

Developing a Neuro NICU

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Susan Hintz

Kathi Randall

Sonia Bonifacio

Disclosures

- I have no conflicts of interest
- I will discuss off-label use of anti-epileptic drugs (AEDs) for treatment of neonatal seizures

Learning Objectives

At the conclusion of this activity, participants should be able to...

1. Summarize the benefits of a designated Neuro NICU
2. Debate the benefits and drawbacks of requiring specific certification for cooling centers
3. Evaluate opportunities to provide enhanced brain care in your NICU

A Newborn with Seizures

- 41-week boy readmitted on day 5 with suspected seizures, lethargy
- Normal pregnancy, maternal UTI at 36 weeks
- Delivery vacuum-assisted with 3 pop-offs, “difficult”
- One day of phototherapy for jaundice, then discharged home
- Day 4- sleepier, feeds less
- Day 5- two seizures → 911
- Are these seizures?
- What is the cause?
- How can we customize treatment?

Outline

- Why a Neuro NICU?
- Models of Neonatal Neurology Care
- The LPCH Neuro NICU
- Improving brain care at your center


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- Why a Neuro NICU?
- Models of Neonatal Neurology Care
- The LPCH Neuro NICU
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Why a Neuro NICU?

- NICU survival is improving
- Neurodevelopmental outcomes are a priority
- Technology has improved to allow better neuromonitoring, imaging and intervention
- Converging expertise in fetal medicine, neonatology, neurology, neuroradiology, neurosurgery, developmental pediatrics

Neonatal Neurocritical Care Service Is Associated With Decreased Administration of Seizure Medication

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1-7
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and Hannah C. Glass, MDCM, MAS^{2,5}

• Cooling

Original Article

Implementation of a Neurocritical Care Program: Improved Seizure Detection and Decreased Antiseizure Medication at Discharge in Neonates With Hypoxic-Ischemic Encephalopathy

Rani Ameena Bashir MD^a, Liza Espinoza MD^a, Sakeer Vayalthrikkovil MD^a,
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Time to electroencephalography is independently associated with outcome in critically ill neonates and children

*†¹Iván Sánchez Fernández, *¹Arnold J. Sansevere, *Rejean M. Guerriero, *Ersida Buraniqi,
*Phillip L. Pearl, ‡Robert C. Tasker, and *Tobias Loddenkemper

Epilepsia, 58(3):420–428, 2017

doi: 10.1111/epi.13653

Outline

- Why a Neuro NICU?
- Models of Neonatal Neurology Care
- The LPCH Neuro NICU
- Improving brain care at your center

The first Neuro ICN



- Dedicated Neuro-Intensive Care Nursery
 - Virtual unit in 58-bed intensive care nursery
 - Cohort of trained NICN nurses
 - Co-management model with a Neonatal Neurology Service in-unit
- 150 consults/year
 - 75% transferred for specialized care
 - 2/3 term, 1/3 preterm
 - 50% have primary neurologic diagnosis

Neuro Expertise as a NICU Resource

- Hammersmith Hospital & Imperial College NHS
 - Referral Center for West London
 - Neurologist within a NICU
 - Consulted on 1-3 babies per week
- Currently over 12 “Neuro NICUs nationwide”
 - Neonatal Neurology
 - Designated neonatal neurologist



Imperial College Healthcare 
NHS Trust

Tele-Neuro-NICU

- Kaiser Permanente Northern California – non-profit integrated health care delivery network with >3.8 million members, ~35,000 births per year
- 13 pediatric neurologists provide phone or in-person consultation to 21 hospitals
- In-person coverage at 2 Level III NICU's (22 and 24 beds), phone consults at other sites
- 1-3 in-person NICU consults/week (1 in 5 call)
- Special interest in vascular neurology, High Risk Infant Follow-up Clinic 3 days/month

