Developmental Care of the Neonate

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If you do enough small things right, big things can happen
- John Wooden -
Objectives

Upon completion of this presentation the participant will be able to:

▪ Describe fetal/neonatal brain development
▪ Identify developmental and physiological differences between the term and premature infant
▪ Identify various stressors experienced by the preemie in the NICU and discuss evidence based methods to reduce them
▪ Describe evidence based nursing interventions designed to enhance the normal development of the preterm and term ill neonate
Brain Development

- Begins in the 3rd week of gestation

- Formation of:
  - neural plate
  - neural folds
  - neural tube
Brain Development

(Giedd, 1999)
Brain Development: Proliferation

- Neural proliferation – cell reproduction
  - Begins at 8 weeks
  - peaks between 12-18 weeks
  - At birth, 100 billion developing neurons in the brain
    - 2x number of adult neurons
    - Cerebrum & cerebellum are last 2 areas of neuronal proliferation
Brain Development: Migration

- Migration – location of cells in appropriate areas
  - Begins shortly after proliferation
  - Peaks between 12-24 weeks
  - Follows a particular path, “inside out” pattern
  - Interaction between infant and environment is believed to shape and “fine-tune” neuronal connections
Brain Development: Migration

Human Neurons Continue to Migrate After Birth, Research Finds

- UCSF Study Reveals Previously Unrecognized Stage of Brain Development

- [https://youtu.be/IACDcxd7hsw](https://youtu.be/IACDcxd7hsw)
Brain Development: Synaptogenesis

- Synaptogenesis – formation of appropriate synaptic connections
  - Begins at 8 weeks
    - Continues in progression as neurons proliferate, differentiate and migrate
  - Dendrites and axons increase their branching

- Only during SLEEP does the third trimester brain achieve prolific synaptogenesis (retrieved from Z-Flo website)
Brain Development: Organization

- **Organization**
  - Layers of neurons in cortex
    - 24-28 weeks
  - Functional validation
    - Plasticity diminishes after this stage of development concludes in early infancy

- Preterm infants are exposed to NICU environments
Brain Development: Myelination

- **Myelination**
  - Lipoprotein covering that speeds conduction along nerve fibers
  - Final stage
    - Begins at 24 weeks and continues into adulthood
    - Peak development is from birth to 8 months
  - Inconsistencies in myelination can cause discrepancies in integration of sensory and motor
Brain Development

- Brain development is activity-dependent
  - experiences and stimuli "shape" the way the connections are made.
  - different beginnings foster different end points
  - Interventions can increase cell maturation, such as environmental enrichment
So why is developmental care crucial?
This is what we are working with…

Fetal Brain Development

- 23 weeks gestation
- 30-32 weeks gestation
- 40 weeks gestation
Developmental care!!

Goal is to optimize development by providing an environment and experiences that support physiologic stability and allow for brain development and growth of the extremely low birth weight infant.
“Everything Matters”
Dr. Heidelise Als
Normal newborn behavior and development

- Regulation/State Cycling
- Posture
- Movement Patterns
  - https://www.youtube.com/watch?v=WkoGQIdC8qU
- Attention
Premature Infants - Developmental Consequences

Evolution of developmental delay is evident by term equivalent

- 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)

Emotional and Behavioral Problems of Preterm and Full-Term Children at School Entry

Hornman et al, 2016

- 401 early preterm (25–31 weeks’ gestational age)
- 653 moderately preterm (32–35 weeks’ gestational age)
- 389 term

“Compared with term children… all preterm children are at risk for persistent and changing EB-problems at school entry”
Psychiatric Disorders and General Functioning in Low Birth Weight Adults: A Longitudinal Study
(Lærum et al. 2016)

- Term SGA group increase in the estimated probability of psychiatric disorders from 9% to 39%

- At 26 y/o, preterm VLBW and term SGA had increased psychiatric disorders (36%, 38% vs 14%)

- Both low birth weight groups had lower educational level and functioning scores than controls and a higher frequency of unemployment and disability benefit.
Neurobehavioral & Developmental care

Myths…

▪ Infants don’t “do” anything
▪ Developmental functioning cannot be determined until school-age
▪ Sleep+eat+poop=success
▪ Wait and See…

Truths…

▪ Valid and reliable tools exist
▪ High rates of developmental challenges among preterm infants
▪ Window of opportunity
▪ Predictors
Sensorimotor Interventions

- Concept that brain development is
  - regulated by genetics
  - influenced by environmental inputs

- Premature infants exposed to:
  - Invasive procedures
  - Multiple caregivers
  - Bright lights
  - Loud noises
  - Poor parental bonding
  - Decreased positive tactile touch

