


Neuro-Critical Nursing and Supporting the Developing Brain


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Dr Gayatri Jagan, MD, FRACP, CCNU
Consultant neurologist,
Neonatal Electrophysiology Clinical Lead,
Neonatal Follow-Up Program,
King Edward Memorial Hospital, Perth, Australia
Perth Children Hospital
University of Western Australia, Perth
Telethon Kids Institute, Perth, Australia



Who's at risk?

- Term (HIE, seizures, respiratory failure, metabolic disease, CNS infections, CNS malformations, late onset sepsis)
- Preterm (severe IVH, HIE, LOS, NEC)



Chawarapitboon et al, Lancet Global Health, 2019

Guiding on timing of involvement to minimise burden on personnel resources

Acuity of condition	Time of pediatric neurology evaluation	Expected duration of neurology involvement
Acute emergent conditions		
Encephalopathy (HIE, TH)	At admission	5-7 days
Seizures (clinical or electrographic)	At admission or recognition	3-7 days
Intracranial haemorrhage (eg: PVH)	At admission or recognition	3-7 days, weekly F/U
Vascular malformations with neurologic complications (AVM/VOGM)	At admission or recognition	3-7 days with F/U as needed
Perinatal stroke	At admission or recognition	3-7 days with F/U as needed

Neuro-critical care

- Dedicated neurological care, specialized neonatal medical and nursing expertise, neuro-monitoring, neuroimaging, neurodevelopmental care and long term follow up, allied health (EIC), social work, clinical psychology
- Aims:** Reduce neurologic injury and optimise long term neurodevelopmental outcomes
- Adults:** improved survival and reduced hospital stay
Suarez 2006, Kramer 2014
- Pediatrics:** evolving and recent studies show promising results
Vavilala 2014, Pineda 2013


Published experience?

- UCSF (2008-2009):** HIE (38%), seizures (35%), severe IVH (14%) and brain malformations (13%)
- cEEG (68%), aEEG (58%)
- Stanford (2013-2015):** heart disease (30%), extreme prematurity (18%), seizures (10%), and HIE (9%)
- cEEG (35%), aEEG (45%), NIRS (69%)
- Majority not for neurological diagnoses but for medical illness (>50% at UCSF and 62% at Stanford)


Guiding on timing of involvement to minimise burden on personnel resources

Acuity of condition	Time of pediatric neurology involvement	Expected duration
Subacute conditions		
CNS infections without acute complications (seizures)	At recognition during daylight hours	5-7 days
CNS malformations without acute complications (seizures)	At recognition during daylight hours	3-5 days
Syndromes with associated neurologic sequelae	At recognition during daylight hours	3-5 days
Ventriculomegaly	At recognition during daylight hours	3-5 days

Neonatal neuro-critical care



HIE and TH
Bedside neuro-monitoring techniques




Mulkey 2014, Bashir 2016, Van Meurs 2018, Harbert 2018

Framework for Neuro NICU team and guidelines for monitoring and neurology consult

Diagnosis	Suggested monitoring	Neurology consult
HIE or use of TH	aEEG, cEEG, NIRS	Yes
Seizures	aEEG, cEEG	Yes
ECMO or preECMO	NIRS, aEEG	As needed
Grade 3 IVH, PVH, hydrocephalus	aEEG	Yes, neurosurgery?
Critically ill or unstable	NIRS, consider aEEG	As needed
Birth <28 weeks GA	NIRS, consider aEEG	As needed
CNS anomalies	aEEG, cEEG	Yes
Metabolic disease	aEEG, cEEG	As needed
Cyanotic congenital heart disease	NIRS	As needed
CNS infection	aEEG, cEEG	Yes
Symptomatic PDA	NIRS	As needed
ALTE	aEEG	As needed

Team?



MDT

- Medical and nursing staff
- Specialists: neuroradiology, neurophysiology, neurosurgeons, developmental behavioural pediatricians
- Early intervention support (physiotherapy, occupational therapy, speech therapy)
- Social workers

Involving pediatric neurologists?