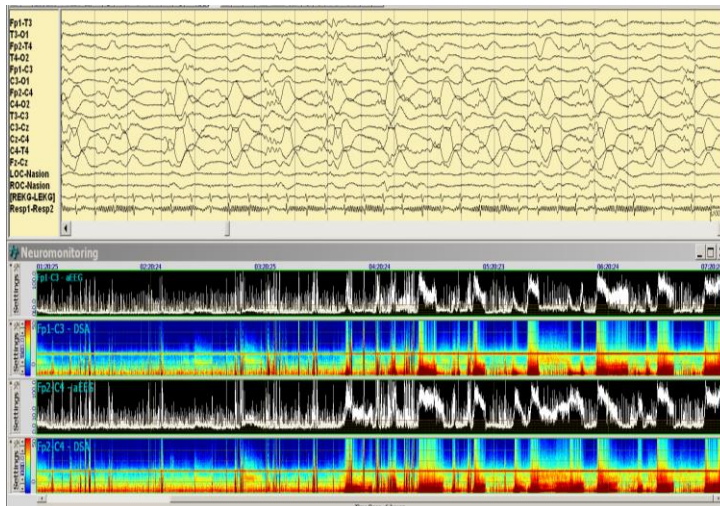
Tele-Neuro-NICU

ORIGINAL ARTICLE

Telemedicine for genetic and neurologic evaluation in the neonatal intensive care unit

TL Wenger^{1,2}, J Gerdes³, K Taub⁴, DT Swarr^{1,3}, MA Deardorff¹ and NS Abend⁴

37 of 39 abnormalities on neuro exam identified (92%) in pilot study



- Tele-EEG rapidly growing nationwide

Special Case: Cooling Centers



State of California—Health and Human Services Agency
Department of Health Care Services



EDMOND G. BROWN JR
Governor

DATE: November 17, 2016

Numbered Letter: 06-1116
Index: Program Administration

TO: CALIFORNIA CHILDREN'S SERVICES (CCS) PROGRAM COUNTY
ADMINISTRATORS, MEDICAL CONSULTANTS, AND STATE SYSTEMS
OF CARE DIVISION OFFICE STAFF

SUBJECT: PROGRAM REQUIREMENTS FOR PROVIDING NEONATAL
THERAPEUTIC HYPOTHERMIA

I. PURPOSE

This Numbered Letter (N.L.) describes minimum requirements for CCS Program-approved Neonatal Intensive Care Units (NICUs) to provide therapeutic hypothermia services to neonates.

California Cooling Centers

- In 2013, Bay Area Cooling Summit began to discuss voluntary standards for sites
- Workgroups targeted specific aspects
 - Training/education
 - EEG/aEEG
 - Ancillary services
- A 2014 survey by Sonia Bonifacio assessed current practices and desired practices of 54 California neonatologists
 - 65% were already cooling

Table 2. Therapeutic Hypothermia Centers ^a				
		n		%
Type of TH	Selective head cooling	1		2.4
	Whole body cooling	37		88.1
	Both	4		9.5
TH protocol used	Yes	42		100.0
TH protocol based on one used in a randomized controlled trial	Yes	39		92.9
	No	1		2.4
	Don't know	2		4.8
Neurology consulted for neonates who receive TH ^b	Yes	39		92.9
	Depends	1		2.4
	No	0		0.0

Table 2. Therapeutic Hypothermia Centers ^a				
		n		%
Brain monitoring used	Yes	37		88.1
	No	5		11.9
Type of brain monitoring ^c	aEEG	13		31.0
	EEG	4		9.5
	both aEEG and EEG	21		50.0
	Don't know	1		2.4
Percent of MRIs reviewed by Pediatric Neuroradiologist	None	7		16.7
	< 50%	5		11.9
	50-99%	4		9.5
	100%	26		61.9
Percent of neonates treated with TH referred for follow-up	<50%	0		0.0
	50-99%	3		7.1
	100%	39		92.9

Practices Important for Providing Safe & High Quality TH

- **Critical** – essential service, should be required at all cooling centers
- **Recommended** – important or advisable, but hospital could perform cooling without this
- **Optional** – may be desirable, but not all required for every cooling center
- **No Opinion**

Table 3. Opinions about Providing Therapeutic Hypothermia		Community/ Intermediate Centers ^a		Regional Centers ^b		Total	
		n	%	n	%	n	%
Pediatric Neurologist available to consult	Critical	19	57.6	10	47.6	29	53.7
	Recommended	10	30.3	10	47.6	20	37.0
	Optional	3	9.1	0	0.0	3	5.6
Nursing Staff trained in TH	Critical	29	87.9	16	76.2	45	83.3
	Recommended	3	9.1	5	23.8	8	14.8
Access to Developmental Followup	Critical	32	97.0	21	100.0	53	98.1
	Recommended	0	0.0	0	0.0	0	0.0
	Optional	0	0.0	0	0.0	0	0.0
Palliative Care Team	Critical	11	33.3	3	14.3	14	25.9
	Recommended	13	39.4	14	66.7	27	50.0
	Optional	7	21.2	3	14.3	10	18.5
	No Opinion	1	3.0	1	4.8	2	3.7
OT/PT available to consult	Critical	24	72.7	15	71.4	39	72.2
	Recommended	6	18.2	6	28.6	12	22.2
	Optional	2	6.1	0	0.0	2	3.7

