Every NICU is a NeuroNICU

Saturday, June 1st

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Academy of Neonatal Nursing® Conferences

#ANNConferences #AcademyNN

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Disclosures

- I am the owner of Synapse Care Solutions.
- I am a clinical advisor and educator for Moberg Research and Aspect Imaging.
- I have a relationship with an essential oil company.
- *I will be discussing the off label use of the following agents:* Melatonin, Xenon, Erythropoietin.

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Objectives

- List the 4 domains of a NeuroNICU Practice
- Provide one example of a neuroprotective practice that you can incorporate into your daily practice.
- Outline one QI project that could measure your NICU's current practice related to one neuro-protective care practice

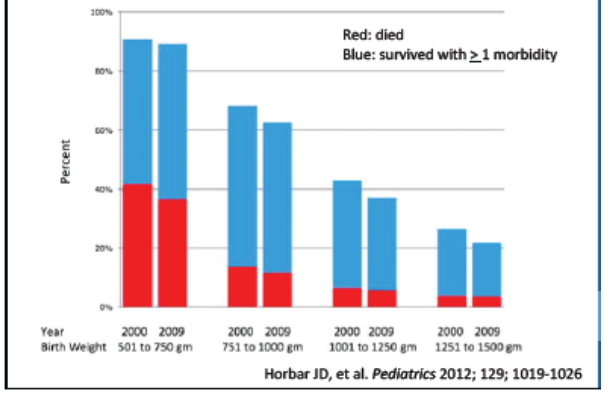
3

Why is there a NeuroNICU Trend?

- Opportunity to focus on outcomes not just survival
- Translate research in to daily NICU practice
- Utilize new technologies at the point of care

5

VON: Mortality and major morbidity among survivors, 2000 vs. 2009



Horbar JD, et al. *Pediatrics* 2012; 129; 1019-1026

8

What we still don't know

- On the basis of our follow-up data we feel that **the size of the hemorrhage** on ultrasound is by no means the only guideline to outcome.
- There may well be **other factors** influencing the result which we cannot yet diagnose by ultrasound.
  - *M. I. Levene - Letter to the Editor, Lancet, 1981*

11

Long Term Follow Up is Essential

- At 6yr, approximately 2 out of 5 of infants who were diagnosed with severe disability at 30mo no longer had severe disability.
- By contrast, 1 in 4 infants without any disability at 30mo were found to have moderate or severe disability at 6yr.

Patel (2016) Short and Long-Term Outcomes for Extremely Preterm Infants. Am J of Perinatology, 33(3), 318-328

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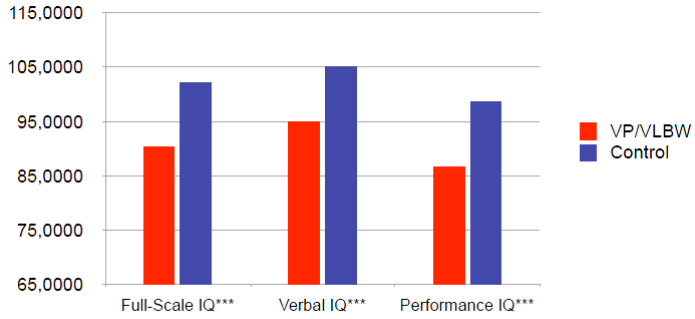
IQ scores at 26 years (n=359)



Error bars: Std. Error

*** p<0.001

Graphic Credit: Dr. Dieter Wolke, UK

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Psych + Mental Health Disorders and Prematurity at 11 years of age (EPICURE UK)

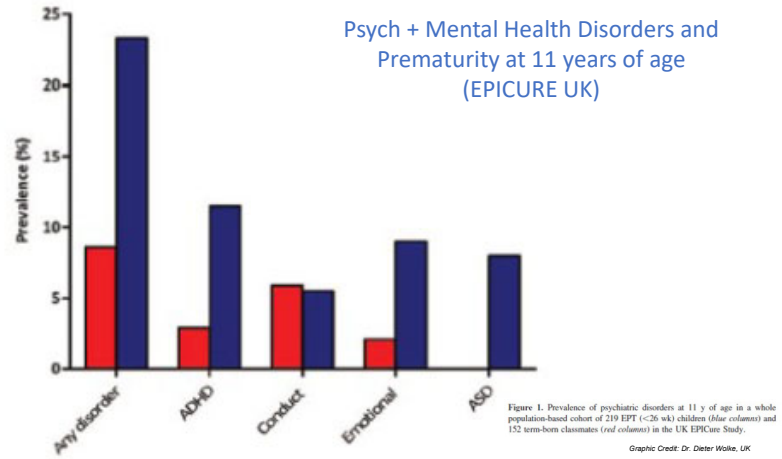

Figure 1. Prevalence of psychiatric disorders at 11 y of age in a whole population-based cohort of 219 EPT (<26 wk) children (*blue columns*) and 152 term-born classmates (*red columns*) in the UK EPICure Study.