Fucile & Gisel (2010)
Sensorimotor Interventions

- Mismatch in sensory input may alter neuronal connections and organization
- Negatively influence later development
- Sensorimotor input (oral/tactile)
  - Infrequent
  - Inappropriate
Sensorimotor Interventions

- Inappropriate/inadequate tactile stimulation has been shown to contribute to
  - Growth failure
  - Oral feeding difficulties
  - Failure to thrive
  - Developmental delays
  - Delayed parental attachment

(Fucile & Gisel, 2010)
Sensorimotor Interventions

- **Oral:**
  - Oropharyngeal administration
    - Use syringe to place directly onto the oral mucosa in the buccal cavity for absorption via the mucosa
  - Allows for systemic absorption of the cytokines and pancreatic secretory trypsin inhibitor (PSTI)
  - Rich source of Oligosaccharides
  - May reduce time to full feeds (Rodriguez et al., 2010)
  - Studies have shown to improve feeding
  - improved weight gain  Fucile & Gisel (2010)
Environment and noise

- Fetal hearing begins at 24 weeks, processing at 30 weeks

- Early & high exposure leads to:
  - Decreased auditory processing, language delays & growth
  - Light too soon affects hearing/auditory processing

Sound

- Unlike intrauterine sounds, nursery sounds are:
  - airborne
  - a wide range of frequencies
- Limited ability to “tune-out” sound stimulus

- Hearing impairment requiring amplification is seen in 1-9% of ELBW (Stephen B.E. & Vohr B.R., 2009.)
Sound

- Noise levels result in both active & quiet sleep deprivation
  - Sleep disruptions reported as many as 234 time within a 24-hour period (Murdoch & Darlow, 1984 and Altimier et al., 1999)
  - Studies from last 3 decades, consistent levels of 50-90 dB in NICU’s, as high as 120 dB
- AAP has recommended NICU noise should not exceed 45 dB
<table>
<thead>
<tr>
<th>Source</th>
<th>Sound Level (dB)</th>
<th>Potential Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airplane engine</td>
<td>130</td>
<td>Pain/ hearing loss</td>
</tr>
<tr>
<td>Rock music</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>Heavy traffic</td>
<td>80-90</td>
<td></td>
</tr>
<tr>
<td><strong>Snapping isolette portholes shut</strong></td>
<td><strong>110!!!</strong></td>
<td></td>
</tr>
<tr>
<td>Placing hard objects on top of isolette</td>
<td>77-84</td>
<td>Prolonged exposure at this level can cause hearing loss</td>
</tr>
<tr>
<td>Med pump alarms</td>
<td>77-84</td>
<td></td>
</tr>
<tr>
<td>Overhead pages</td>
<td>79</td>
<td></td>
</tr>
<tr>
<td>3 people talking at the same time</td>
<td>73-84</td>
<td>Interrupts sleep patterns</td>
</tr>
<tr>
<td>Water in vent tubing</td>
<td>62</td>
<td></td>
</tr>
</tbody>
</table>
Sound

- Speaking quietly when at the bedside
- Quiet devices when possible
- Avoid tapping or placing objects on top of the isolette
- Place isolettes/beds away from doorways/sinks
- Avoid across the room conversations and overhead pages
Sound

- Close isolette portholes GENTLY
- Empty water in oxygen or ventilator tubing
- No radios
- Keep music boxes at a low level
- Pad garbage cans
- Quiet Time
Quiet Time

- Set aside 1-2 hrs each shift where staff/families are encouraged to speak softly (with goal of 24 hours)
- Avoid unnecessary procedures
- No rounds during this time
Light

- Vision is the last sense to develop
- Preemie has few defense mechanisms
  - Eyelids are thin
  - Large pupils
  - Decreased ability to constrict
- Early light leads to
  - Interference with auditory discrimination pathways
  - Problems with peripheral vision, motor coordination, disconjugate gaze & visual processing disorders

- flexibility of ambient lighting from 1-60 footcandles (ftc)
- 60 ftc is sufficient lighting to perform most procedures
- Animal studies show retinal damage when maintained in high, continuous levels of light
## Patient Room: Lighting Requirements

<table>
<thead>
<tr>
<th>Applications &amp; Tasks</th>
<th>Visual Age of Observers (in years)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>&lt;25</td>
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<tr>
<td>Examination</td>
<td>25</td>
</tr>
<tr>
<td>Reading</td>
<td>10</td>
</tr>
<tr>
<td>Television Viewing</td>
<td>2.5</td>
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<tr>
<td>Shower</td>
<td>5</td>
</tr>
<tr>
<td>Vanities</td>
<td>7.5</td>
</tr>
<tr>
<td>Night Lights</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Reference: 10,000 footcandles = sunny day, 0.01 footcandles = full moonlight
Light