Table 3. Opinions about Providing Therapeutic Hypothermia		Community/ Intermediate Centers ^a		Regional Centers ^b		Total	
		n	%	n	%	n	%
aEEG monitoring throughout TH	Critical	22	66.7	16	76.2	38	70.4
	Recommended	5	15.2	4	19.0	9	16.7
	Optional	5	14.2	0	0.0	5	9.3
	No Opinion	0	0.0	1	4.8	1	1.9
Continuous video EEG monitoring	Critical	7	21.2	5	23.8	12	22.2
	Recommended	12	36.4	10	47.6	22	40.7
	Optional	13	39.4	5	23.8	18	33.3
	No Opinion	0	0.0	1	4.8	1	1.9
Continuous video EEG monitoring available 24/7	Critical	7	21.2	3	14.3	10	18.5
	Recommended	8	24.2	10	47.6	18	33.3
	Optional	15	45.5	7	33.3	22	40.7
	No Opinion	1	3.0	1	4.8	2	3.7
Pediatric Neuroradiologist review MRI	Critical	13	39.4	6	28.6	19	35.2
	Recommended	15	45.5	10	47.6	25	46.3
	Optional	3	9.1	5	23.8	8	14.8
	No Opinion	1	3.0	0	0.0	1	1.9

Table 3. Opinions about Providing Therapeutic Hypothermia		Community/ Intermediate Centers ^a		Regional Centers ^b		Total	
		n	%	n	%	n	%
From quality perspective, is there a minimum number of neonates to be treated							
	No	10	30.3	5	23.8	15	27.8
	Yes	22	66.7	16	76.2	38	70.4

- In practice, median number of cooled infants at each site was 12/year
- Respondents suggested a minimum volume of 10 neonates/year

Special Case: Cooling Centers



State of California—Health and Human Services Agency
Department of Health Care Services



EDMOND G. BROWN JR
Governor

- Cooling Centers shall treat 6 patients annually
- If <12 patients per year, have a formalized relationship with a regional center of expertise
- Neonatologist working in conjunction with a pediatric neurologist and clinical nurse specialist
- Child neurologist available for consultation at all times, at minimum by phone
- cEEG available, at minimum, during regular hours
- cEEG must be interpreted within 24 hours
- All babies get either cEEG or aEEG for duration of cooling and rewarming
- All infants must perform on site MRI prior to discharge, to be interpreted by a neuroradiologist with experience in neonatal brain imaging

Outline

- Why a Neuro NICU?
- Models of Neonatal Neurology Care
- The LPCH Neuro NICU
- Improving brain care at your center

The LPCH Neuro NICU

- Patients
 - Which patients?
 - When/for how long?
- People
- Technology
 - Neuromonitoring
 - Neuroimaging
 - Neuroprotection
- Training & Research
- Care after the NICU

What is the LPCH Neuro NICU?

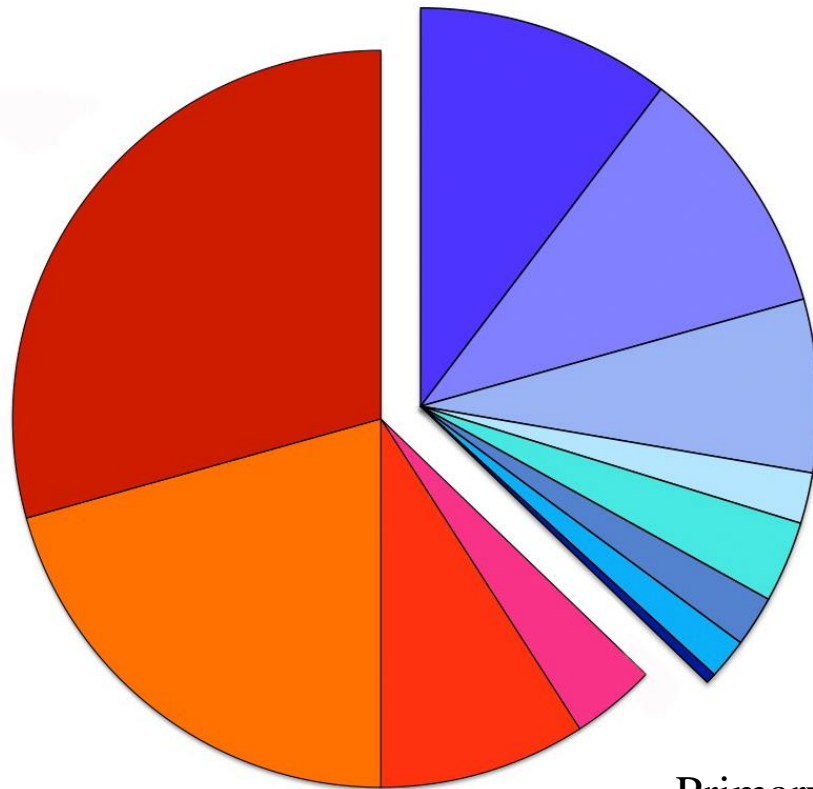
- 6 bed virtual unit within a unit
- Opened April 2013
- Emphasis on training, communication, and high quality interdisciplinary care
- Joint daily Neuro NICU rounds
- Core team of >70 Neuro NICU trained RNs
- In our first year, 220 babies received care in the Neuro NICU