- Single dedicated neonatal neurologist: significantly ↑ number of consults, reviews per patient, variety of diagnoses and use of video EEG Mulkey 2014
- Dedicated vs rotating neurologists?
- Joint consultation is important

Neonatal neurologic examination

- **General assessment** (temperature, vitals, head size, fontanelle/s, sutures, scalp, swellings, auscultation, spine, skin: hypopigmented patches: tuberous sclerosis, facial hemangiomas: Sturge Weber syndrome, TORCH, dysmorphismis, atrophy/hypoplastic orbicularis oris muscle, arthrogyposis: congenital my. Gravis, myopathies, SMA)
- **Motor function**
- **Cranial nerves**
- **Reflexes** (superficial, deep tendon and developmental)
- **Sensory exam**
- **Behavioural assessment**

NNE: motor function

Active tone



Neuro-critical care at the bedside

- **Four domains:** assessment, monitoring, protection and development
 - **Assessments:** neurologic exam, Sarnat's staging, pain and sedation scores, additional by allied health teams, general movements
 - **Monitoring:** cEEG, aEEG, NIRS, neuroimaging
 - **Neuroprotective strategies:** integrate into ongoing care (IVH prevention bundles, positive touch, parental interaction, FiCare, skin-to-skin care, KMC, exposure to parental voice, music therapy, developmentally appropriate positioning and containment, less exposure to light and noise), parent education and empowerment, palliative care team
- Corde-Agullo 2016, Reynolds 2013, Scalo 2018, Coskey 2014, Webb 2015, Byers 2003, Shaw 2013, Piloquin 2016

NNE: motor function

- **Passive tone:** New Ballard's score: 28 weeks (popliteal angle, scarf sign)
- **32-34 weeks:** symmetrical, smooth, spontaneous movements
- **Term:** common physiologic: fragmented myoclonus, facial twitches, irregular respiratory movements
- **Sustained tremulousness beyond D4:** cortical dysfunction

Infant vertical suspension



Assessment

- Neonatal neurologic examination
- Reliable neurologic exam possible in **first 6 hrs** of life
- **Factors affecting:** passive tone and posture vary with GA
- ✓ Level of alertness (quiet sleep, active sleep, awake/drowsy, alert, crying)
- ✓ Experience of clinician
- ✓ Serial examinations
- ✓ Sedation from medications/ anaesthetics
- ✓ Hypothermia (including TH)

New Ballard score

Neuromuscular maturity	0	1	2	3	4	5
Posture	Relaxed	Relaxed	Relaxed	Relaxed	Relaxed	Relaxed
Neck extension	Flexion	Flexion	Flexion	Flexion	Flexion	Flexion
Arm flexion	Flexion	Flexion	Flexion	Flexion	Flexion	Flexion
Popliteal angle	180°	180°	180°	180°	180°	180°
Head lag	180°	180°	180°	180°	180°	180°
Head tilt	180°	180°	180°	180°	180°	180°
Head in line	180°	180°	180°	180°	180°	180°

The new Ballard score is used to estimate gestational age from neuromuscular and physical features. The scores of each feature are added to calculate a maturity rating that correlates with gestational age.

Adapted with permission from: Ballard JL, Khoury JC, Wedig K, et al. New Ballard Score, expanded to include extremely premature infants. *J Pediatr* 1991; 119:917. Copyright © 1991 Elsevier/Date.

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NNE: tone

- Hyper/hypotonia
- **Movement abnormalities:** jitteriness, seizures, hemiparesis, unilateral immobile upper limb (brachial plexus palsy), thoracic/ lumbar cord lesions (LL abnormal, UL normal), persistent choreo-athetoid movements (bilirubin encephalopathy, metabolic)

NNE: cranial nerves

- **CN I and II:** peppermint smell (32w), sternocleidomastoid muscle function: difficult to test in neonate
- **CN II:** blink to light (26w), fixation (32w), follow red cotton wool ball (34w), Turn to soft light (37w), optokinetic stimuli (36w)
- **CN II and III:** pupillary light responses (35w)
- **CN III, IV, VI:** Doll's eye response (25w)
- **CN V:** tactile stimuli, corneal reflex
- **CN VII:** blink eyelids
- **CN VIII:** startles or blinks w.r.t sudden noise
- **CN V, VII, IX, X, XII:** suck swallow
- **CN IX and X:** difficulty in swallow, palatal movements, weak or absent gag
- **CN XII:** tongue deviation/fasciculation

