Core Concepts of Developmental Care in the NICU

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Disclosure of Financial Relationships

Juli Braswell has no disclosures

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Objectives:

- Identify the comorbidities of prematurity
- Understand the development of the brain and sensory systems in premature infants and how premature birth affects development
- Understand the goal of neuroprotection and the optimal environment for a premature infant
- Be able to identify premature infant's signs of stress and signs of state regulation
- Understand the value of the 7 Core Measures for neuroprotection during care in the NICU
- Be able to identify ways to implement developmental care in your own environment to minimize the negative impact of the NICU experience

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Long term consequences of prematurity

- MRI's show the structure of the premature infant's brain is different than a term infant at term
- Functional MRI's show the brains of children born premature function differently
- 15% of ELBW (Extremely Low Birth Weight) infants will have cerebral palsy.
- Infants born <1500g have a lower IQ at 26 years
- 2-5% of ELBW infants will have a severe visual or hearing impairment.
- Premature infants are 3 times more likely to have autism.

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Long term consequences of prematurity

- Infant's born prior to 37 weeks, are more likely to have epilepsy as an adult even if they do not have additional neurological disorders.
- Significant increased risk for psychological disorders including depression, anxiety, bipolar disorder and non-affective psychosis.
- Increased risk of ADHD and eating disorders
- Nearly 30% ELBW infants *with normal cranial ultrasound* had either cerebral palsy or a low mental developmental index.
- Only 61% of babies born at 24-32 weeks were free of mild, moderate, or severe disability at 5 years of age.

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How can we protect the brain?

Developmental care is the world wide standard that has been proven to provide neuroprotection.

BUT First… what is so different about the premature baby's brain that needs protecting?

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Preterm Brain Development

- By gestational week 10, the neural tube & basics of the neural system are established
- The fiber pathways that will become the brain's information superhighway are forming. The cells that will make up the neocortex—the part of the brain that coordinates sight, sound, spatial reasoning, conscious thought, and language—begin to communicate (Konkel, Lindsey)
- Premature infants in our NICU who are born between 23 and 32 weeks gestation spend 2-4 months growing and developing OUTSIDE of their mothers' wombs.
- Between about 27 and 30 weeks, short- and long-range connections between different brain regions begin to form and development of network connections peak. (Konkel, Lindsey)
- A growing body of research suggests that cognitive impairments may be caused by disruptions in the way the brain is wired before or shortly after birth.
- Creation of brain cells with interconnections between neurons, and cell pruning occurs during 3rd trimester & early infancy
- Stimulation of the brain determines which synapses in the brain are kept and which ones are not.
- The developing brain relies on environmental and endogenous stimuli to help it determine which connections should be pruned and which should not. "When a neuron fires after a proper signal, its synaptic connections are solidified," . "If a neuron's synaptic connection is rarely fired, it regresses and is removed." - R. Wright, MD
- Babies' brains then grow by 1% each day, beginning right after the infant is born.

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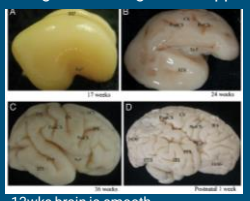
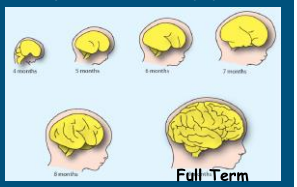
Importance of brain growth in the 3rd trimester

Big brain changes are happening while our babies are in the NICU



- 13wks brain is smooth
- 26wks develop central & lateral sulci but smooth cortex
- 30wks brain regions are defined

Preterm birth disrupts development of the brain's structure and the development of the sensory systems.



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From THIS in utero

WE are in consistent contact with these babies DURING THIS TIME!

To THIS in NICU

… All while the brain is trying to organize

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4 Factors of Brain Development

All systems are connected and do NOT develop in isolation.

For example, sensory stimulation has an emotional component and a motor response.

