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
  - MRI
- **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?

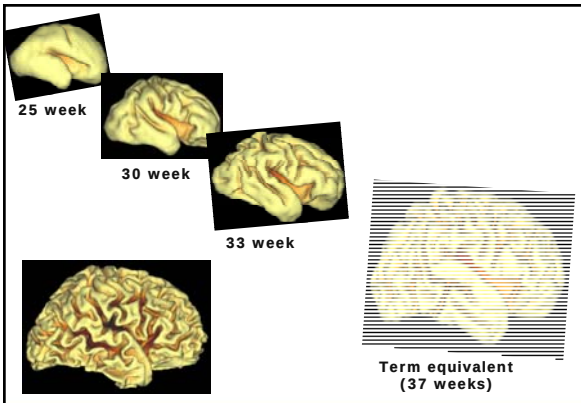
- High rates of developmental challenges among preterm infants
- Many infants have overcome medical barriers
- Many can tolerate targeted interventions that can change the foundations of early development and optimize outcome
- Rapidly changing brain development
  - Window of opportunity

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

Greater emphasis in neurological examinations

- Orientation / attention abilities
- Regulation (motor /physiologic /attentional /state)
- Signs of stress

Greater emphasis in neurobehavioral exams

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

Breaking Down the Neurobehavioral

- Self Regulation
- Motor
- Attention

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

- Neurological
  - Pretchl's General Movement Assessment-up to 20 weeks
  - HNNE-preterm and term
  - Premie-Neuro-neurological, movement and responsiveness scale
- Neurobehavioral
  - NNNS
  - NBAS
  - APIB
  - NAPI
- Observational
  - NONB-Naturalistic Observation of Newborn Behavior
  - Infant Behavioral Assessment
- Motor
  - TIMP

Neonatal Assessments

Assessment	Author	Population	
ENNAS – Einstein Neonatal Neurobehavioral Assessment Scale	Kurtzberg *et al.* 1979	Preterm (P) & Term (T) infants	
APIB - Assessment of Preterm Infant Behavior	Als, Lester, Tronick & Brazelton 1982	P, T & at risk infants	Certified training is required. Derived from the original NBAS (1973).
NNE – Neonatal Neurobehavioral Examination	Morgan *et al.* 1988	High risk infants (including P)	
NAPI – Neurobehavioral Assessment of the Preterm Infant	Korner & Thom 1990	P P	Training via video tape, reliability assessed by qualified teacher.

Neonatal Assessments

Assessment	Author	Population	
NBAS – Neonatal Behavioral Assessment Scale 3rd edition	Brazelton & Nugent 1995	Healthy P& T infants	Extensively used as both an assessment and intervention tool. Certified training.
HNNE - Hammersmith Neonatal Neurological Examination 2nd edition	Dubowitz, Dubowitz & Mercuri, 1999	Healthy & at risk P, T infants	Self-training via published guide with a pro forma inclusive of diagrams.
NNNS – NICU Network Neurobehavioral Scale	Lester & Tronick 2004	T, P & at risk infants, esp. substance exposed	Certified training through the NNNS Assessment Training Program (Brown University).
Premie-Neuro	Daily and Ellison 2005	P infants (from birth) 23-37 weeks' GA	

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
  - Dubowitz, Mercuri, Dubowitz (1998) An optimality score for the neurologic examination of the term newborn. Jorunal of Pediatrics; 133 (3): 406-16.
- Scores below 31 are considered suboptimal

Comprehensive Neonatal Neurobehavioral Assessment E.g. NNNS (NICU Network Neurobehavioural Scale)

- 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
- Incurvation

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

Items to Assess

- Defensive
- ATNR
- Moro

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

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

Video

Questions?

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