The NNICU Top ~~10~~ 13

Diagnosis	LOS	Monitoring	Neuro consult
HIE/cooling	7-10	aEEG/cEEG & NIRS	Yes
Seizures	7	aEEG/cEEG	Yes
ECMO/pre-ECMO	7	NIRS	PRN
Critical/unstable	7	NIRS & consider aEEG	PRN
Preemie <29 weeks	7-10	NIRS	PRN
Grade III/IV or hydrocephalus	7	aEEG/cEEG	Yes
Metabolic disease	7	aEEG/cEEG	PRN
CNS anomalies/Primary neurologic disorders	7	aEEG/cEEG	Yes
Cyanotic CHD	7	NIRS	PRN
CNS infection	7	aEEG/cEEG	Yes
Symptomatic PDA	7	NIRS	PRN
Brief Resolved Unexplained Event /ALTE	3	aEEG	PRN
Indirect Hyperbilirubinemia >95 th %	3	aEEG & NIRS	PRN

2013-2014 NNICU Admissions

- 247 patients
- 28% of NICU volume
- 64% had a non-neurological primary diagnosis
- 42% preterm



Primary Medical Diagnoses

- Cyanotic CHD (29.3%)
- Extreme Prematurity < 28 weeks (20.7%)
- Critical/Unstable (9.1%)
- Metabolic Disease (3.7%)

Primary Neuro Diagnoses

- Seizure (10.3%)
- HIE/Cooling (10.3%)
- Neuro Concerns w/o firm diagnosis (7.0%)
- Meningitis (5.2%)
- Grade III/IV IVH/Hydrocephalus (3.3%)
- Neural tube defects (2.1%)
- CNS anomalies (1.7%)
- Stroke (0.4%)

People: Interdisciplinary Care

- Designated Neuro NICU nurses
- Neonatology providers
- Neurology consult service
- Developmental care team
- Neurosurgery, Neuroradiology
- High Risk Infant Follow-Up Clinic