Graphic Credit: Dr. Dieter Wolke, UK

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Why is there a NeuroNICU Trend?

- Opportunity to focus on outcomes not just survival
- Translate research in to daily NICU practice
- Utilize new technologies at the point of care

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Neuro-NICU's: Getting above the clavicles

Photo credit – www.ucsf.edu

- UCSF NeuroIntensive Care Nursery –2007
- Phoenix Children's NeuroNICU – 2009
- Johns Hopkins
- St. Louis Children's
- Vanderbilt Medical Center
- Children's National Medical Center, Washington D.C.
- Boston Children's - Peds Neuro ICU
- Lucile Packard Children's at Stanford
- Loma Linda University Children's Hospital
- Sharp Mary Birch & Rady's Children's – San Diego
- Riley Children's – Indiana
- CHOC – Orange, CA
- And More…

Glass, Bonifacio, Peloquin, Shimotake, et al. Neurocritical Care for Neonates. *Neurocrit Care*. 2010 June ; 12(3): 421–429. doi:10.1007/s12028-009-9324-7.

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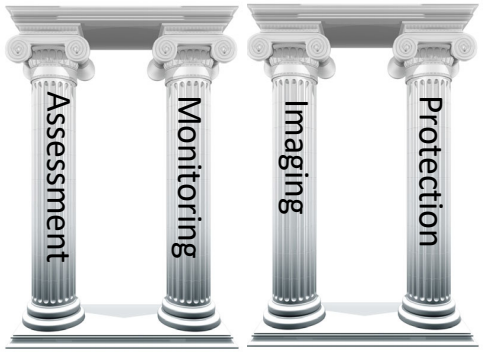
4 Pillars of Neuro-Nurturing NICU Care



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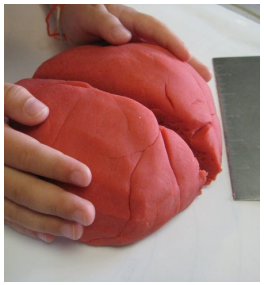
Every NICU is a Neuron-ICU

- Neuro-NICU's can be a:
  - QI project
  - Expanded Program
  - New unit design/environment
  - Change in culture



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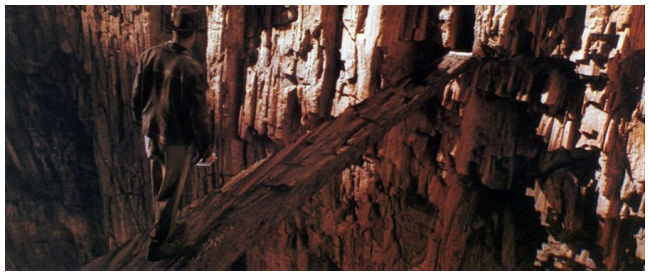
THE CHASM

- Bridging the gap between the type of care a patient SHOULD receive (i.e. EBM) and the quality of care they DO receive.



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Where you are now? Where do you want to go?

Practice	Personnel
Research/QI	Equipment

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Pillar #1 – Neuro-Assessment

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Why we perform a neuro-assessment..

1. Assess the integrity of the CNS
2. Assess and monitor an infant's neurobehavioral development and risk, including neurological recovery & need for early intervention
3. Monitor symptoms of drug withdrawal
4. Serve as an intervention to help families understand their infant's cues and to connect with their infant
5. Assess the effects of an intervention

Brown & Spittle, Current Pediatric Reviews 2014

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Clinical Neuro Exam Tools

Age specific, State Specific, Situational Specific, Disease specific

APGAR, SARNAT

DUBOWITZ, NBAS, NNNS

FINNEGAN, NPASS, PIPPS, FACES

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Sarnat Exam for HIE – For Cooling Eligibility and For Serial Exam

NE	Normal	Sarnat Mild	Moderate	Severe
Level of consciousness	Alert, responsive	Hyper-alert	Lethargic	Stupor, coma
Activity	Spontaneous	spontaneous or decreased	Decreased	None
Posture	Normal	Mild flexion	extension	decerebrate
Tone	+ flexor tone	+ flexor tone	hypotonic	flaccid
Reflexes				
-Suck	strong	weak	weak/bite	absent
-Moro	complete	↓ threshold to illicit	incomplete	absent
Autonomic				
-Pupils	dark/light mm	mydriasis	constricted	Non reactive
-Heart rate	100-160	↑ HR	↓ HR	variable
-Respirations	regular	regular	periodic	apnea