Both structure and function of the brain is influenced by the interaction of 4 major factors:

1. Genetic Endowment
2. Internal or Endogenous Stimulation
3. External Experiences and Stimulation of the Sensory Organs
4. The Environment

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Brain Development

1. Genetic Endowment- Nature vs Nurture

- Each person's genetics help determine the architecture, cell differentiation and cell migration.
- TIming, intensity, and type of stimulation can affect gene expression.
  - Pain
  - Smell
  - Sound
  - Touch
  - Chemical

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Brain Development

2. Endogenous or Internal Stimulation:

- A fetus has spontaneous brain activity that is crucial to brain development that must occur in the ABSENCE of outside stimulation.
- The neurons fire in synchronous waves at 28 weeks of gestation and they only happen during REM sleep.
- These waves of stimulus help form permanent connection and circuits that are the basic architecture of the brain. Most of these neurosensory connections happen in the last 20 weeks of gestation.
- THE BRAIN IS BUILT DURING REM SLEEP!

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Brain Development

3. Sensory Stimulation:

- Timing, intensity and type of stimulation can interfere directly with the development of the brain.
- There are critical periods of development for each sensory system that can be altered if another system is stimulated during that time.
- All sensory systems need appropriate outside stimulation EXCEPT vision.
- Vision does not need external stimulation until at or near term!!!

Cover those eyes!

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Brain Development

Sensory Stimulation in utero:

- Only hears low pitch sounds
- Movement is slow and dampened by the fluid environment with the body contained in flexion.
- Light is dim and cycled between day and night
- Touch is only skin to skin
- Only smells amniotic fluid

Sensory Stimulation in NICU

- High pitched sounds at greater decibels
- Movement is fast and in many planes with extremities away from the body.
- Bright lights and minimal difference between day and night.
- 95% of touch is procedural, stress and pain producing. Typically, only a total of 1 hour a day is positive touch.
- The most sensitive parts of the body (mouth, hands and feet) receive the most negative touch.
- Exposed to fragrant chemicals and cleansers

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Brain Development

4. Environment:

1. Physical- position and movement affect motor development
2. Chemical- nutrition, medications, and toxins affect gene expression
3. Sensory- stimulation of all sensory systems affect brain architecture, sleep, memory learning and brain plasticity
4. Social/Emotional- sensory stimulation effects limbic system and emotional learning and memory. Frontal lobe development is significantly affected

*Abnormal environmental stimuli CAUSE altered BRAIN STRUCTURE and FUNCTION

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The Sensory Systems

The sensory systems develop in a particular order:

1. Touch →7-9wks
2. Movement & Body Awareness→20-25wks
3. Hearing→23-25wks
4. Smell/Taste→28wks (taste buds 13-15wks)
5. Vision→31 wks

What fires together wires together!!

- ➔ If we are facilitating vision before it is supposed to be developing then those connections are firing prematurely and preventing other systems from firing, connecting and integrating.
- ➔ Sensory systems continue to develop in the order they would in the womb, but now their senses are getting extra stimulation in the NICU.
- ➔ Necessary to facilitate positive sensory experiences to support development

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Protecting Brain Development

Neuroprotection is the strategy that supports the developing brain, facilitates normal development and prevents disability.

Developmental Care is the way caregivers provide neuroprotection. Understanding an infant's signals and cues is basis of this method.

Intentional Caregiving is doing care routines and procedures WITH your patient and not TO your patient.

Infant Behavior is based on the function and developmental level of the brain. Understanding the difference in premature brain function and term brain function is vital in providing appropriate care.

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Protecting Brain Development

- Developmental care helps us to guide our own interactions in terms of timing, intensity.
- Don't continue to do things out of habit! Be intentional!
- The BEHAVIOR OF THE BABY gives us continuous expression of the BABY'S BRAIN FUNCTION.
- Practice reading their cues and use it as a guide for modifying the environment, interaction and care.

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Developmental Care

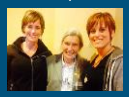
The work of Sameroff, Brazelton and AIs

Each infants strengths and weaknesses are evaluated as well as their tolerance for external stimulation. This provides the caregiver with information on how to best adapt the environment to support the infant.