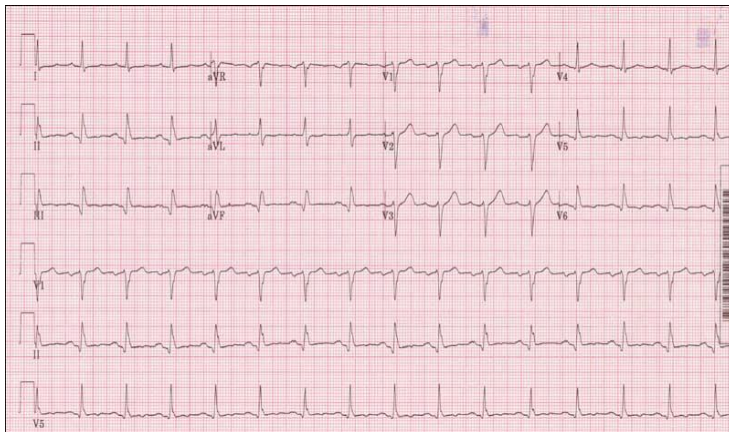
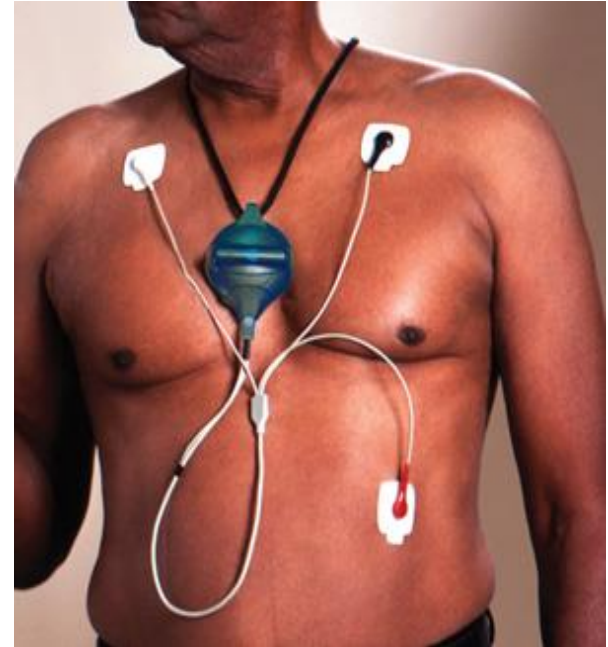
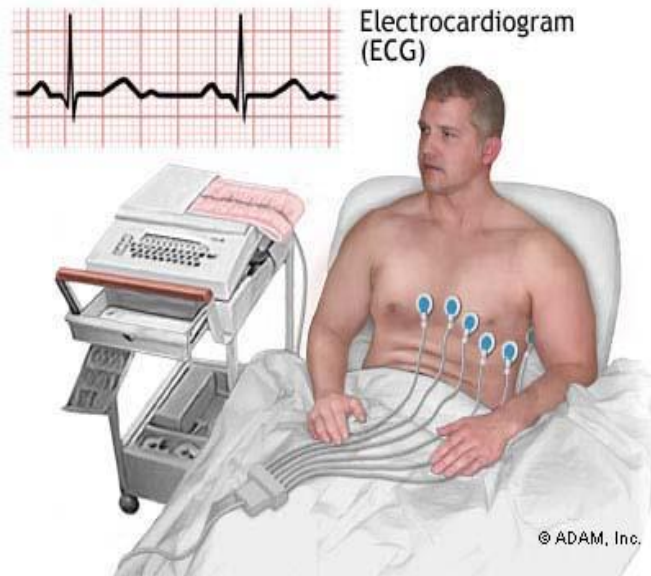
Technology: Brain Monitoring

- Continuous Video-EEG monitoring
- Amplitude-integrated EEG (aEEG)
- Near Infrared Spectroscopy (NIRS)
- Complimentary, bedside tools used in conjunction with clinical assessment and other diagnostics
- Provide real-time information about brain function

Brain Monitoring: EEG

- Video EEG monitoring available 24/7
- Remote review by pediatric neurophysiologists
- Standard care for neonates with suspected seizures
- Evidence-based protocols for high risk patients

ECG vs Screening Telemetry



Technology: When to get (a)EEG?

- When there is an obstacle to the neuro exam, but information on brain function is needed
- To formulate prognosis
- Any baby where seizures are suspected
- In neonates at high risk for seizures
- To assess response to treatment



Technology: Impact of Monitoring

- Implementation of cEEG in a Neuro NICU¹
 - 51%→ 48% with clinically diagnosed seizures
 - 34%→ 53% had seizures on EEG
 - 0%→ 14% with subclinical seizures diagnosed
 - 70%→ 37% discharged on antiseizure medicine
 - 62.2 mg/kg→ 46 mg/kg mean phenobarbital
- cEEG and aEEG Influences Management²
 - Spot EEG only vs aEEG vs cEEG
 - Adjust risk of antiseizure med use ↓67%
 - With aEEG ↓38%

1. Bashir RA. Pediatric Neurology. 2016

2. Jan S. Dev Neurosci 2017

Technology: Impact of Monitoring

- Monitoring with a standard treatment protocol²
 - Phenobarbital levels 56.8 → 41 ug/ml
 - Status epilepticus 46 → 36%
 - Length of stay decreased 9.7 days
- Neurocritical care service with VEEG²
 - Received 30 mg/kg less phenobarbital
 - 5 fewer days seizure medicine

