Neurobiology of Risk and Resilience of Children with Suspected Fetal Alcohol Spectrum Disorders (FASD)

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Objectives
1. To review the diagnostic classification of Fetal Alcohol Spectrum Disorders (FASD)
2. To review the diagnostic criteria of FAS
3. To highlight the effects of intrauterine alcohol exposure on the developing brain (structural and functional changes in the brain)
4. To discuss opportunities to promote resilience in children with FASD.

1. Classification of FASD’s

What is Fetal Alcohol Syndrome?
• Preventable birth defect caused by maternal alcohol consumption during pregnancy
• Characterized by physical, cognitive and behavioral abnormalities
  – Many abnormalities are a reflection of damage that was done to the brain of the developing fetus
• Results in lifelong impairments

The Umbrella of FASD

Partial Fetal Alcohol Syndrome

The Spectrum of FASD

OR
**Fetal Alcohol Syndrome (FAS)**

**Diagnostic Criteria**

- Confirmed Maternal Alcohol Exposure
- Abnormal Facial Features
  - Short palpebral fissures
  - Smooth philtrum
  - Thin vermillion border
- Growth deficiencies
  - Height or weight <10%
- CNS Dysfunction
  - Structural
  - Neurological
  - Microcephaly

**Partial Fetal Alcohol Syndrome (PFAS)**

- Confirmed Maternal Alcohol Exposure
- Abnormal Facial Features (≥2)
  - Short palpebral fissures
  - Smooth philtrum
  - Thin vermillion border
- AND one or more of the following:
  - Growth deficiencies
    - Height or weight <10%
  - CNS Dysfunction
    - Structural
    - Neurological
    - Microcephaly
- Complex Pattern of Behavior or Cognitive Abnormalities

**Alcohol Related Birth Defects (ARBD)**

- Confirmed Maternal Alcohol Exposure
- Abnormal Facial Features (≥2)
  - Short palpebral fissures
  - Smooth philtrum
  - Thin vermillion border
- AND
- One or more congenital defects:
  - Malformations or Dysplasias
    - Heart
    - Lungs
    - Bone
    - Kidneys
    - Vision
    - Hearing System
- OR
- Two or more minor anomalies

**Alcohol Related Neurodevelopmental Disorder (ARND)**

- Confirmed Maternal Alcohol Exposure
- AND 1 of the following:
  - CNS Neurodevelopmental Abnormalities
    - Microcephaly at birth
    - Structural brain abnormalities
    - Neurological hard signs
  - OR
  - Complex pattern of behavioral or cognitive deficits
    (*inconsistent with developmental level, and unexplained by genetic background or environmental conditions*)

**Cognitive and Behavioral Abnormalities in FASD**

- Complex pattern of behavioral or cognitive deficits
  (*inconsistent with developmental level, and unexplained by genetic background or environmental conditions*)
  - Learning disabilities
  - Deficits in school performance
  - Poor impulse control
  - Problems in social perception
  - Language deficits
  - Poor capacity for abstraction
  - Specific deficits in mathematical skills
  - Problems in memory, attention or judgment

**Diagnosing FASD**
2. Diagnostic Criteria of FAS

Fetal Alcohol Syndrome (FAS) Diagnostic Criteria

- Abnormal Facial Features (≥2)
  - Short palpebral fissures
  - Smooth philtrum
  - Thin vermillion border

- Growth deficiencies
  - Height or weight <10%

- CNS Dysfunction
  - Structural
  - Neurological
  - Functional

FAS Facial Characteristics

- Palpebral Fissure Length (PFL) < 10%

Dysmorphology in FAS

- Palpebral Fissure Length
- FAS Facial Characteristics

University of Washington Lip-Philtrum Guide Rank 4 or 5 for race
Minor Anomalies
- Railroad Track Ears
- Clinodactyly
- Camptodactyly
- Shortened 5th Finger

Minor Anomalies
- Hockey Stick Palmar Crease

Fetal Alcohol Syndrome (FAS) Diagnostic Criteria
- Abnormal Facial Features (≥2)
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  - Thin vermilion border
- Growth deficiencies
  - Height or weight <10%
- CNS Dysfunction
  - Structural
  - Neurological
  - Functional
Growth in FAS
- Prenatal or postnatal height, weight or both <10%
- Documented at any one point in time
- Adjusted for age, sex, gestational age, and race or ethnicity
- Growth deficit is not due to FTT/ endocrine disorder, or environmental factors