Chalak et al. Pediatrics 2003:351

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Pillar # 2 - Bedside Brain Monitoring

- Complimentary tools used *at the* ***bedside***
- Used ***in conjunction*** with other neuroassessments and diagnostics (e.g. neurologic exam, head ultrasound, CT, MRI)
- Provides bedside, ***unit-based*** clinicians with *continuous,* ***real-time*** information about neurologic status

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Bedside Neuro-monitoring Devices

Continuous video EEG (cEEG)

Amplitude integrated EEG (aEEG)

Near infrared Spectroscopy (NIRS)

BRAIN FUNCTION

BRAIN PERFUSION

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What does Neuro-Monitoring Tell Us?

aEEG – Brain Function

- Immediate/continuous evaluation of brain activity

NIRS – Brain Perfusion

- Brain hemodynamics and oxygenation

- Prediction of outcome
- Response to medical treatment
- Earlier interventions aiming to improve outcome

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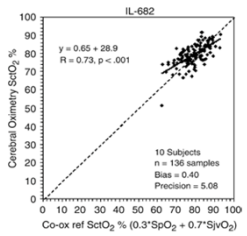
Near infrared spectroscopy (NIRS)

- Continuous, real-time, non-invasive measure of regional tissue oxygenation (rSO2)
- Able monitor cerebral, renal and mesenteric tissues
- Cerebral rSO2 is validated with jugular venous saturation



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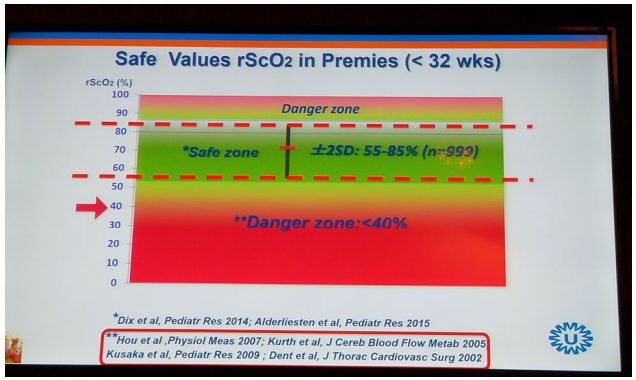

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High & Low rScO2 are associated
with poor neurodevelopmental outcome

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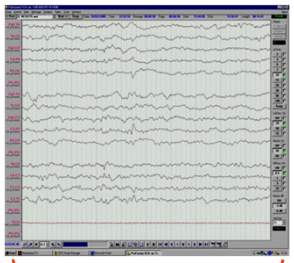
Comparing EEG and aEEG

Conventional EEG, 16 channels



10 seconds

aEEG, 2 channels

3.5 hours

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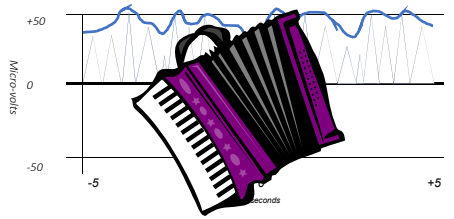
The EEG is made positive and the max and
min peak voltage is compressed
every 15 seconds in to single strokes



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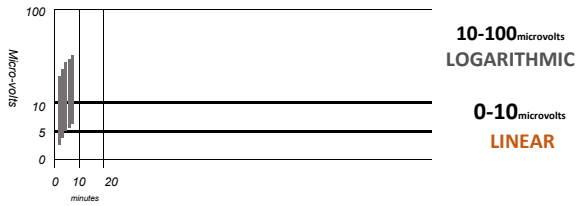
The absolute value of the amplitude peaks is plotted on on a semi-logarithmic scale, one "brush stroke" at a time



10-100microvolts
LOGARITHMIC

0-10microvolts
LINEAR

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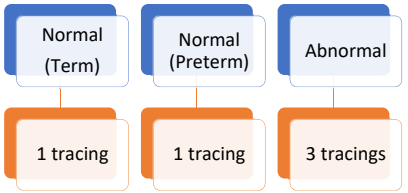
5 aEEG Patterns