1. Harris ML. J Child Neurol 2016
2. Wietstock SO. J Child Neurology 2015

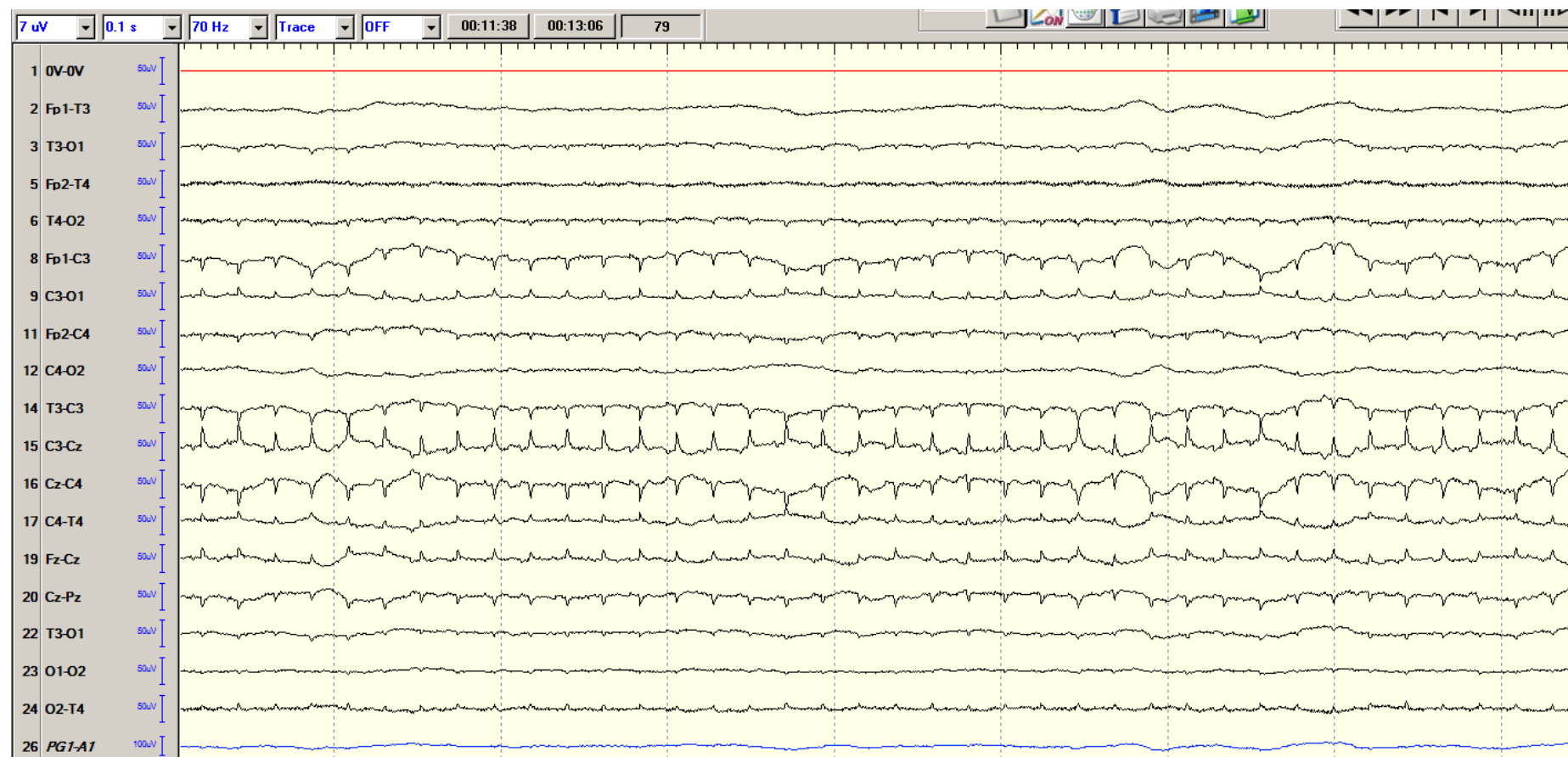
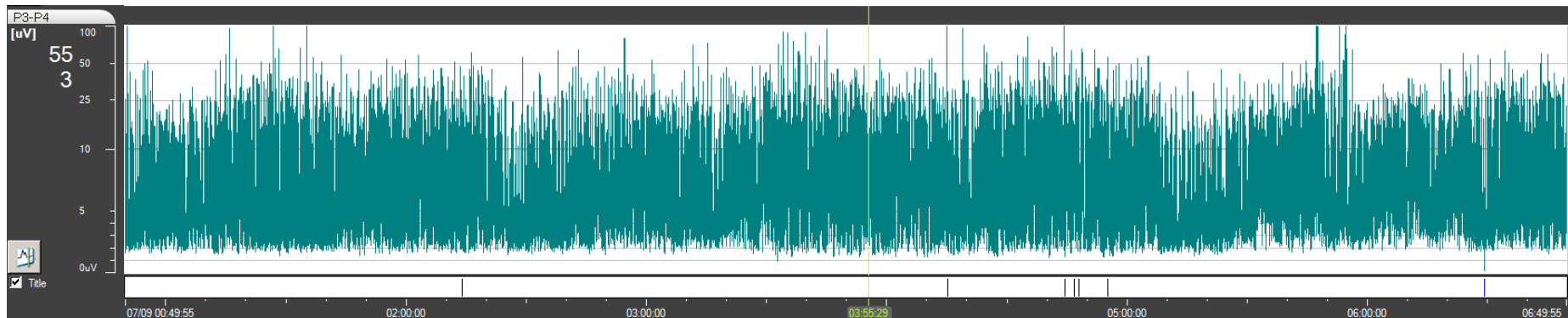
www.acns.org/guidelines.cfm