Fetal Alcohol Syndrome (FAS) Diagnostic Criteria
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- Growth deficiencies
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  - Structural
  - Neurological
  - Functional

CNS Abnormalities in FAS
- Structural
  - FOC <10%, adjusted for gender and age
  - Clinically significant brain abnormalities observable through thorough brain imaging (MRI/DTI/PET)
    - Corpus callosum
    - Basal ganglia
    - Cerebellar vermis

CNS Abnormalities in FAS
- Neurological
  1) Seizures not due to a postnatal insult or fever
  2) Soft neurologic signs
    - Coordination difficulties
    - Visual Motor Problems
    - Nystagmus
    - Difficulty with motor control
  3) Cannot be due to environmental or organic causes

CNS Abnormalities in FAS
- Functional
  a. Global cognitive deficit or significant developmental delay
    - > 2 SD below the mean
    - IQ < 70 (Mental Retardation)
  b. Deficits in > 3 functional domains
    1. Specific learning disabilities : math/ visuospatial skills
      - Uneven profile of cognitive skills
      - Poor academic achievement
      - Discrepancy between verbal and nonverbal skills
    2. Motor function delays or deficits
      - Visual-motor/ visuo-spatial coordination
      - Delayed motor milestones
      - Difficulty with writing or drawing
      - Clumsiness
      - Balance problems
      - Poor dexterity
CNS Abnormalities in FAS

• Functional
  b) Deficits in > 3 functional domains
  3. Executive function deficits:
     – Poor organization and poor planning
     – Limited concrete thinking
     – Lack of inhibition
     – Difficulty grasping cause and effect
     – Inability to delay gratification
     – Difficulty with multistep directions
     – Poor judgement
     – Inability to apply knowledge to new situations

CDC, 2005

CNS Abnormalities in FAS

• Functional
  b. Deficits in > 3 functional domains
  4. Attention and hyperactivity problems
  5. Social skills problems
  6. Sensory sensitivities
  7. Pragmatic language problems
  8. Memory Deficits
     – Forgetting well learned/ previously learned material
     – Difficulty responding to common parenting practices

Deficits in 3 Functional deficits > 1 SD below the mean

CDC, 2005
Intrauterine Effects of Alcohol Exposure

Effects on the developing fetus are determined by DOSE, DURATION and TIMING

Embryogenesis

Facial Dysmorphology: DOL = 17 (mouse)

Neurotoxic Effects of Alcohol on the Developing Brain

- Neurogenesis
- Cell Growth and Differentiation
- Neuronal Migration
- Synaptogenesis
- Apoptosis
- Plasticity

Timeline for Neurogenesis

- Neuronal Proliferation:
  - Peak = 2-4 months of gestation
- Migration:
  - Peak = 3-5 months of gestation
- Organization:
  - Peak = 6 months of gestation to several years postnatal
- Myelination:
  - Birth to many years postnatal

There is no safe time to drink while pregnant
Brain Regions Affected by Prenatal Alcohol

Effects of Alcohol on the Corpus Callosum

- Function of Corpus Callosum: Connect right and left hemispheres of the brain
- Effects of Alcohol on Corpus Callosum:
  - Partial or complete agenesis of the corpus callosum
  - Hypoplasia or displacement of the corpus callosum
- Associated with neuropsychological deficits
  - Decreased bimanual coordination
  - Impaired verbal learning ability
  - Impaired executive and psychosocial function

Effects of Alcohol on the Cerebellum

- Function of Cerebellum: Important for motor functions such as posture, balance, and coordination, and attention
- Effects of Alcohol on Cerebellum:
  - Reduced surface area
  - Decreased volume of the cerebellum and anterior cerebellar vermis
  - Displacement of superior and anterior edges of the anterior vermis
- Associated with certain functional deficits in
  - Balance
  - Bimanual coordination
  - Attention
  - Verbal learning and memory

