Short- and Long-Term Cognitive and Behavioral Effects of Premature Birth

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The speaker has signed a disclosure form and indicated he has no significant financial interest or relationship with the companies or the manufacturer(s) of any commercial product and/or service that will be discussed as part of this presentation.

Session Summary

During this session a review of the short- and long-term cognitive and behavioral effects of prematurity will be discussed. A review of the medical risk factors contributing the possible cognitive and behavior problems in children born premature will be reviewed.

Session Objectives

Upon completion of this presentation, the participant will:

- understand the central nervous system effects of prematurity;
- understand associated cognitive effects of prematurity;
- understand the behavioral and psychological effects of prematurity.

References


Session Outline

See presentation handout on the following pages.
Short and Long term cognitive and behavioral effects of premature birth
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Primary questions
1. What are the short-term and long-term consequences of premature birth on development?
2. How can we identify those children at greatest risk for poor outcomes so that we can recommend appropriate services?

Outline
• Neuroanatomy and Neuropathology of prematurity
• Methodological issues
• Lifespan outcomes
  • Case examples
• Risk Factors

Neuroanatomy review
Everything you need to know about Neuroanatomy:
• http://www.youtube.com/watch?feature=player_embedded&v=FQjgsQ5G8ug
Perhaps a more simplistic view:
• http://www.youtube.com/watch?v=snO68aJTOP

Neurons

White and Gray Matter
White matter
Gray matter
Brain Development

First Trimester
- Development of neural tube
- Production of neurons
- Basic axonal pathways of brainstem
- Migration of cells
- Differentiation of cells

Brain Development

Second Trimester
- Basic wiring of brain (large patterns of connectivity between neural regions)
- Connections of thalamus to the cortex
- Intracortical pathways begin to establish
- Appearance of corpus callosum
- Organized cell death (apoptosis)
- First motor activity of fetus

Brain Development

Third Trimester
- Reciprocal connectivity from higher-order cortical areas to primary areas
- Initial myelination
- Large descending pathways from cortex
- Synaptic connections between neocortex and related structures
- Total Brain volume increases 2.7 fold
- Cortical gray matter increases 4 fold
- Myelinated white matter increases 5 fold

Neuropathology

Two primary processes:
- Hypoxic ischemia
- Exposure to maternal infection

Neuropathology

Primary brain abnormalities
- Periventricular Leukomalacia (PVL)
  - 5 – 15% of VLBW kids
- Intraventricular Hemorrhage (IVH)
  - 10 – 25% of VLBW kids
- Ventricular Dilation (reduced cortical volume)
Neuropathology

What brain regions are affected?
• Subcortical structures
  • Basal Ganglia, hippocampus, etc.
• White matter circuits

Defining prematurity
Based on Birth weight – preferred method in research
• Low Birth weight (LBW): < 2,500 g
• Very Low Birth weight (VLBW): < 1,200 g
• Extremely Low Birth weight (ELBW): < 1,000 g
Based on Gestational age: not as precise
• Preterm birth: < 37 weeks
• Very preterm birth: < 32 weeks
• Extremely preterm birth: < 29 weeks

Measuring outcomes
• Global outcome measures
  • IQ
• Specific cognitive domains
  • Attention
  • Memory
• Functional domains
  • School performance
  • Adaptive functioning

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Early outcomes
• Infancy
  • Decreased memory, processing speed, attention, and mental representation as young as 7 months
  • Increased irritability and poor emotional regulation
• Toddlers/Preschoolers
  • Working memory and Executive deficits
  • Motor skills, language, and attention
Case Example #1

- 4 year old boy
- International adoption
  - Early neglect
- 28 weeks gestation
  - Birth weight unknown
- Birth asphyxia suspected
- Prolonged mechanical ventilation
- MRI: mild PVL
- Abnormal EEG but no clinical seizures

Case Example #1

- O.T., P.T. and S.L. therapies
- Special needs preschool
- Concerns: attention, hyperactivity, comprehension problems
- Evaluation results
  - Below average IQ
  - Language deficits
  - Visual-perceptual deficits
  - Attention problems
  - Adaptive and academic deficits

Case example #2

- 3 year old girl
- 24 weeks gestational age
- 652 grams
- BPD
- Normal neonatal ultrasound

