Neurobehavioral Assessment of High Risk Infants in the NICU

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Objectives

• Discuss the purpose of the neurobehavioral exam.
• Define different assessments available for use with high risk infants in the NICU.
• Discuss how to administer and interpret assessment results.

How is My Baby Doing?

• Assessment of Risk: Medical Factors and Diagnoses
• Caregiver Report
• Advanced Imaging
  • EEG
  • CUS
  • M6I
• Infant Behavior

Neonatal Assessment Myths

• Infants don’t do anything
• Developmental functioning cannot be determined until childhood
• Infants who sleep, poop, and eat look great!
• “Wait and see” is a good plan
• Parents and pediatricians always know the infant’s deficits

What is the Neurobehavioral Assessment:

• Functional evaluation of infant performance
  • CNS integrity
  • Incorporates the impact of environmental stress, brain injury, medical interventions, therapy
• Relies on premise that each infant has inherent capabilities
  • These capabilities can be altered by brain injury, disease, or the environment
• Includes assessment of a wide range of responses

Comprehensive Evaluation is Critical to Understand the Infant’s Whole Story...

• Self Regulation
• Attention
• Reflexes
• Movement
• Positional changes and challenges
• Feeding
Neurobehavioral Assessment Truths

- Valid and reliable tools are available to assess during early infancy
- Comprehensive evaluation of the young infant can uncover strengths/deficits related to foundations for later skill acquisition
- Early identification can enable implementation of early intervention to optimize outcome
- Neurobehavioral assessment can be used to guide parents to understand their infant’s strengths and areas of challenge

Behavior and Development

- Not something to address after all medical factors have resolved.
- Instead, something we should be addressing in tandem.

Neurobehavioral Assessment in the NICU

- Use caution and choose the right tools, based on the age, medical status, and vulnerability of the infant
- Remain sensitive and flexible during any assessment
- Embrace change...

Knowing When to Assess....

- Special training and experience with high risk infants in the NICU
  - Stress and approach signals
  - Understand vulnerabilities of immature preterm infants and understand complexities of engagement in the midst of medical complications
- There are tools that rely on observation
- Others can be done when an infant is able to tolerate a diaper change without physiological compromise
- There is an expanding repertoire of tools available as the infant’s medical factors resolve and as PMA advances

The Assessment

- Not a painful procedure
  - Fluid, controlled movements
  - Learning, memory
- It is an interaction
  - Responsive handling
  - Sensitive
  - Can be therapeutic!

Progression of Tolerance of Handling

- Potential physiological compromise with any handling
- Motor stress signs
- Short periods of handling with some compromise to states of arousal
- Increasing periods of alertness and tolerance of handling
- Coping with environmental stressors and still available to interact with caregivers and meet needs (feeding)
Why Are Assessments in the NICU Important?

- High rates of developmental challenges among preterm infants
- Many infants have overcome medical barriers
- Many can tolerate targeted interventions that can change the foundations of early development and optimize outcome
- Rapidly changing brain development
  - Window of opportunity

First Year of Life

- Window of opportunity/child’s brain becomes wired
- Early stimulation sets the stage for how children will learn and interact with others throughout life
- Good or bad experiences affect the wiring of the brain and connections to the CNS
- Stress results in increased cortisol, which causes brain cells to die and reduces connections

Time in the NICU is Critical Too...

- Rapid brain development
- Neurobehavioral changes

Premature Infants - Developmental Consequences

- Evolution of developmental delay is evident by term equivalent
- Our cohort:
  - Compared to full term infants:
    - Poor orientation ($p<.001$)
    - Poor tolerance of handling ($p<.001$)
    - Poor self regulation ($p<.001$)
    - More sub-optimal reflexes ($p<.001$)
    - More stress ($p<.001$)
    - More hypertonicity ($p<.001$)
    - More hypotonia ($p=.001$)
    - More excitability ($p=.007$)