Effects of Alcohol on the Basal Ganglia

- Function of Basal Ganglia: Includes the caudate nucleus, putamen, and globus pallidus. They are involved in motor abilities and cognitive functions, including executive function
- Effects of Alcohol on Basal Ganglia: Decreased volume of the caudate
- Associated with certain functional deficits in
  - Executive function
  - Attention
  - Response inhibition (i.e., shifting from one task to another)
  - Inhibition of inappropriate behavior
  - Spatial memory
  - Higher cognitive function

Effects of Alcohol on the Hippocampus

- Function of Hippocampus: Consolidation of new memory
- Effects of Alcohol on Hippocampus: Decreased volume of the hippocampus (Greater volume loss on L > R)
- Associated with certain functional deficits in
  - Spatial memory
  - Other memory functions

Effects of Alcohol on the Hippocampus

- Figure 1: Brain areas affected by prenatal alcohol exposure.
- Effects of Alcohol on the Corpus Callosum
- Effects of Alcohol on the Cerebellum
- Effects of Alcohol on the Basal Ganglia
- Effects of Alcohol on the Hippocampus

- Image: Brain regions affected by prenatal alcohol exposure.
Effects of Alcohol on Cortical Development

- Function of Cortex: Cortex is comprised of gray matter (cell bodies and dendrites) and white matter (axons surrounded by sheaths of myelin). White matter contains the necessary connections for proper cognitive function.
- Effects of Alcohol on Cortex:
  - Decreased white matter volume
  - Abnormalities in white matter tracts
- Associated with certain functional deficits in
  - Cognition
  - Motor function
  - Attention
  - Executive function

White Matter Tract Differences: FASD

- Widespread involvement of white matter tracts in children with FAS
- Abnormalities noted in neural pathways involving:
  - Corpus callosum (bilateral coordination)
  - Corticospinal tracts (motor function)
  - Occipito-temporal tract (visual processing)
  - Right cingulum (connection between temporal and frontal lobes)

Neural Pathways Affected in FASD

- Motor Problems/Incoordination
- Attention/Behavior Problems
- Visual-Motor Impairments
- Sensory Integration Difficulties
- Social Skills Deficits

Neurodevelopmental Consequences of Intrauterine Alcohol Exposure

- Attn/Behavior Problems
- Motor Problems/Incoordination
- Language Deficits
- Memory Deficits
- Self-Regulation Difficulties
- Developmental Delay

Neurodevelopmental Consequences of Intrauterine Alcohol Exposure: Infant – Toddler Symptoms
4. Case-Based Learning
Could it be...
An F.A.S.D.????

5. Optimizing Outcomes in FASD: Promoting Resilience

Optimizing Outcomes in FASD: Promoting Resilience

- Promoting Early Diagnosis
  - “The FAS diagnosis and the diagnostic process…are part of a continuum of care that identifies and facilitates appropriate health care, education, and community services.”

- Diagnosis is recommended prior to age 6 to help a child with FAS reach his developmental potential

Fetal Alcohol Syndrome: guidelines for referral and diagnosis. (2005). Department of Health and Human Services, p. 22-23

Optimizing Outcomes in FASD

- Promoting Early Diagnosis
  - Targeting high risk populations:
    - The CHILD as the point of entry
      - Children of substance abusing mothers
      - Children in foster care
      - Children who are internationally adopted

The incidence of FAS is 10X higher for children in the foster care system

Optimizing Outcomes in FASD

- Promoting Prevention
  - The mother has information to prevent FAS in future births
  - The MOTHER as a point of entry: GOAL: Identify woman who are drinking during pregnancy, and provide them with intervention services
  - Children who are born to women who STOP drinking in their pregnancy have better outcomes than those who CONTINUE to drink in pregnancy

CDC, 2005
Optimizing Outcomes in FASD

- Promoting Intervention:
  - Protective factors
    - Stable and nurturing caregiving environment during the school years
    - Absence of exposure to violence
    - Minimal number of placement / caregiver changes
    - Eligibility for social and educational services

Optimizing Caregiver Stability

CDC, 2005

Indications for Social and Educational Services

- Cognitive impairment
- Memory deficits
- Executive dysfunction
- Behavior problems
- Attention problems