-Dr. T Berry Brazelton, MD

Developmentally Supportive Care has proven to reduced days in the hospital, decreased cays on the ventilator, earlier feeding success, a marked reduction in complications and improved neurodevelopmental outcomes during the first 18 months of life that are sustained until 8 years of age.

-Dr. Heidelise Als
Developmental psychologist



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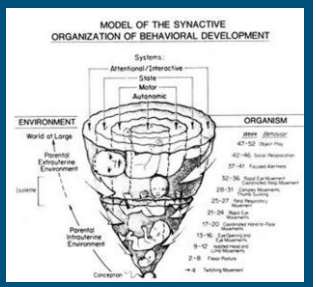
Developmental Care

Prevailing philosophy of care in the NICU world wide.

The caregiver must understand how the patient communicates in order to provide the best care.

There are many theories that promote developmental care. The Synactive Theory is a good representation of how each sensory system and the gestational age affect the ability of the infant to function in their environment.



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How do premature infants communicate?

AUTONOMIC Stress Signs

- Tachypnea, poor breathing pattern
- Mottled, flushed, pale, cyanotic skin
- Gagging or Spit up
- Yawning or Hiccups

STATE Stress Signs:

- Poor transition between states
- Abrupt state changes
- Hyperalert or Disorganized
- "Shut Down Response"

MOTOR Stress Signs:

- Flaccidity- limp extremities; gaping face; low tone trunk
- Hyperflexion & frantic movement
- Leg extension, saluting, finger splaying, "sitting on air"
- Trunk arching
- Grimace
- Tongue extension

WE MUST LISTEN BY OBSERVING!

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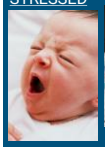
STRESSED



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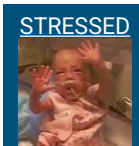

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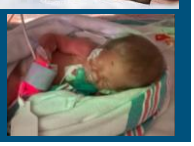

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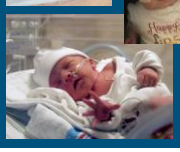

NOT STRESSED

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What are signs of good Developmental Care?

- ➔ Infant is able to transition smoothly between states without significant stress signs (stable autonomic, motor and state regulation)
- ➔ Baby can attend and engage with environment
- ➔ Homeostasis and an organized baby

Brazelton Behavior States:

1)Deep Sleep → 2)Light Sleep → 3) Drowsy → 4) Quiet Alert → 5)Active Alert → 6) Crying

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7 CORE MEASURES of Neuro-Protective Care

A Framework of Implementing Developmental Care in the NICU

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Core Measure 1: Healing Environment

Goal: To minimize the impact of the NICU environment on the infant's developing central nervous system.

Interventions:

- Provide appropriate nurturing touch during caregiving interactions
- Gentle but firm static containment & no light touch (SLOW on - SLOW off)
- Promote skin to skin holding daily
- Move the infant slowly when changing positions
- Provide scent free environment - use scent & taste of mothers milk
- Decreased noise (>50 decibels)
- If infant overstimulated - limit talk and interaction as needed until better tolerated
- Cover infant's eyes during every examination
- Support thermoregulation with neutral thermal environment

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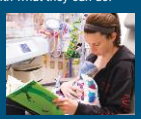
Core Measure 2: Partnering with Families

Goal: Promote infant-parent bonding and parents supported as the most important caregivers for their infant.

Interventions:

- Acknowledge the trauma, loss and grief of having a child admitted to the NICU.
- Communicate the infant's needs in a respectful and understandable way.
- Educate parents on how to properly and independently care for their infant.
- Instill confidence in the parent's caregiving abilities.
- Let parents help with what they can do.



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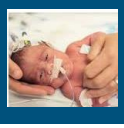
Core Measure 3: Positioning and Handling

Goal: Support the infant's development by providing supportive positioning and handling that encourages autonomic stability, midline and flexion support, and developmentally appropriate stimulation while preventing contractures, bone deformities and skin breakdown.