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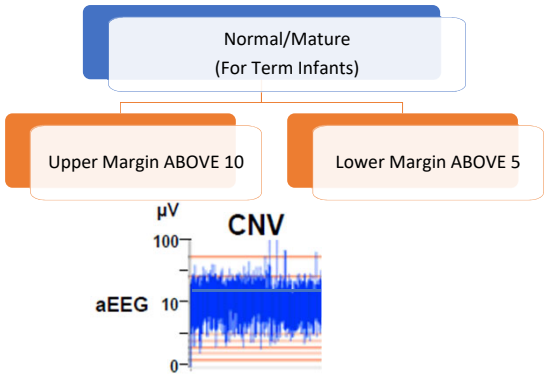
CONTINUOUS NORMAL VOLTAGE



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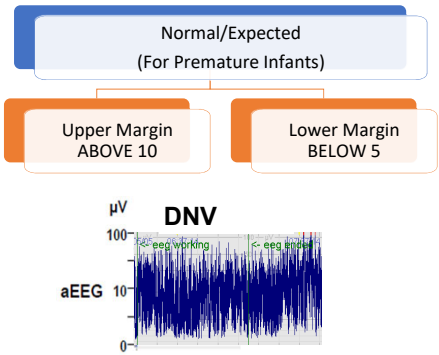
DISCONTINUOUS NORMAL VOLTAGE



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Pillar #3 – Neuro-Imaging

MRI/MRS, Ultrasound, CT (for emergencies/trauma), F-MRI, PETs

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Advanced Magnetic Resonance Imaging Measures of Impaired Organizational Events in Premature Infants

MRI MEASURE	MAJOR FINDINGS
Volumetric MRI	Decreased regional volumes, especially cerebral cortex, white matter, basal ganglia, thalamus, and cerebellum
Diffusion tensor imaging	Decreased fractional anisotropy in white matter, relatively increased radial diffusivity, variably altered axial diffusivity
Surface-based measures	Decreased cerebral cortical surface area and cortical folding/gyrification
Functional MRI	Impaired development of measures of connectivity, including especially thalamocortical connectivity

Volpe Textbook of Neurology, 8th Ed., 2018

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Sedation Free MRI

- Feed and swaddle method
- Assistive and immobilization devices

Pediatr Radiol (2008) 38:260–264
DOI 10.1007/s00247-007-0705-9

REVIEW

Transport, monitoring, and successful brain MR imaging in unsedated neonates

Amit M. Mathur · Jeffrey J. Neil · Robert C. McKinstry · Terrie E. Inder

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What we still don't know

- Neither **structural** brain alterations nor the medical complications common in the NICU population fully explain the variation in long-term neurobehavioral development
  - Milgrom, Pediatric Research, 2010

Early Sensitivity Training for Parents of Preterm Infants: Impact on the Developing Brain

JEANNETTE MILGROM, CAROL NEWNHAM, PETER J. ANDERSON, LEX W. DOYLE, ALAN W. GEMMELL, KATHERINE LEE, ROD W. HUNT, MERILYN BEAR, AND TERRIE INDER

Vol. 67, No. 3, 2010
Printed in U.S.A.

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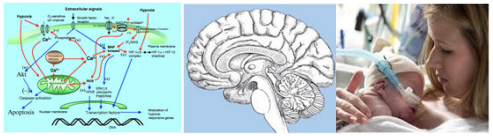
Pillar #4: Neuro-Protection

- Initially applied to treatments/care to prevent injury and cell death
  - Term babies – HIE, Stroke, Seizures, Infection
  - Premature babies – IVH, PVL, Seizures, CLD, Infection



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What we've tried for the last 15 years:

- Antenatal Steroids
- Mag Sulfate
- Indomethacin
- Ibuprofen
- Phenobarb
- Caffeine
- Sedation
- Delayed Cord Clamping
- Improved auto-regulation
- Mid-Line Positioning
- Developmental Care
- Therapeutic Positioning
- Early Intervention of Hydrocephalus

Carteaux P, Pediatrics (2003)

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1. PREVENT PRIMARY INJURIES

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Maintain Midline Head Position x 72 hours

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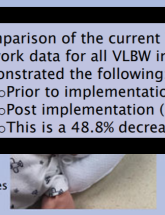
Building Better Baby Brains – The 4B Project

NICU Nurse Driven IVH Prevention Initiative

Allyssa VanArsdale, RN, BSN and Frances Upton, RN, ADN
East Tennessee Children's Hospital (ETCH) Knoxville, TN