Optimizing Caregiver Stability

CDC, 2005

Indications for Social and Educational Services

Infant – Toddler Symptoms

- Attention/behavior problems
- Developmental delay
- Self-regulation difficulties
- Memory deficits
- Sensory integration disorder

Optimizing Caregiver Stability

CDC, 2005

Indications for Social and Educational Services

- Language deficits
- Motor problems / incoordination
- Visual-motor impairments
- Self-regulation difficulties

Optimizing Caregiver Stability

CDC, 2005

Indications for Social and Educational Services

- Academic difficulties
- Attention problems
- Motor problems / incoordination
- Alcohol exposure


Indications for Social and Educational Services

- Visual-motor impairments
- Sensory integration disorder
- Attention problems
- Motor problems / incoordination

Optimizing Caregiver Stability

CDC, 2005

Indications for Social and Educational Services

- Alcohol exposure
- Memory deficits
- Executive dysfunction
- Developmental delay

Indications for Social and Educational Services

- Self-regulation difficulties
- Motor problems / incoordination
- Language deficits
- Alcohol exposure


Indications for Social and Educational Services

- Sensory integration disorder
- Memory deficits
- Attention problems
- Motor problems / incoordination

Optimizing Caregiver Stability

CDC, 2005

Indications for Social and Educational Services

- Academic difficulties
- Attention problems
- Motor problems / incoordination
- Alcohol exposure
Optimizing Caregiving Stability

How do caregiving relationships influence social-emotional development?

⇒ Lessons from attachment theory

What is Attachment?
- Described by John Bowlby in 1969
- A bond, tie or enduring relationship between a young child and his caregiver
- Occurs by 12 months of age to primary caregiver, regardless of quality of care
- Quality of the attachment relationship varies with the history of the infant’s caregiving experiences, and reflects the history of caregiving sensitivity (Sroufe, 1985)
  - Secure vs. Insecure Attachment

Evolution of Attachment
- Infancy in mammals is characterized as a period of helplessness and vulnerability
- Infant is completely dependent on his caregiver for care and protection
- The attachment system evolved as a behavioral system to promote infant’s proximity to the caregiver

What Are Attachment Behaviors?
- Result from a biological drive seen in all mammals and primates
- Describes the behavioral responses of a young child upon separation from his mother figure

When Do We See Attachment Behaviors?
- Attachment system is activated when the infant is in a state of arousal (distress)
  - Absence/distance from caregiver
  - Caregiver departs
  - Unfamiliar situations
  - Illness
  - Hunger
  - Cold
  - Pain
  - Cold
  - Hunger
  - Illness

Ainsworth, 1978
Attachment Behaviors Promote Proximity

- Attachment behaviors are the infant’s way of signaling the caregiver (protector) to come closer to the infant
  - Looking
  - Vocalizing
  - Crying/Calling
  - Following
  - Clinging

\[ \Rightarrow \text{Proximity Seeking and Contact Maintenance Behaviors} \]

Caregiver Responsiveness Influences Attachment Classification

Infant is distressed, signals caregiver
Caregiver responds inconsistently to signals
Infant learns that when he signals for his caregiver, his needs will be not be met, or will be met inconsistently

\[ \text{INSECURE pattern of attachment results} \]

Why Attachment Matters

- Early relationship experiences influence later child development
  - Patterns of the caregiver–child relationship as described by attachment theory have proven to be the most robust predictors of subsequent development.
    (Sroufe, 1988)
  - Through the context of early relationships infant forms initial expectations about himself and others, which become internalized, and provide a framework for later social relationships
    – “Internal Working Model”

Attachment and R Brain Development

- The quality of early experience impacts the experience-dependent maturation of the limbic system
  (Schore, 1994, 2001)
  - Secure attachment relationships facilitate synaptogenesis in R limbic system (Schore, 1994)
  - Mediates stress coping capacities of the individual
  - Early adverse attachment experiences result in brain organizations that are ineffective in regulating emotion and coping with stress.
    (Crittenden, 1987; Schore, 1994)

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    (Crittenden, 1987; Schore, 1994)
Attachment and Child Development: Source of Resilience