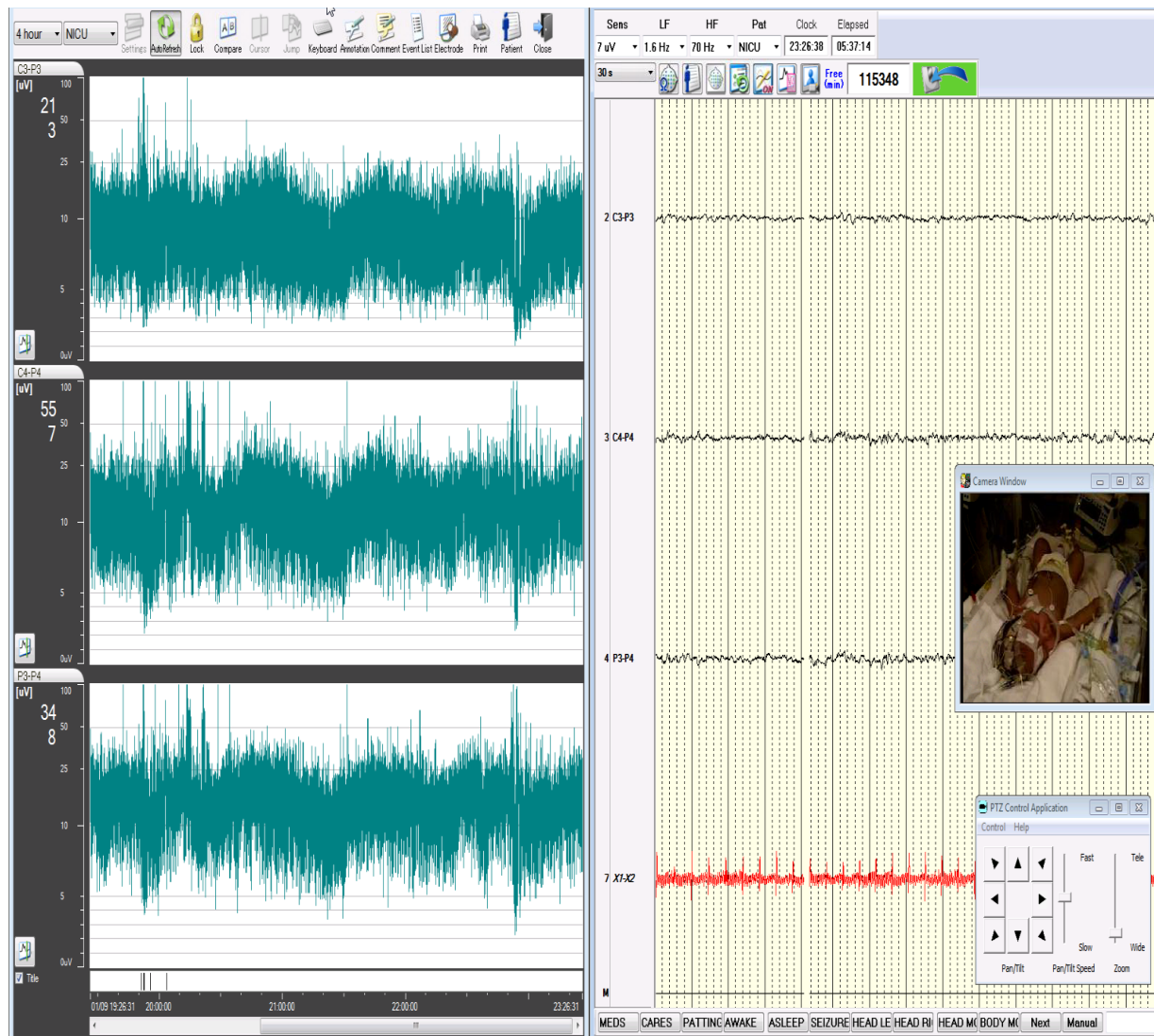
ACNS GUIDELINE

The American Clinical Neurophysiology Society's Guideline on
Continuous Electroencephalography Monitoring in Neonates