Sarnat staging for HIE

Stage	Stage 1	Stage 2	Stage 3
Level of consciousness	Hyperalert	Lethargic	Stuporous or comatose
Posture	Normal	Strong distal flexion, complete extension	Flaccid
Spontaneous activity	Normal or decreased	Decreased	No activity
Reflexes			
Suck	Weak	Weak/Incomplete	Absent
Moro	Strong, easily elicited		Absent
Autonomic system			
Pupils	Dilated	Constricted	Variable, unreactive to light, unequal
Heart rate	Tachycardia	Bradycardia	Variable
Respiration		Periodic breathing	Apnea
Seizures	None	Common	Uncommon

Pain and sedation scoring (32-60w)

6.3.3 CRIES

CRIES is a tool that measures the physiological and behavioral variables. Crying, 0 requires increased oxygen administration. Unreactive vital signs, 1, tachycardia, and tachypnea 0-2. The tool was validated on term newborns 32 and 36 weeks gestational age and demonstrated good predictive validity. Reliability (inter-rater agreement) scores and kappa values are 0.82 and 0.79, respectively. Construct validity was established by comparing scores pre- and post-analgesic administration with other validity measures (see table 1).

Criteria	Score
Crying	0-2
Respiratory rate	0-2
Heart rate	0-2
Intermittent facial grimacing	0-2
Sum of scores	0-8

NNE: reflexes

- **Superficial** (corneal, cremasteric, anal wink, Babinski: physiological)
- **Deep:** from 33w (jaw, triceps, brachio-radialis, knee)
- **Developmental**

Reflex	Description	Age	Disappears	CNS Origin
Moro	Startled facial → extension, flexion of arms, legs	Birth	6-8 mo	Brain stem vestibular nuclei
Grasp	Finger in palm → hand, elbow, abdominal flexion	Birth	4-6 mo	Brain stem vestibular nuclei
Rooting	Check stimulus → turns mouth to that side	Birth	4-6 mo	Brain stem trigeminal system
Trunk incurvation	Withdrawal from crawling along ventral surface	Birth	6-9 mo	Spinal cord
Plantar	Stimulus on plantar surface → flexion of foot (plantar)	Birth	4-6 mo	Cerebral cortex
Trunk neck	Flexion/extension when supine	Birth	4-6 mo	Brain stem vestibular nuclei
Prechtl	Stimulate full → extends arms	6-8 mo	Never	Brain stem vestibular

Pain and sedation scoring (28-40w)

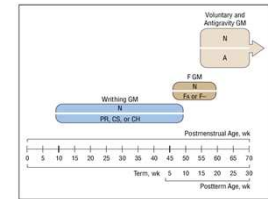
6.3.1 The Premature Infant Pain Profile (PIPP)

This tool consists of a seven-item 4-point scale that measures behavioral, physiological, and cerebral indicators (Fig. 8). These measures include gestational age, behavioral state, oxygen saturation, brow furrow, eye position, and mouthed behavior. Initial validity and study testing involved 1000 term and 1000 preterm infants and demonstrated good predictive validity. Reliability (inter-rater agreement) scores and kappa values are 0.82 and 0.79, respectively. Construct validity was established by comparing scores pre- and post-analgesic administration with other validity measures (see table 1).

Item	0	1	2	3	4
Behavioral state	Asleep	Quiet	Awake	Active	Very active
Oxygen saturation	90-94%	95-96%	97-98%	99-100%	100%
Brow furrow	No furrow	Minimal	Moderate	Severe	Very severe
Eye position	Midline	15-30°	30-45°	45-60°	60-90°
Mouthed behavior	None	Minimal	Moderate	Severe	Very severe

Precht's general movements

- Present at birth (writting) for 6-9 weeks and then change to fidgety (resolve by 20 weeks PMA)



NNE: sensory and behavioural

- **Sensory:** tactile, pain
- **Behavioural:** Newborn Behavioural Assessment Scale (NBAS) 27 behavioural responses and 20 reflex items

* Consolability - is assessed to assess in a crying infant. A number of techniques are used to try to calm the infant within 15 seconds. They include infant sucking on a pacifier or the examiner's finger, holding, placing a hand on the infant's belly, restraining one or both arms of the infant, soothing by voice, or a combination of a soothing voice and the examiner's face approaching the infant. Infants with brain injury are more difficult to console than a normal infant.