Interventions:

- Utilize a positioning tool such as the Infant Positioning Assessment Tool (IPAT)
- Maintain a midline, flexed, contained and comfortable position at all times with hands to mouth.
- Provided 4-handed support during positioning and caring activities (two person cares)
- Swaddle bathing and swaddle weighing

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Core Measure 3: Positioning and Handling



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Core Measure 4: Safeguarding Sleep

Goal: Support and protect prolonged periods of uninterrupted sleep by clustering care. Transition to "Safe Sleep" when developmentally appropriate.


Interventions:

- Keep isolettes covered at all times but transition to light cycling at 32 weeks (some say 28 weeks).
- Assist infants in transitioning from sleep to awake with gentle touch and calm voice.
- Provide skin to skin
- Cycled lighting for older infants
- Demonstrate and educate caregivers about Safe Sleep and Tummy Time
- AAP recommends 45 decibels or less in the NICU & <35 decibels is required for sleep

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Core Measure 5: Optimizing Nutrition

Goal: Provide feedings that are safe, functional and nurturing while preventing oral aversions.


Interventions:

- Use cue-based feeding protocols to determine when an infant is developmentally ready for oral feedings.
- Provide early and frequent skin to skin holding.
- Support mother's breast milk supply
- Support bonding of mothers who chose not to breastfeed
- Prevent trauma and negative stimuli to the mouth.
- Use breastmilk for mouth care

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Core Measure 6: Protecting Skin

Goal: Prevent skin injury from birth to discharge



Interventions:

- Provide humidity and thermoregulation based on age/weight.
- Use appropriate positioning and pressure relieving devices
- Minimize use of adhesives and carefully remove adhesives to prevent skin damage.
- Only use water for infants <1000g and Ph neutral cleansers that are fragrance free for infants over 1000g.

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Core Measure 7: Minimizing Stress and Pain

Goal: Promote self regulation and neurodevelopmental organization

Interventions:

- Provide individual care in a manner that anticipates, prioritizes, and supports the needs of the infant.
- Use a validated pain tool, but most importantly watch your babies signs and signals.
- Provide non-pharmacological pain management (positioning, containment, pacifier and sucrose).
- Allow parent support for painful procedures
- Educate parents on how to read infant's signs of stress and ways to provide comfort.

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In 1987, the American Academy of Pediatrics formally declared that it was unethical to continue to operate on infants without the use of anesthetics.

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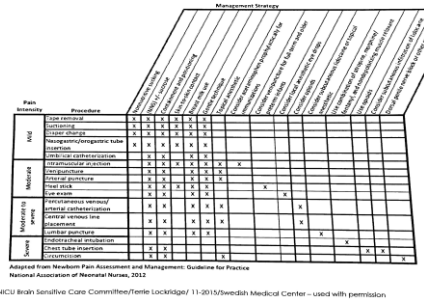
Manage procedural pain by using standardized best-practice guidelines:



Adapted from Newborn Pain Assessment and Management: Guideline for Practice
National Association of Neonatal Nurses, 2012

NICU Brain Sensitive Care Committee/Terrie Lockridge/ 11-2015/Swedish Medical Center – used with permission

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Is there Research on Neonatal Stress and Pain?

- Although it has been nearly 27 years since Anand and Hickey's seminal article on neonatal pain established that nociceptive activity constitutes an overwhelming physiologic stress for infants, in some neonatal intensive care units (NICUs), 79.2% of painful procedures are performed without analgesia. **Compared with healthy newborns, infants in NICUs experience a median of 75 (range 3-364) painful procedures during hospitalization and 10 (range 0-51) painful procedures per day of hospitalization**. *(Hatfield, Linda A 2014)*
- In thirteen studies, infants born extremely preterm (≤29 wk) had greater numbers of painful procedures that were associated with delayed postnatal growth, with poor early neurodevelopment, high cortical activation, and with altered brain development. (Valeri BO, Holsti L, Linhares, 2015)
- Unaddressed neonatal pain can result in **long lasting physiologic & neurodevelopmental consequences**. (Eckstein Grunau R. 2013)
- Long term outcomes can be affected by poorly managed neonatal pain. (Bhalla T, et al, 2013).
- Earlier gestational age at birth and cumulative pain exposure from tissue-breaking procedures and/or _____ _____ influence the degree of change in neurodevelopmental outcome and the somatosensory and/or emotional components of pain response in later life. (Walker, Suellen M. 2019)

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Is there Research on Neonatal Stress and Pain?