- Isolette covers
- Dimmer switches on room lights
- Shield baby’s face when turning on bright lights
- Close window shades when possible
Sleep Preservation

- Sleep & sleep cycles begins @ 26-28 weeks
- Needed for
  - Neurosensory and motor systems
  - Creation of memory and long-term memory circuits
  - Essential for maintenance of brain plasticity over a lifetime  (Graven & Brown, 2008)
Sleep Preservation

Sensory Systems that require REM sleep for normal development:

- Somatesthetic – touch
- Kinesthetic – movement
- Proprioception – position
- Chemosensory – smell & taste
- Auditory
- Vision
- Limbic – emotion and social learning
- hippocampus – memory

(Graven & Browne, 2008)
Sleep Preservation

- Brain plasticity
  - Change, adapt & learn in response to environment and stimuli
  - Rely on sleep cycles throughout a lifetime
    - Begins in REM sleep in late sleep/early neonatal development
Neuroplasticity

1. MENTAL ACTIVITY
   - This can be a thought, feeling, or action.

2. CREATION OF NEW NEURAL STRUCTURES
   - Neurons fire together, forming a brief connection by communicating through gaps called synapses.

3. REPETITION OF MENTAL ACTIVITY
   - Strengthening of neural connection

4. SUPPORT FOR NEW NEURAL CONNECTIONS
   - Wiring together for more lasting circuits.
Sleep Preservation

- Touch times should allow for ample sleep
  - Promote & protect sleep cycles
  - Never wake a baby in REM sleep
- Sleep deprivation or disruption leads to:
  - Disordered sensory system
  - Decreased learning and memory capabilities
  - Smaller adult brain
  - Irritability

Methods to Promote Physiologic Stability and Decrease Stress
Cluster Care

- This does not mean you do everything at once
- Plan interventions to promote the longest periods of undisturbed rest to promote synaptogenesis
- Preemies have short periods of alertness
  - Aversive interventions should be avoided when in the quiet/alert state to maximize energy and promote positive interactions with caregivers
Coordinate Care

- Cares are done as a team
  - Physician, RT, RN, consults, etc. coordinate times to assess
  - “High-risk” procedures done with 2 caregivers
    - Suctioning
    - Positioning
- One person responsible for containment at all times
- Parents can help contain

http://dx.doi.org/10.1053/j.nainr.2008.10.011
Cues

Each infant has its own set of signals which provide us with indications when to approach and interact and when to allow them to regroup.
Handle with Care

- Infants in the ICN are subject to multiple examinations, procedures and care

- Interrupted sleep patterns

- Worst case scenario:
  - inflicts pain
  - causes changes in oxygenation
  - changes physiologic stability
Avoiding the unnecessary

What is really needed?

- Abdomen girths
- Weights
- Bathing
- Suction
- Chest physiotherapy
- Sedation
Minimize pain, stress & noxious stimuli

Important aspect of care for the neonate

Pain, stress & noxious stimuli can all lead to physiologic instability

ALL handling and care of the infant and their experiences affect BRAIN DEVELOPMENT

“What fires together, wires together”
Handle with Care

- Avoid things noxious stimulation straight out of a deep sleep
- Consistent caregivers
- Avoid the “hands out of nowhere”
- Avoid the unnecessary
Calming Techniques

- Always offer the baby ways to calm him/herself:
  - Something to hold on to
    - clasping hands together
    - blanket
  - Non-nutritive sucking
    - Pacifier
    - Hands to mouth
Calming Techniques

• Contain

• Boundaries

• Swaddle if possible
Parental support

- Help parents recognize infant cues and stress signals
- Emphasize the differences in temperament among preemies
- Give them lots of opportunities to have enjoyable and successful interactions with their babies
Parental support

- Skin to skin
- Implement when infant stable
  - can be done even while intubated and/or with lines
- Two person assist (RN/RT/parent)
- Proper alignment
- Timeframe 1-3 hours
- Standing transfer
Parental support

- Twenty-year Follow-up of Kangaroo Mother Care Versus Traditional Care
  - Charpak et al, 2017

- 264 infants weighing <1800g at birth
- Reevaluated at 20 years of life
- KMC and control groups were compared for:
  - health status, neurologic, cognitive, and social functioning
American Academy of Pediatrics: Policy Statement from the Task Force on Sudden Infant Death Syndrome 2005

▪ BACK TO SLEEP
  • Side sleeping is not as safe as supine
▪ Use a firm sleep surface
▪ Keep soft objects & loose bedding out of the crib
▪ Place crib in smoke-free environment
▪ Do not use home monitors to reduce the risk of SIDS
AAP Policy Statement

- Avoid development of positional plagiocephaly
  - Encourage “tummy time” when infant is awake and observed
  - Alter supine head position
AAP Policy Statement

- A separate but proximate sleeping environment is recommended (crib/bassinette within one arms length)
  - At least for first 6 months, up to 1 year ideally
- Consider offering a pacifier at nap time and bedtime
- Avoid overheating
- Avoid commercial devices marketed reduce the risk of SIDS
AAP Policy Statement

- Continue the “Back to Sleep” campaign
  - Public education to secondary caregivers (child care providers, grandparents, foster parents & babysitters)

- HCP in intensive care nurseries, as well as those in well-infant nurseries, should implement these recommendations well before an anticipated discharge
What does a safe sleep environment look like?