Patterns of Development From 34 weeks Postmenstrual Age to Term

- Rapid changes in final 6 weeks of extra-uterine life
- Changes in motoric function
  - Increasing hypertonia ($p<.001$)
  - Decreasing hypotonia ($p=.001$)
  - Declining quality of movement ($p=.006$)
- Changes in behavior
  - Increasing arousal ($p<.001$)
  - Increasing excitability ($p<.001$)
  - Decreasing lethargy ($p<.001$)
Exploring the Early Development of the Premature Infant

- Development in the NICU is not static
- Acquisition of medical factors and brain injury
- Brain development
- Neurobehavioral changes

Understanding early development can:
- Allow a better understanding of factors that can be helpful or harmful in the NICU environment
- Can equip the clinician with strategies to optimize development in the NICU
  - Environmental
  - Therapeutic
  - General positive experiences/Parenting

Assessment and Interventions in the NICU

- Tailored to the infant
  - Postmenstrual age
  - Medical status
  - Energy expense
  - Other interactions

WHAT DO NEONATAL NEUROLOGICAL & NEUROBEHAVIORAL ASSESSMENTS TYPICALLY INVOLVE?

- Muscle tone (active & passive; pattern of distribution)
- Reflexes
- Quality of movements
- Neurologic signs
- Orientation / attention abilities

Greater emphasis in neurological examinations

Greater emphasis in neurobehavioral exams

Breaking Down the Neurobehavioral

- Self Regulation
- Motor
- Attention

The Normal Newborn

- Regulation/State Cycling
  - Infant sleeps most of the day but wakes for 8-10 feedings per day
  - Cries to indicate needs
  - Can self soothe
  - Hands to mouth/hands to midline

- Posture
  - Physiological flexion-flexed hips, knees, and elbows with shoulder horizontal adduction
  - Relaxed tone at rest

- Movement Patterns
  - Actively extends arms with return to flexion
  - Movements are mainly non-purposeful
  - In prone, infant raises head briefly
  - Holds head in line with body when pulled to sit
  - In supported sitting, can right head to midline
  - In standing, supports weight and does stepping

- Attention
  - Visual focus and track
  - Shifts gaze to auditory stimulation

Self Regulation

- Capacity to soothe him or herself when stressed
- How the infant copes with the demands of the environment

  - Stress signs
  - Irritability/excitability
  - Adaptive responses
State Regulation
- Affects other areas of function
- Ability to assess other areas is state dependent
  - Quiet awake state optimal
  - Is infant able to maintain this state?
  - Does infant transition abruptly from sleeping to crying?
- Baseline posture and movement is difficult to assess in a poorly regulated infant
- There is a relationship between self regulatory abilities, motoric function and behavior

Baseline Posture and Movement
- Active and passive tone
- Posture
- Quality of movements
  - Quality and quantity
  - Tremors and clonus
  - Spontaneous movements
  - Cramped or fluid
  - Jerky
  - Startles
  - Dominated by reflexes

Neuromaturation: Motoric Functioning
- Early reflexes and movement are the foundation of learning motor skills
  - Movement progresses from primitive reflexive patterns to voluntary, controlled movement
  - Reflex patterns subside as balance, postural reactions, and voluntary motor control emerge
  - Low level skills are prerequisites for certain high level skills
- Having balanced flexors and extensors for fluid movement impacts the ability to achieve developmental milestones
  - Moving joints through full range of motion prevents muscle shortening and loss of range

Attention
- Habituation
- Arousal/lethargy
- Excitability
- Orientation
  - Visual
  - Auditory
  - Reciprocal interactions
  - Complex interaction between attention, motor function and self regulation

The Larger Picture
- The specific response being tested
  - Asymmetry
  - Infant’s response to handling
    - Perception
    - Response
    - Coping
  - Other responses
    - Startles, tremors, tonal pattern changes
    - Stress signs
    - Level of arousal

Skill Based Assessment
- Sleeping
  - Habituation
  - Behavior
  - Self regulation
- Feeding
  - Motoric
  - Self regulation
  - Behavior
- Interacting
  - Self regulation
  - Visual and auditory skills
  - Orientation
  - Behavior
Assessments in the First Year of Life

- Dubowitz
- Prechtl
- Bayley Scales of Infant Development
- Peabody Developmental Motor Scales
- Infanib
- More...