- Until 1970's.1980's, beliefs in a study that neonates are less sensitive to pain than adults because of a less functional & immature nervous system and believed fewer analgesics were needed for neonates. Paralytics were used to keep infants from thrashing.
- Glucose, regardless of its association with maternal cuddling, has been shown to help block or weaken the processing of cortical pain in neonates. *(Bembich S, Cont G, Causin E, et al. 2017)*
- Increased exposure to procedural pain has been associated with poorer cognitive and motor scores , impairments of growth , reduced white matter and subcortical gray matter maturation , and altered corticospinal tract structure. *(Walker, Suellen M. 2013)*
- During normal development, infant pain transmission and pain modulation undergo rapid growth beginning at 22 weeks gestation; achieving mature functioning at approximately 2 months of age. Noxious stimuli during this vulnerable period of neuronal plasticity may trigger unpredicted long-term epigenetic changes, which affect the brain, neurodevelopment, pain modulation, and pain reactivity into adulthood. *(Hatfield, Linda A. 2014)*

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Research on Reducing Pain

- Nonpharmacologic pain management such as **facilitated tucking**, **oral sucrose**, and **kangaroo care** have all significantly mitigated biobehavioral pain response associated with acutely painful procedures. (Hatfield, Linda A, Murphy, Nancy, et al. 2018)
- Non-pharmacological interventions are valuable strategies that can reduce neonatal pain directly by blocking nociceptive transduction/transmission or by activation of descending inhibitory pathways. Noninvasive techniques such as sweet-tasting substances, kangaroo care, breast milk and breastfeeding, non-nutritive sucking (NNS), swaddling, and facilitated tucking have been shown to be effective in soothing infants undergoing painful/stressful procedures (Perry, Mallory et al. 2018)
- Pharmacologic products have profound negative effects in some neonates. We know sedatives reduce the endogenous stimulation within the brain that is necessary for brain development.
- Sensorial saturation is an analgesic approach to preventing pain (heel-prick, eye exam, IM shots, & oral tube placements) that includes oral sugar, massage, and caregivers' voice. SS was the most effective treatment in all cases, except in endotracheal suctioning. It was a safe & more effective for neonatal pain from a heel-prick than oral sucrose or glucose in both term and preterm babies. (Locatelli B, Belline CV, 2018)

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How to bring Developmental Care to your NICU

- Gather a team
- Find a framework to help keep you get organized
- Identify an area where you can make the most change.
- Determine your short and long term goals
- Develop an education plan

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How to bring Developmental Care to your NICU

- Don't get discouraged!
- Changing culture is hard.
- Encourage staff to attend conferences on developmental care.
- Find a champion to support you
- Reach out to other units and social media groups for help when you get stuck

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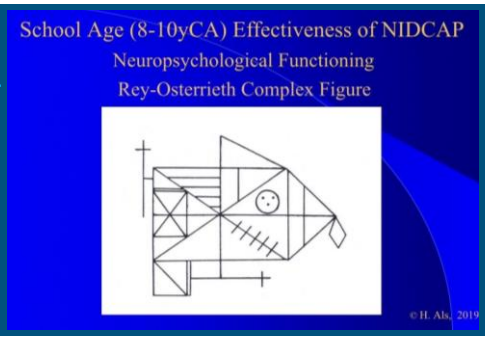

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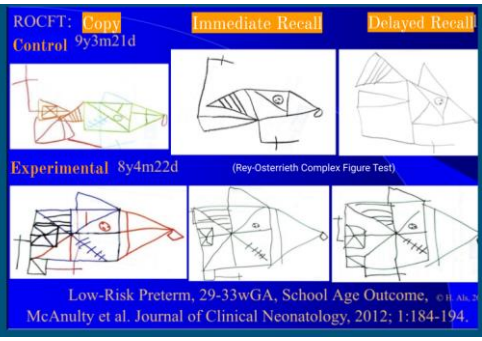

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Protect their brain.

It's the only one they get!

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