Lower the risk of sudden infant death syndrome (SIDS).

Don’t forget Tummy Time when the baby is awake and is being watched.

Use a firm mattress in a safety-approved* crib covered by a fitted sheet.

Make sure nothing covers the baby’s head.

Place your baby on his or her back to sleep for naps and at night.

Use sleep clothing, such as a one-piece sleeper, instead of a blanket.

Do not use pillows, blankets, sheepskins, or pillow-like bumpers in your baby’s sleep area.

Do not let anyone smoke near your baby.

Keep soft objects, stuffed toys, and loose bedding out of your baby’s sleep area.

*For more information on crib safety guidelines, call the Consumer Product Safety Commission at 1-800-638-2072 or visit their Web site at http://www.cpsc.gov.

U.S. Department of Health and Human Services
National Institute of Health
National Institute of Child Health and Human Development

Lenioff Children’s Hospitals
Positioning
Positioning

- Therapeutic positioning can influence normal alignment & neuromotor control

- Limited intrauterine space promotes “physiologic flexion”

- Correct and incorrect positioning affects the neurobehavioral organization, musculoskeletal development and neuromotor functioning
Positioning

Principles of Activity-Dependent Development:

- Repetitive use in the formation of neural connections & pathways

- Overtime, without boundaries, the infant does not return to a flexed, midline position

"Neurons that Fire Together, Wire Together…"
Positioning

- Preterm infants demonstrate low postural tone
- Amount of hypotonicity dependant on gestational age
Positioning

- The loss of the uterine “boundary” causes the preemie to “fix” or lean into the bed surface in an extension posture.
Extrauterine Environmental Challenges

- Hypotonia
- Gravitational forces
- Need for boundaries
- Equipment which tends to force extension
Positioning Goals

- Decrease the effects of gravity
- Prevent musculoskeletal deformity
- Promote sensory motor development
- Provide boundaries
- Enhance self-regulatory behavior through good positioning
- Promote skin integrity
Positioning Goals

- Neutral or slightly flexed neck
- Gently rounded shoulders
- Elbow flexion
- Hands to face or midline
- Trunk slightly rounded with pelvic tilt
- Hips partially flexed and adducted and knee flexion
- Secure boundaries for foot bracing
- Neutral or slightly flexed neck
- Gently rounded shoulders
- Trunk slightly rounded with pelvic tilt
- Elbow flexion
- Hands to face or midline
- Hips partially flexed and adducted and knee flexion
- Secure boundaries for foot bracing
Benefits of Good Positioning

▪ Improves breathing mechanics
▪ Improves quality of sleep and reduces crying/fussiness
▪ Enhances flexion of limbs/trunk
▪ Facilitates midline skills
▪ Reduces stress
▪ Less calories utilized and improved weight gain
Outcomes of Poor Positioning

- Skull flattening on sides of the head
- Decreased depth of rib cage
- Hip external rotation and abduction (frog legs)
- Retraction and abduction of shoulders (W)
- External tibial torsion
- Increased neck extension with right sided head preference
Neutral Head Position

Head midline first 72 hours with increased HOB

- Turning head to one side may:
  - Increase intracranial pressure $\rightarrow$ ↑ cerebral venous pressure
  - Occlude major ipsilateral veins $\rightarrow$ ↓ cerebral venous drainage

- Prevents IVH

- Can be done with any type of respiratory support
Prone

- Facilitates flexion and head control
- Improves oxygenation
- Keep hips and knees flexed
- Knees under hips
  - Flexed and close to the body
- Hands near mouth
- Head to side
Prone

Yes!

No!
Prone
Supine

- Time on back will decrease severity of head molding

- Keep shoulders flexed with hands on chest or abdomen

- Hips and knees flexed

- Symmetry throughout
  - No hip rotation
Supine Do’s
Supine Do’s
Supine “Don’ts”
Side lying

- Facilitates flexion
- Encourages hand to mouth
- Decreases arching
Side Lying

- Chin tucked with head to midline, arms forward with hands to face or mouth, hips and knees flexed
Side Lying

- Chin tucked with head to midline, arms forward with hands to face or mouth, hips and knees flexed
QUESTIONS??
References


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