- Secure attachment classification is related to
  - Increased social competence
  - Improved self-esteem
  - Persistence in problem solving
  - Increased independence
  - Decreased behavior problems
  - Increased resilience and protection against stress

(Sroufe, 1983; Sroufe, 1985; Pianta, 1990)

Attachment and Child Development: Source of Vulnerability

- Insecure attachment classification is related to increased risk for later psychopathology
  - Boys with a history of avoidant or resistant attachment were more likely to be social withdrawn and have anxiety disorders (e.g., Warren, 1997)
  - Early insecure attachment is associated with greater peer rejection and higher internalizing and externalizing behaviors in preschool (Wood, 2002; Gutman-Steinmetz, 2006)

- Early Disorganized infant-parent relationships affect later child development: (Carlson, 1998; Lyons-Ruth, 1996; Green, 2002)
  - More negative parent-child interactions
  - Increased child behavior problems in preschool, elementary school, HS
  - Increased aggression in school aged children
  - Later psychopathology and dissociation

“Secure Attachment” Behaviors

- Actively seeks contact or interaction upon return
  - If distressed, seeks and maintains contact
  - If no distress, actively greets caregiver
  - Contact is effective in terminating distress
- Caregiver is a secure base for exploration
  - Readily separates to explore toys
  - Affective sharing of play
  - Readily comforted when distressed (returns to play)

Megan, 18 months

Corrion, 25 months

Promoting Resilience

NATURE THROUGH NURTURE
The Neurobiology of Resilience: The Role of Caregiving

- Low licking mothers
  - Low licking offspring
- High licking mothers
  - High licking offspring

Attachment and R Brain Development

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Attachment: Stages of Development

- Secure attachment relationships
  - Facilitate synaptogenesis in limbic system
  - Mediate stress coping capacities
- Early adverse attachment experiences lead to ineffective brain organization

The Neurobiology of Relationship Stress Reactivity of Children in Foster Care

- Salivary cortisol obtained from a sample of children in foster care and a comparison group
- Children in foster care demonstrated less decline in levels across the day compared with non-foster care group
- Conditions associated with foster care interfere with children's ability to regulate neuroendocrine functioning.

The Neurobiology of Relationship Stress Reactivity of Children After Intervention

- Relational intervention provided to children in foster care
- Cortisol reactivity was measured before and after stressor
- Cortisol reactivity in intervention group similar to non-foster care group → Improved stress reactivity with relational intervention

Promoting Resilience in Foster Care: Promoting Relationships

- Intervention designed to help children in foster care develop regulatory capacity
- Intervention helps caregivers:
  1. Provide an environment to help child develop increased regulatory capacity
  2. Reinterpret child's alienating cues
  3. Provide consistent nurturing care

Promoting Resilience Intervention Goals

1. Provide an environment to help child develop increased regulatory capacity
2. Reinterpret child's alienating cues
3. Provide consistent nurturing care

- Simplify and Structure Environment
- Respond Don't React
- Go Forth and Nurture
Tools for the Toolbox
- Addressing Developmental needs
- Promoting First Relationships
- Handouts from the Circle of Security®

Neurodevelopmental Consequences of Intrauterine Alcohol Exposure
Infant – Toddler Symptoms

Diagnostic Workup
• Confirm / obtain history about prenatal alcohol exposure.
• Obtain comprehensive diagnostic evaluation to confirm diagnosis
  – Physical Exam
  – Assessment of Growth
  – Developmental/ Behavioral /Psychological assessment
  – Evaluate dysmorphology by a geneticist
• Provide developmental services to address areas of vulnerability

Promoting First Relationships
Dedicated to promoting children’s social-emotional development through responsive and nurturing caregiver-child relationships
Promoting Resilience

Intervention Goals

1. Provide an environment to help child develop increased regulatory capacity
   - Simplify and Structure Environment

2. Reinterpret child’s alienating cues
   - Respond Don’t React

3. Provide consistent nurturing care
   - Go Forth and Nurture

(Almost) Everything I Need to Know About Being a Parent in 25 Words or less

Always: be BIGGER, STRONGER, WISER, and KIND.

- Whenever possible: follow your child’s need.
- Whenever necessary: take charge.

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What we hope for in parent-child relationships

“This is my favorite place - inside your hug.”