* Habituation - Habituation is a marker of cortical inhibitory function and measures the infant's ability to learn to diminish higher response to repetitive stimuli. The use of repeating light or auditory stimuli are used to test for habituation. The showing of a soft light visually elicits a blinking response that diminishes in intensity over the first four to five trials, and afterwards ceases with subsequent trials. Similarly, auditory stimuli, such as hand claps, elicit a startle response to the first four or five stimuli, after which there is little to no response. The lack of habituation is compatible with cortical dysfunction, which is exemplified by the behavior of an infant with prenatal substance exposure.

Pain and sedation scoring (23w-100 days)

6.3.2 Neonatal Pain Agitation and Sedation Scale (N-PASS)

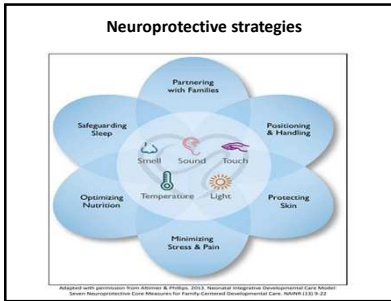
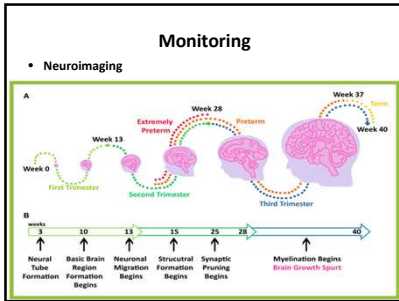
This tool consists of five indicators that have demonstrated reliability and validity as pain measures in various neonatal pain assessment scales (Fig. 9). These indicators are consolability, agitation state, facial expression, interocular distance, and vital signs. The tool was tested on term and preterm infants and demonstrated good predictive validity. Reliability (inter-rater agreement) scores and kappa values are 0.82 and 0.79, respectively. Construct validity was established by comparing scores pre- and post-analgesic administration with other validity measures (see table 1).

Assessment Criteria	0	1	2
Crying	No cry with or without painful stimuli	Mild or moderate cry with painful stimuli	High pitched or inconsolable cry
Behavior State	No response to any stimuli	Alertness, intermittently	Restless, squirming
Facial Expression	Neutral	Minimal	Any pain expression
Interocular Distance	Normal	Minimal	Any pain expression
Vital Signs	HR, BP, SpO2	HR, BP, SpO2	HR, BP, SpO2

Monitoring

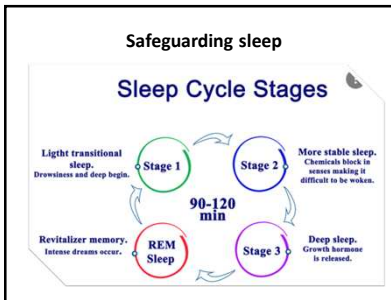
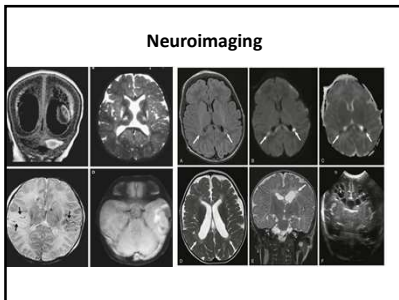
- cEEG, aEEG, video EEG

Required	Suggested	Considered
Seizure treatment	Acute intracranial hemorrhage, grade 3 & 4	ECMO (leaky)
Seizure evaluation	Acute intracranial hemorrhage	Inborn error metabolism
Suspected hypoxic ischemic encephalopathy (HIE)	Moderate & large subdural hemorrhage	Hydrocephalus
Suspected encephalitis	Head trauma	Encephalitis
Suspected seizures	Thrombotic thrombocytopenic syndrome	Meningitis
Characterization of spells	Processes involving cerebral edema & risk factors (e.g. HIE, ECMO patients, hypernatremia, non-ketotic hyponatremia)	
	Unexplained encephalopathy	
	Sedated or paralyzed patients at high risk for brain injury	
	Propagations	



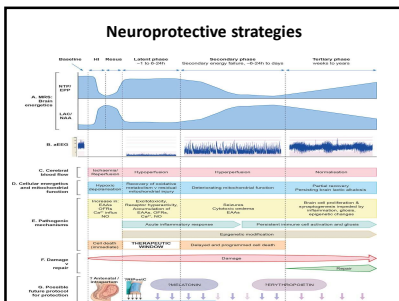
Positioning for success

- Aim for **containment**, rather than restraint
- Flexible enough to allow spontaneous movement, firm enough to limit excessive activity
- When possible, hands should be able to move towards face/mouth for self-comfort