IVH Prevention Guidelines for the Bedside Caregiver

1. Admit infant to a be… location against a s… low traffic area whe… which *decreases no… from other monitor… traffic.*
2. Report mean arteria… pressures lower tha… age to medical staff… *and support which p… blood pressure fluc…*
3. Maintain midline (neutral) head alignment when positioning or lifting infant for care or procedures which *avoids jugular vein compression impeding venous drainage.*



Impact

- Increased the staff nurses' and respiratory therapists' knowledge base regarding anatomy and …fant's brain and it's …flow fluctuations.
- …he impact that basic …can produce because
- …ng and using a … collected both documented and visualized data.
- Tracked admissions of infants less than thirty-two weeks gestation and monitored for the occurrence of IVH. Gestational ages of this group ranged from twenty-three weeks and three days to thirty-two

- Comparison of the current Vermont Oxford Network data for all VLBW infants treated at ETCH demonstrated the following:
  - Prior to implementation (2015)- 21.3% IVH
  - Post implementation (2016)- 10.9% IVH
  - This is a 48.8% decrease in all grades of IVH.

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Infant Positioning Assessment Tool (IPAT)

Max Score = 12

Indicator	0	1	2
Shoulders			
Hands			
Hips			
Knees, ankles, feet			
Head			
Neck			

Coughlin, Lohman, & Gibbins (2010) Reliability and Effectiveness of an Infant Positioning Assessment Tool to Standardize Developmentally Supportive Positioning Practices in the Neonatal Intensive Care Unit, Newborn and Infant Nursing Reviews , Volume 10, Issue 2 , Pages 104-106, June 2010

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Mid-Line DOES NOT mean Supine!

Optimal Position

- Midline
- Flexed
- Contained

Image Source: http://www.nurturedbydesign.com/en/thezaky/medical-staff_development.php

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Prevention of Common NICU Complications

- Mounting Evidence for infection and Inflammation and it's impact on brain development
- Rethink other NICU programs as Neuro-Protective
  - NEC Prevention
  - Sepsis Prevention
  - Ventilator-Induced Brain Injury

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2.PREVENT SECONDARY INJURY

- Interventions That Aim To:
  - Reduce Injury Progression (Containment)

Johnson, Fatemi, Wilson, Northington. Lancet Neurology, 2011 (10).

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Time Is Brain: Starting Therapeutic Hypothermia within Three Hours after Birth Improves Motor Outcome in Asphyxiated Newborns

Marianne Thoresen[a–c] James Tooley[b] Xun Liu[a] Sally Jary[a, b] Peter Fleming[b] Karen Luyt[a, b] Anoopam Jain[b] Pamela Cairns[b] David Harding[b] Hemmen Sabir[a]

[a]Neonatal Neuroscience, School of Clinical Sciences, University of Bristol, St. Michael's Hospital, Bristol, and [b]Neonatal Unit, University Hospitals Bristol, St. Michael's Hospital, Bristol, UK; [c]Department of Physiology, Institute of Basic Medical Sciences, University of Oslo, Oslo, Norway

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3 - INCREASE CELLULAR TOLERANCE

- Protect Neurons from Additional Injury after Insult (increase their tolerance)

Johnson, Fatemi, Wilson, Northington. Lancet Neurology, 2011 (10).

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Cocktails on ICE

Adjuncts to Hypothermia:

- EPO – antioxidant, anti-inflammatory
- Xenon – NMDA-receptor antagonist
- IGF-1
- Melatonin
- Anti-epileptics
- Cord blood

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4 – REPAIR INJURED CELLS

- Interventions That Aim To:
  - Salvage and repair injured cells
    - No clinical interventions available; research ongoing

Johnson, Fatemi, Wilson, Northington. Lancet Neurology, 2011 (10).

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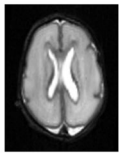
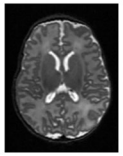
5 – SUPPORT NORMAL BRAIN DEVELOMENT



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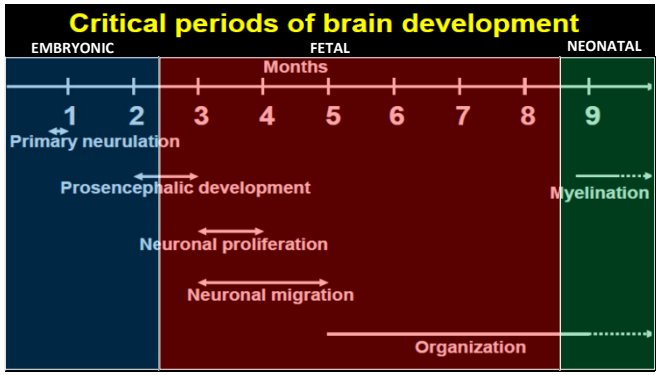

