor scores on Bayley III (Crapnell, et al, 2015)
- ▶ Feeding problems more common in children with higher internalizing domain scores, depression/withdrawal and anxiety scores on Bayley III (Crapnell, et al, 2015)
- ▶ Oropharyngeal dysphagia linked to gross motor severity using GMFCS but present across all levels (Benfer, et al, 2013)

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## Chronic Health Issues

### Impact

- ▶ Children with special health care needs are at risk for range of poor psychosocial and educational outcomes (Forest, et al, 2011)
- ▶ Pulmonary abnormalities more pronounced in children with preterm birth and h/o moderate to severe BPD (Baraldi, et al, 2009)
- ▶ Circular pattern - feeding and swallowing problems can result in chronic pulmonary or constipation problems which further impact intake (Adams, et al, 2014)

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## Long-Term Health & Educational Needs

- ▶ Neurodevelopmental impairment affects 35-50% school-age children born very preterm (Johnson, et al, 2009)
- ▶ Cognitive scores 11-12 points lower than terms peers (Kerr-Wilson, et al 2012)
- ▶ Fine motor & gross motor deficits (deKieviet, et al, 2009)
- ▶ Visual motor integration deficits (Geldof, et al, 2012)

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## **The Premature Infant** **Early Experiences**

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## Overall Experience

- ▶ Born with immature brain/nervous system, GI system, Respiratory system
- ▶ Early life in an NICU
- ▶ Atypical types of stimulation/pain/interaction
- ▶ Cues difficult for caregivers to comprehend

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## Stress and the Premature Infant

- ▶ Stress becomes an issue when equilibrium is pushed out of balance due to environment causing bodily/mental tension
- ▶ Stress during early development associated with long-term changes in neurobehavioral development
- ▶ Stress to trauma - "the result of exposure to an inescapably stressful event that overwhelms a person's coping mechanism" (Van der Kolk, 1997)
- ▶ Stress reduction is a goal of intervention before term age (Hadders-Algra, 2011)

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## Neuroprotection

- ▶ Rapid change in brain last trimester (Buss, et al, 2012)
- ▶ Period of dendritic growth, synaptic connections, apoptosis, myelination, pruning (Shaker, 2017)
- ▶ Simultaneous actions for preterm infant in NICU 1. Becoming a feeder, 2. Developing sensory/motor pathways (Shaker, 2017)
- ▶ Pathways that are created (positive & negative) are reinforced (Shatz, 1992)
- ▶ Stress activates "fight/flight"-release of stress hormones (Smith & Vale, 2006)
- ▶ Repeated stress can alter brain structure/neurobehavior (Smith, et al, 2011)

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## Neuroprotection

- ▶ Repeated stress/altered pathways impact feeding in NICU and after discharge (Shaker, 2013)
- ▶ Repeated stress associated with feeding/altered pathways can result in later refusal to feed (Shaker, 2013)
- ▶ Positive response by caregivers to infant communication and avoidance of negative feeding experiences target for cue-based (Shaker, 2017)



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## Importance of Feeding in the NICU

- ▶ Most frequent cause of delayed discharge from NICU is reaching full feeds
- ▶ Infants born earlier than 28 weeks ga, extremely low birth weight, complex medical diagnoses at greater risk for delayed full feeds
- ▶ The degree of medical complexity / number of diagnoses closely correlate with longer time to reach full oral feeds

(Jadcherla, et al, 2010)

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## Feeding: “Then” and Now

### **Volume Driven**

- ▶ Volume/Time based
- ▶ Risk oral aversion
- ▶ Risk negative physiological impacts
- ▶ Risk poor model for parents
- ▶ Neurobehavior/brain structure at risk

### **Co-Regulated/Cue-Based**

- ▶ Infant is active participant in collaboration/guides (Shaker, 2017)  
"Being fed becomes "being supported to feed"
- ▶ Feed begins with hunger cues and ends with satiation cues

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## Examples of Distress

### **Autonomic Stress**

- ▶ Bradycardia
- ▶ Sneezing
- ▶ Yawning
- ▶ Gagging
- ▶ Tremors or twitching

### **Motoric Stress**

- ▶ Flaccid tone
- ▶ Hyperextension of extremities
- ▶ Grimacing
- ▶ Finger splaying
- ▶ Arching

### **State-Related Stress**

- ▶ Diffuse sleep or awake states
- ▶ Eye aversion
- ▶ Irritability
- ▶ Crying
- ▶ Staring

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## **Prematurity** **Impact on Caregivers/Family**

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## Maternal Experience

- ▶ Birth transitions from natural process to crisis
- ▶ Crisis results in negative emotions
- ▶ Grief and guilt
- ▶ Early attachment impacted by high tech environment
- ▶ Infant less able to interact

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## Parent Perceptions

- ▶ Parent/provider partnerships in NICU/PICU – conflict, communication problems, lack of collaboration (Lutz, 2012)
- ▶ System barriers/financial concerns escalated parent distress & expectations violated in comparison to “normal” families (Lutz, 2012)
- ▶ Mothers vs fathers in NICU – more stress (Pallas, et al, 2012), increased change to (her) daily routine (Clotey & Dillard, 2013), more guilt, role damaged (Lindberg & Ohrling, 2008)
- ▶ Fathers reported overall higher stress levels/mothers reported more health related problems, more depression, social isolation, and role restriction (Howe, et al 2014)
- ▶ Parents with preterm infants continue to report more stress than those with term (Howe, et al, 2014)

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## Family Support

- ▶ Empathize family experience
- ▶ Provide opportunities for families to share their feelings/needs
- ▶ Assist with identification of support systems
- ▶ Advocate
- ▶ Encourage healthy coping strategies

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THE END