IVH prevention bundle

- for infants <30 weeks GA for the first 72 hours of life
- ✓ Maintain neutral head position with head of bed up to the highest position
- ✓ No daily weights until day 4
- ✓ No holding or kangaroo care, but encourage parents to provide containment ("hand hugs") during this time as tolerated



Safeguarding sleep

- Protect sleep cycles, and especially REM sleep
- Use **spontaneous awake periods** for routine caregiving whenever possible
- Allow **rest periods** of at least 60 minutes to complete a normal sleep cycle
- Promote a **quiet environment** without loud noises to ensure uninterrupted sleep
- If necessary to wake up infant, approach using a soft voice followed by a gentle touch
- Protect eyes from bright lighting at all times and avoid use of overhead spot lights
- Maintain **dim ambient lighting** between "cares"
- Use **narcotics** and **sedatives** carefully, since both interfere with REM and non-REM sleep
- Facilitate prolonged **skin-to-skin** to promote normal sleep patterns

Positioning checklist

- Shoulders softly rounded forward?
- Hands towards midline, able to touch face/mouth if possible for self-comforting?
- Hips aligned and pelvis tucked?
- Knees, ankles, feet aligned and softly flexed?
- Neck neutral or slightly flexed, no hyperextension?
- Head midline, or turned slightly right or left?
- Avoid turning more than 45° to either side

Positioning

- **Prone positioning**
- ✓ Select appropriate size bedding. If infant is between sizes, use smaller size to prevent abduction of legs and shoulders, and to allow shoulders and hips to flex around the positioner
- ✓ Bottom of prone positioner should end around the umbilicus
- ✓ Avoid turning head to a full 90° angle by allowing it to rest slightly off edge of positioner



Handling with care

- Intracranial pressure (ICP) is lowest when the **head is midline** and the **HOB is elevated**.
- Caution should be taken **when changing diapers** to prevent sudden fluctuations in ICP when the feet are raised above the head.
- Important during the first several days of life for IVH prevention, but should also be **avoided** throughout hospitalization to minimize GI reflux.
- Avoid raising feet above head whenever possible
- Slide new diaper under infant and lift slightly at hips to remove old diaper
- To clean diaper area, lift knees to the chest while supporting the back and buttocks
- Consider placing the infant on one side to clean buttocks and diaper area

Protecting skin

- **Largest organ** of the body, and makes up about 13% of weight in a preterm, versus 6-10% of adult's weight.
- Sensory receptors (nociceptors) embedded at the dermal layer detect and transmit messages about touch, pain, pressure, and temperature.
- **Touch** is the **first** of the senses to develop early in fetal life, with sensory neurons found around the mouth and face by week 7, and covering the entire body by week 20.
- The foetus (and preterm infant) has **more sensory nerve endings** than the adult, which are closer to the surface of the skin.
- **Hands, feet, and mouth** are especially sensitive to touch due to the density of sensory nerve fibres

Handling with care



Preventing increased ICP

- Suction (ETT, deep nasal/oral) only when clinically indicated
- Minimize pain and stress
- Flush and draw from umbilical lines very slowly (1 ml over 30-45 seconds)

What can we do in NICU?

- Role model use of **gentle but firm touch**, which is tolerated better than stroking
- Use care to **minimize noxious touch** to the hands, feet, and mouth
- **Skin to skin care** (KMC) provides an excellent means of offering safe, nurturing touch
- Apply and remove **adhesives** cautiously, as these are the primary source of skin breakdown in the NICU

Handling with care

- Rapid and unsupported movement (such as the "**premie flip**") triggers **sensory distress** and **excessive motor activity**, as infants attempt to stabilize themselves to a fixed surface during the **vestibular disturbance**.
- **What can we do?**
- Minimize stress and support autonomic stability during rest and caregiving interventions by utilizing **careful handling** and **containment** techniques.
- Consider using a **second person** to assist with position changes for intubated infants.
- Whenever possible, **avoid disturbing infants** during sleep and try to use spontaneous awake periods for caregiving.
- If necessary to awaken infant, start with a **soft voice** followed by gentle touch