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Neuro-Development


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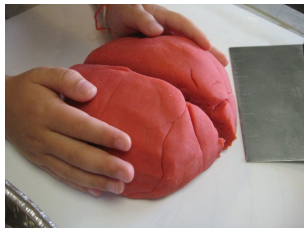
Two Theories of Brain Development

- Neural Blooming (0 to 5 years)
  - What fires together, will wire together



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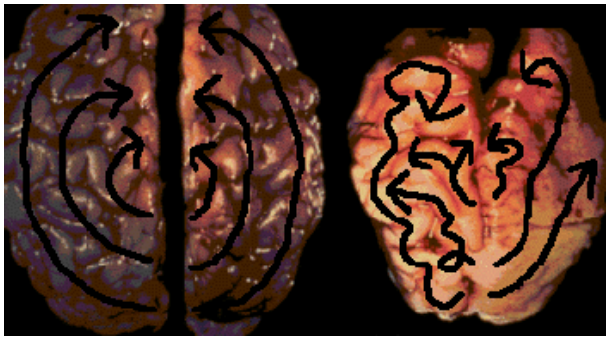

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Two Theories of Brain Development

- Neural Blooming (0 to 5 years)
  - What fires together, will wire together
- Neural Pruning (5 years +)
  - Use it, or lose it

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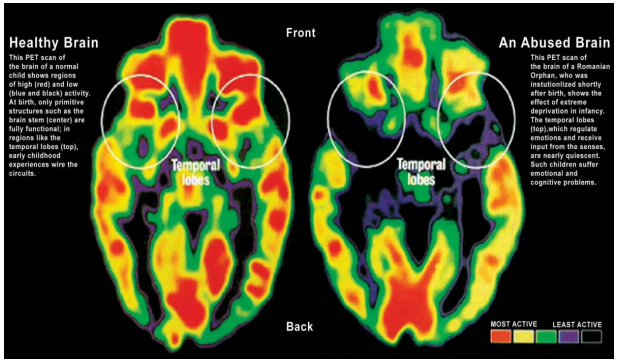

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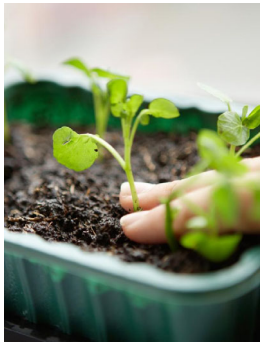
Expanding the Definition of Neuro-Protective Care

- Interventions That Aim To:
  1. Prevent Injury
  2. Prevent extension of injury
  3. Salvage injured cells
  4. Grow new neurons
  5. Nurture the neurons we have



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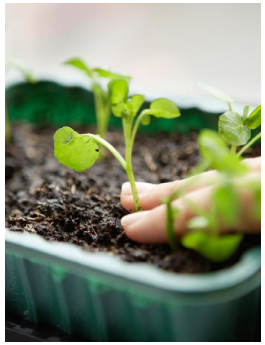
Neurogenesis - Sprout New Brain Cells

- Interventions That Aim To:
  - *Grow New Neurons (neurogenesis)*
    - **Investigational:**
    - EPO
    - Stem Cell
    - IGF-1
    - **Practical:**
    - Massage
    - Kangaroo Care



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KC Promotes brain maturation

- Higher Bayley Mental and Motor scores
- Higher IQ's
- better brain complexity (more synapses)
- 2-4 weeks more maturity than non KC preterm infants

– Scher MS et al. (2009)

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Neuro-Nurturing – Organization + Proliferation

- Interventions That Aim To:
  - *Nurture the neurons we have*

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#1 - MINIMIZE PAIN

- Mounting evidence that repeated stress has profound and long-lasting effects on the CNS
  - Especially during the critical early periods of infant development
- Stressors can be:
  - Physical
  - Psychological
  - Social

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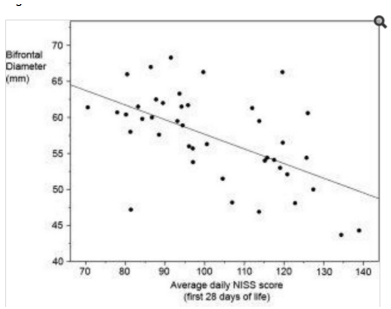