Neonatal Assessments

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Author</th>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>EINAS – Einstein Neonatal Neurobehavioral Assessment Scale</td>
<td>Kurtzberg et al. 1979</td>
<td>Premature (P) &amp; Term (T) infants</td>
</tr>
<tr>
<td>APIB – Assessment of Premature Infants Behavior</td>
<td>Als, Lester, Tronick &amp; Brazelton 1982</td>
<td>Premature, Term, &amp; at risk P infants</td>
</tr>
<tr>
<td>NNNS – NICU Network Neurobehavioral Scale</td>
<td>Lester &amp; Tronick 2004</td>
<td>Premature (P), Term (T), &amp; at risk infants</td>
</tr>
<tr>
<td>Premie-Neuro</td>
<td>Daily &amp; Ellison 2005</td>
<td>Premature infants (from birth) 23-37 weeks GA</td>
</tr>
</tbody>
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Evaluations for Medically Fragile, Preterm Infants

- Premie-Neuro
  - 23-37 weeks PMA
  - Abbreviated form for infants <28 weeks PMA and/or who are still on a mechanical ventilator
  - Scoring based on PMA at time of evaluation
  - 1-5 minutes to assess
  - Total score converted to categorical score

Dubowitz/Hammersmith

- For infants at or around term age
- Takes approximately 10 minutes to administer
- Requires moving the infant in non-supine positions
- 34 items
- Each item is scored as 0, .5, or 1 point for a total maximum score of 34
- Scores below 31 are considered suboptimal
Comprehensive Neonatal Neurobehavioral Assessment

- 115 items are scored
  - Approximately half are administered and scored
  - Other half are observations throughout the evaluation

Assessment "Packages"
1. Habituation
2. Unwrap & supine
3. Lower extremity reflexes
4. Upper extremity & facial reflexes
5. Upright responses
6. Infant prone
7. Pick-up infant
8. Infant supine on examiner’s lap (attention)
9. Infant spin
10. Infant supine in crib

Summary Scores:
- Quality of Movement
- Non-Optimal Reflexes
- Regulation
- Attention
- Excitability
- Asymmetrical Reflexes
- Hypotonicity
- Arousal
- Hypertonicity
- Handling
- Lethargy

Understanding Early Development Can:
- Allow a better understanding of factors that can be helpful or harmful
- Can equip the clinician with strategies to optimize development
  - Environmental
  - Therapeutic
  - Positive experiences/Parenting

Items to Assess
- Plantar grasp
- Babinski
- Lower extremity recoil
- Popliteal angle
- Heel to ear
- Lower extremity traction

Items to Assess
- Scarf sign
- Upper extremity recoil
- Palmar grasp
- Upper extremity traction
  - Rooting
  - Sucking

Items to Assess
- Trunkal tone
- Pull to sit
- Head righting
- Placing
- Bearing weight
- Stepping
- Ventral suspension
- Incursion

Items to Assess
- Head raising in prone
- Spontaneous crawling
  - Holding in arms
  - Holding at shoulder
Items to Assess

• Auditory orientation
  • Voice
  • Other noise (rattle)
• Visual orientation
  • Face
  • Object
  • Horizontal, vertical, arc

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Items to Assess

• Defensive
• ATNR
• Moro

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Observations

• Startles
• Tremors
• Quality of movement
• Stress signs
• Posturing
• Asymmetries
• Coping skills
• Transitions from state to state

• Gaze aversion
• Nystagmus
• Irritability
• Fatigue
• Color changes
• Consolability
• Thumb adduction
• Back arching
• Cry

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Conclusions

• Early neurobehavioral assessments are helpful
• Early behavior is meaningful
• There are multiple standardized assessments available to assess high risk infants
  • Each can be chosen based on the population, the PMA intended to assess, domains of function one wishes to assess and whether there are certified examiners at the site intended
• A normal examination in the newborn period is reassuring
• Many infants with an ‘abnormal’ neonatal exam may show later recovery
  • Uncertain how early environment and interventions change outcomes of those with transient problems

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Questions?

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