Swaddled bathing



Minimising stress

- Assess for **stress cues**, indicating need for containment and a pause to allow recovery
- Assess for **stability cues**, indicating that it is safe to continue caregiving or interaction
- Provide **nurturing touch** whenever possible, especially after caregiving or procedures
- Safeguard **sleep**

Cues

Stress (Disorganization) Cues	Stability (Organization) Cues
Physiologic/Autonomic System -Apnea, bradycardia -Respiratory pauses, tachypnea -Color changes (pallor or cyanosis) -Tremors, startles, twitches -Gagging, spitting up, straining -Greening, yawning, hiccoughing Behavioral/Motor System -Flaccidity (trunk, extremities, face) -Hypertonicity, arching -Finger splay, fisting -Facial grimace Behavioral/State System -Frazzled, diffuse activity -Rapid movement between states -Fussing, irritability -Glassy-eyed, staring, gaze aversion -Panicked, worried alertness Self-help Cues -Hand to mouth activity -Hands clasped -Grasping	Physiologic/Autonomic System -Maintains consistent color -Stable respirations -Reduction of tremors -Stable digestion Behavioral/Motor System -Smooth, well-modulated tone -Synchronous, smooth movements -Grasping and hand to mouth activity -Sucking Behavioral/State System -Clear, robust sleep states -Rhythmic, robust crying -Active self-quieting/consoling -Focused, shiny-eyed alertness -Intent, animated facial expression Self-help Cues -Seeking boundaries -Habituating to repetitive stimulation by entering into light sleep

- ### Partnering with parents
- Discuss infant's clinical condition and needs in a **culturally appropriate, clear** manner
 - Use **active, empathetic listening** with parents as they express their concerns and fears
 - Acknowledge and support where parents are in terms of the stages of grief and loss
 - Assist parents in accessing resources
 - Create a **welcoming environment** where parents know that they are valued
 - Allow parents to join in **infant's care** to the extent they choose, whenever they desire
 - Encourage containment ("**hand hugs**") both during and after caregiving
 - If able to do so without awakening, allow parents to provide containment during sleep
 - Parents may hold "between" cares as tolerated, but stress the critical need for infant to sleep as much as possible
 - Encourage parents to **read to infant** when awake to support language development
 - Promote skin-to-skin as soon as possible, as often as possible, for as long as possible
 - Empower parents to **recognize and respond** to infant cues appropriately
 - Explain that when dealing with infants, "**the infant leads and the adult follows**"
 - **Help parents** become competent in infant care, building confidence towards discharge
 - Support parents as they evolve into their roles as expert and advocate for their child

- ### Team education and training
- Didactic sessions and hands-on training
 - Neurologic examination skills, neuroanatomy, seizure recognition and management, knowledge about common neurologic conditions, aEEG application and interpretation, NIRS application and interpretation, TH equipment use, neuroimaging, neuroprotective bundles, palliative care and long term follow up
 - Parent support group
 - Highly trained Neuro NICU educator!

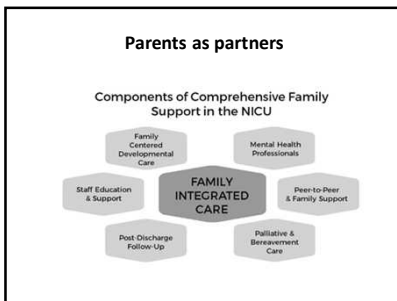
Never forget!

- **Managing pain** (non-pharmacologic; containment, NNS, sucrose, skin-to-skin, breastmilk, and pharmacologic measures)

- **Optimising nutrition**

- ### Nurturing environment
- Temperature
 - Touch
 - Vestibulo-stimulation/ proprioception (KMC)
 - Taste and smell
 - Sound and noise (cochlear cell damage when >85Db): aim <45Db
 - Lighting and vision

- ### Team education
- Checking annual competence of nursing and medical staff
 - Development of guidelines, checklists and training modules
 - Significant reduction in time to initiate monitoring, increase in electrographic seizure detection, decrease in clinical seizure misdiagnosis, reduction in seizure medication burden
Van Meurs 2015