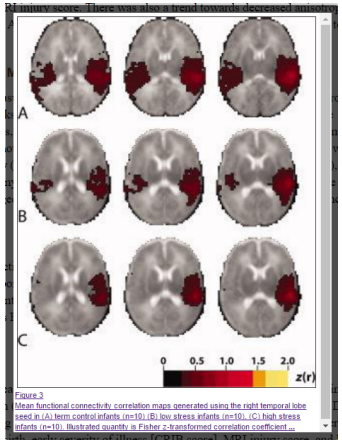

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Maternal holding + painful experiences

Breastfeeding, when compared to placebo or no intervention control, effectively reduces behavioral pain response associated with common puncture procedures in infants

- ✓ Heart rate
- ✓ Cry duration
- ✓ Behavioural facial response

Shah et al. Breastfeeding or Breast Milk for Procedural Pain in Neonates. *Cochrane Database, 2012.*

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IJN
Iranian Journal of Neonatology
http://ijn.mums.ac.ir

Open Access — Original Article

Effect of Spike Lavender Lakhlakhe on Pain Intensity Due to Phlebotomy Procedure in Premature Infants Hospitalized in Neonatal Intensive Care Unit: A Randomized Clinical Trial

Noushin Beheshtipoor[1]*, Fatemeh Bayani[2], Mitra Edraki[3], Shahnaz Porarian[4], Alireza Salehi[5]

1. Department of Pediatric Nursing, Faculty of Nursing and Midwifery, Shiraz University of Medical Sciences, Shiraz, Iran
2. Department of Nursing and Midwifery, Shiraz University of Medical Sciences, Shiraz, Iran
3. Community-Based Psychiatric Care Research Center, Department of Pediatric Nursing, Faculty of Nursing and Midwifery, Shiraz University of Medical Sciences, Shiraz, Iran
4. Community-Based Psychiatric Care Research Center, Department of Nursing and Midwifery, Shiraz University of Medical Sciences, Shiraz, Iran
5. Student Research Committee, Shiraz University of Medical Sciences, Shiraz, Iran

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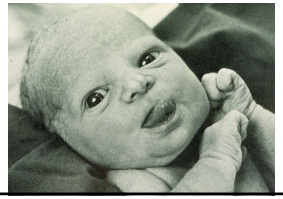
#2 - Balance SENSORY Experiences



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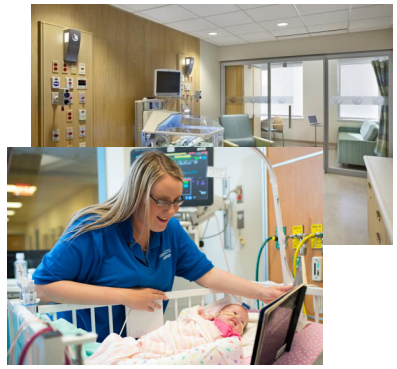
ENVIRONMENT OF CARE

- Private rooms
- Minimize noise
- Maximize language



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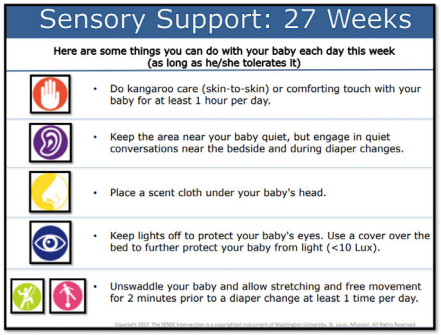
St. Louis SENSE Program

- Modulated and Accelerated Sensory Exposure Program



CREDIT:
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University Kentucky – ClinicalTrials.gov

https://uknow.uky.edu/uk-healthcare/pediatric-experts-find-aromatherapy-effective-promoting-infant-healing-nas-recovery

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#3 - PROMOTE BONDING & CONNECTION

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What impairs functional and emotional connections

- Separation – physical and emotional
  - In another hospital
  - In an incubator
  - Emotionally detached
- Pre-existing maternal mental health issues
- Infection – disrupts normal synaptic development
- Lack of nutrition – pre/post natal

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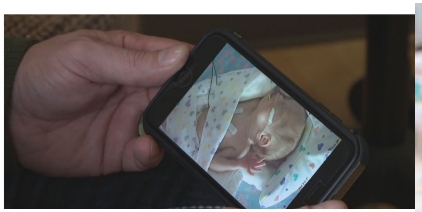
Inside the NICU: cameras keep families connected to their NICU babies

by Erin Hawley | Tuesday, March 13th 2018



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New Definitions to Consider

Attachment

- Can be Unilateral
- Based in anxiety or loss
- Doesn't develop until first year (when mobility is increased)