Case example #2

- Delayed development
- O.T. in the past
- Not in preschool
- Concerns: language and behavior
- Evaluation results
  - Average IQ, language, and school readiness skills
  - Low average adaptive skills
  - Poor emotional regulation and attention

School age outcomes

- Lower school readiness skills
- Deficits in: executive functioning, attention, memory, perceptual-motor skills, and visual processing
  - Not due to neurological or sensory problems
- Speech-language problems less prominent at this age
- Adaptive and social deficits emerge
- Pronounced math problems
  - High rates of special education services
- Increase in symptoms of ADHD
  - ~ 23% rate of ADHD diagnosis

Case Example #3

- 7 year old boy
- 27 weeks gestation
- 907 grams
- Grade 2 IVH
- Developmental delays
- Family history of learning problems
Case Example #3

- Completed special needs preschool
- In 1st grade with special education
- Concerns: memory, comprehension, hyperactivity
- Evaluation results:
  - Impaired IQ and adaptive functions
  - Global mild to moderate deficits
  - Dx mild intellectual disability

Case Example #4

- 11 year old girl
- 23 weeks gestation
- 680 grams
- BPD
- Grade 1 IVH and PVL (right greater than left)
- Mild craniofacial abnormalities

Case Example #4

- Developmental delays
- Diagnosed with ADHD
- O.T., P.T., and S.L. therapies as young child
- 5th grade homeschooled
- Concerns: organization, memory, frustration tolerance, social immaturity

Evaluation results:
- Verbal IQ = 119; Nonverbal IQ = 94
- Nonverbal deficits
- Deficits in planning and problem solving (executive functions)
- Fine motor deficits
- Above average reading but below average math
- Concerns with anxiety and mood

Adolescence and Young adulthood

- Executive deficits
- Lower high school graduation rates
- Lower college attendance
- Higher rates of anxiety/depression (especially in females)
- Lower rates of substance use

Taylor, 2010
Case example #5

- 19 year old male
- 27 weeks gestation (twin pregnancy)
  - Twin sister is intellectually disabled
  - Medical records not available
  - Diagnosed with ADHD
  - Untreated sleep apnea

Case Example #5

- Problems with motivation and attention since high school
- Now in Freshman year at a community college
- GPA = 3.0
- Daily MJ user
- Future: law enforcement or real estate

Evaluation results
- Average IQ
- Deficits: Attention, Executive functions, memory, and fine motor skills
- Language and visual spatial skills are intact

Effects on the Family

- Increased parental stress and burden
- Decreased parental well being
- Greater effects in children with persisting health problems
- Greater effects in the ELBW group
- Evidence for resiliency
  - Increased bonding

Primary questions

1. What are the short-term and long-term consequences of premature birth on development?
2. How can we identify those children at greatest risk for poor outcomes so that we can recommend appropriate services?
   - Significant variability
   - Early deficits are documented
   - Nonverbal and attention/executive deficits emerge over time
   - Math is often a weakness
   - Family functioning can be affected
Outline

- Neuroanatomy and Neuropathology of prematurity
- Methodological issues
- Lifespan outcomes
  - Case examples
- Risk Factors

Biological risk factors

- Chronic lung disease
  - Predicts global impairment
- Brain ultrasound abnormalities
  - PVL, IVH, Ventricular Dilation
  - Predict nonverbal skills better than verbal
- Birthweight
  - Risk for developmental impairment
  - 40-63% with < 750 g
  - 20 - 38% with 750 – 1,499 g
  - 8 – 8% with 1,500 – 2,500 g
  - 5 % with term controls

IVH Grading

- Risk of neurodevelopmental disability (Volpe, 2000)
  - Grade I: 5 - 10%
  - Grade II: 15 – 20%
  - Grade III: 35 – 55%
  - Grade IV: > 90%

Environmental risk factors

- Socioeconomic status
- Parental distress
- Caretaker burden
- Family Resources
- Home and school supports
  - Can be moderators of outcomes

Gender

- Boys
  - Poorer outcomes
  - Greater susceptibility to perinatal insults to brain and lungs
Biopsychosocial Model
(Taylor, 2010)

Biological Risk
Neuropsychological deficits
Learning problems
Social-behavioral problems

Direct and moderating environmental effects

Primary questions

- What are the short-term and long-term consequences of premature birth on development?
- How can we identify those children at greatest risk for poor outcomes so that we can recommend appropriate services?
  - Biological risks
  - Environmental risks
  - Protective factors