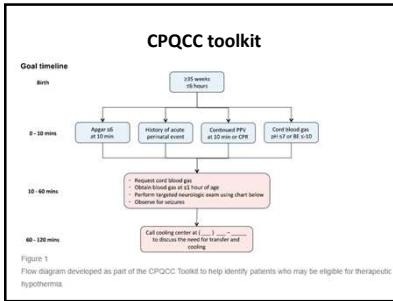


- ### Lighting and vision
- Protect sleep, especially **REM sleep**
 - Use **adjustable lighting** at each bedside, strive towards a day/night cycle for the NICU
 - Use **minimal amount** of light needed to accurately assess and manage infant
 - Consider the use of penlights and flashlights whenever possible
 - **Protect eyes** from direct light during assessments, rest periods, and after pupil dilation for ROP exams
 - Use **heavy incubator covers** to limit excessive light exposure during sleep, underside of these covers should be solid and dark colored to minimize unnecessary visual stimulation
 - **Limit visual stimuli** early on, with focus on parent's faces

- ### Advances in neuro-critical care
- **TH for HIE**
 - 4 large trials of TH, 33.5 deg C for 72 hours... reduced risk of death or moderate-severe disability at 2 yrs
Gluckman 2005, Accorardi 2006, Simbruner 2010, Shankaran 2005
 - **NNT: 7 to spare 1 child death or moderate-severe disability**
 - **2010:** Neonatal task force of ILCOR supported TH for HIE
 - **Most TH centres** use: evidence based protocol (92%), neurology consultation (92%), aEEG or EEG (88.5%), MRI interpreted by paediatric neuro-radiologists (71%), developmental follow-up (93%)... California
 - **Critical to offer:** a EEG (70%), MRI (69%), OT and PT (67%) and developmental follow-up (94%), minimum of 10 HIE patients/year
Harris 2014, Wusthoff 2018

Improve screening for HIE

- QI initiatives
- **CPQCC** (California Perinatal Quality Care Collaborative) toolkit since 2015
- Transfer of neonates needing TH from regional and peripheral centres
- **Factors a/w ineffective screening:** lack of cord or neonatal blood pH or base deficit measurements, delay in call for transfer (2.4 hrs for those with HIE who received TH vs. 12.6 hrs for those with HIE but not treated), annual volume of births (<500 births/yr: only 69% eligible were transported for TH)
- Ongoing education is IMPORTANT



Applications beyond NICU

Review: Acta Paediatr. 2019 Nov;109(11):1965-1971. doi: 10.1111/apa.14546. Epub 2019 Aug 30.

Neurocritical care of high-risk infants during inter-hospital transport

Nedham Gupta^{1,2}, Lara Shipley³, Nitin Goel⁴, Kathryn Browning Campo⁵, Andrew Leslie⁶, Don Sharkey⁷ &

CPQCC toolkit

Improving seizure detection and management

- Most seizures subtle and all abnormal movements are not seizures
- Continuous video EEG is gold standard
- Unclear whether management of seizures improves outcome, but ongoing seizures worsen brain injury and affect outcomes
Wilder 2002, Haber 2013, Khuroochankay 2016
- Use standardized protocol driven treatment improves consistency and outcomes
- Reduced exposure to anti seizure medications improved feeding and hospital length of stay outcomes
- Lower risk of epilepsy in later age when managed by a neuro-critical service
Glass 2018

Key messages

- Improved neonatal care, routine surfactant use, antenatal steroids, antenatal magnesium sulphate
- **Survival without disability is the ultimate goal!**
- Neuro-critical care is an emerging concept in neonatology but reiterated through HIE related therapies
- Providing safe, evidence based neuro-critical care is an important strategy to achieve optimum outcomes for high-risk infants and their families

Field BMJ 2008, Lemons 2001, Fanaroff 2007, Bado 2006, Horbar 2012, Costelloe 2012

CPQCC toolkit

Improving neurologic care and outcomes for preterm infants

- Antenatal steroids and magnesium sulphate
Mercer 2006, Roberts 2017, Schmid 2013, McLendon 2003
- Delivery at a tertiary perinatal centre
- Golden hour management (platinum phase)
- Head position, rates of drawing blood and volume administration, ventilation strategies with avoidance of hyper or hypo carbia, temperature control, BP management, low stimulation environments, reduction of prematurity related complications (BPD, NEC, LOS)
- Specialised area in NICU
(Small Baby Units)

Thanks for listening