Attunement

- A deep emotional connection to another human being
- Begins in utero (synchrony)
- Linked to the ANS and HPA systems
- Learning to read faces and emotions

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Attunement with Others

David Arredondo M.D.

https://youtu.be/URpuKgKt9kg

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Family Nurture Intervention

- RCT of 150 babies in a NYC Level 4 NICU (Columbia University)
- Intervention is started as soon as possible after premature birth (26 to 34 weeks)
- Calm Cycle Theory is taught to parents
- Results include:
  - More mature EEG
  - Less parental anxiety
  - Less ASD

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Family Nurture Intervention: Explanation & Outcomes

https://youtu.be/cKXcgWDaDDQ

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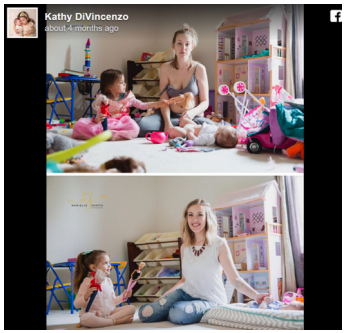
#4 - SUPPORT MATERNAL MENTAL HEALTH

- Depression is a common mental health diagnosis
- Treating mothers can result in better outcomes for babies
  - Improved toddler attachment
  - Improved toddler temperament
  - Improved maternal parenting efficacy



Developmental cascade effects of interpersonal psychotherapy for depressed mothers: Longitudinal associations with toddler attachment, temperament, and maternal parenting efficacy

Elizabeth D. Handley [a1], Louisa C. Michl-Petzing [a1], Fred A. Rogosch [a1], Dante Cicchetti [a1] [a2] ... DOI: https://doi.org/10.1017/S0954579417000219

Published online: 12 April 2017

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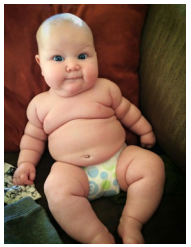
#5 - OPTIMIZE NUTRITION

- Growth is Brain
- Optimal Nutrition is Neuroprotective
  - Protein
  - Essential Fatty Acids
  - Mother's Milk
  - Infusion causes fat loss
- The Phenomenon Extra Uterine Growth Restriction is common (up to 35%)



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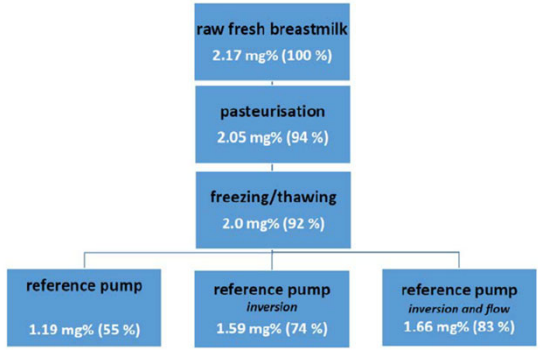

REFERENCE: *Igawa, Mio & Murase, Masahiko & Mizuno, Katsumi & Itabashi, Kazuo. (2013). Is fat content of human milk decreased by infusion?. Pediatrics International. 56. . 10.1111/ped.12248.*

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The 4 Pillars of Neuro-Nurturing NICU

• Neuro-Assessment – Clinical /pain assessment – Metabolic – MRI/MRS – Ultrasound – Follow up care	• Neuro-Monitoring – EEG – aEEG – NIRS – Hearing Screen – N-Trainer ®
• Neuro-Protection – Cooling – Medications – IVH Bundles (Head position, etc..)	• Neuro-Development – Parents – Positioning – Sensory Environment – Sleep – Pain/Stress/Separation – Nutrition

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HERE'S HOW:

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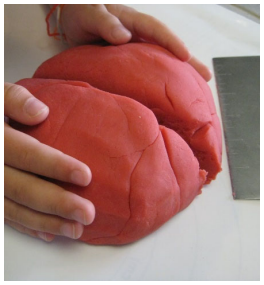
Every NICU is a Neuron-ICU

- Neuro-NICU's can be a:
  - QI project
  - Expanded Program
  - New unit design/environment
  - Change in culture



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Where you are now? Where do you want to go?

Practice	Personnel
Research/QI	Equipment

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Where to go from here….

- Pick an issue
  - Your #1 Issue = Passion
  - Your Easiest Issue = Success & Momentum

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Final Thoughts

- Brain injury is a reality of many infants in the NICU.
- The brain is the organ that has the greatest impact on long term quality of life and function.
- We have the opportunity to improve the quality of life of high-risk infants, and the quality of care provided through the expansion of new technologies, therapies, and practices.

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