Renée A. Shellhaas, Taeun Chang,† Tammy Tsuchida,† Mark S. Scher,‡ James J. Riviello,§ Nicholas S. Abend,||
Sylvie Nguyen,¶ Courtney J. Wusthoff,# and Robert R. Clancy||*

J Clin Neurophysiol 2011;28: 611-617





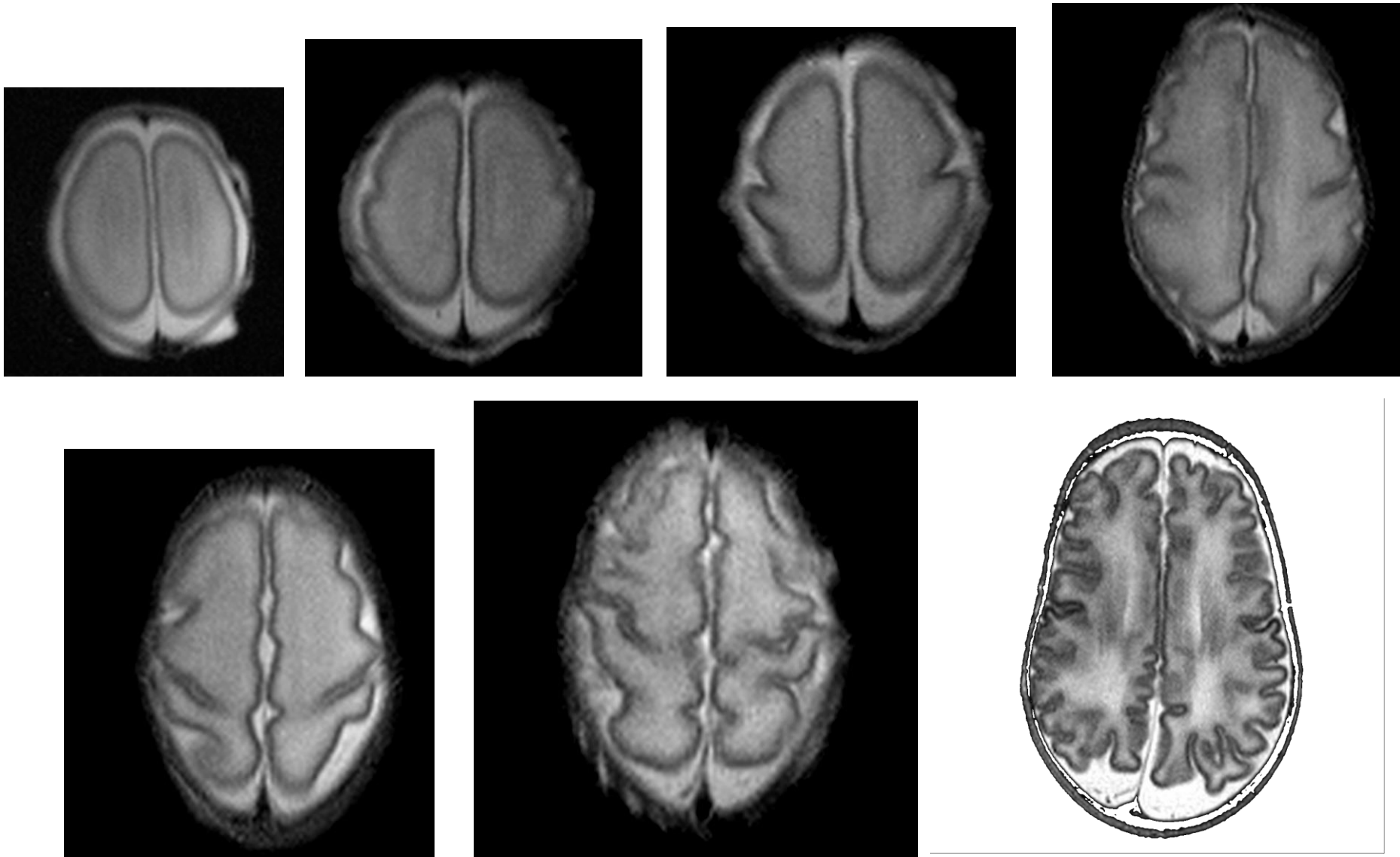
Technology: NIRS

- Near Infrared Spectroscopy (NIRS)



Technology: Imaging

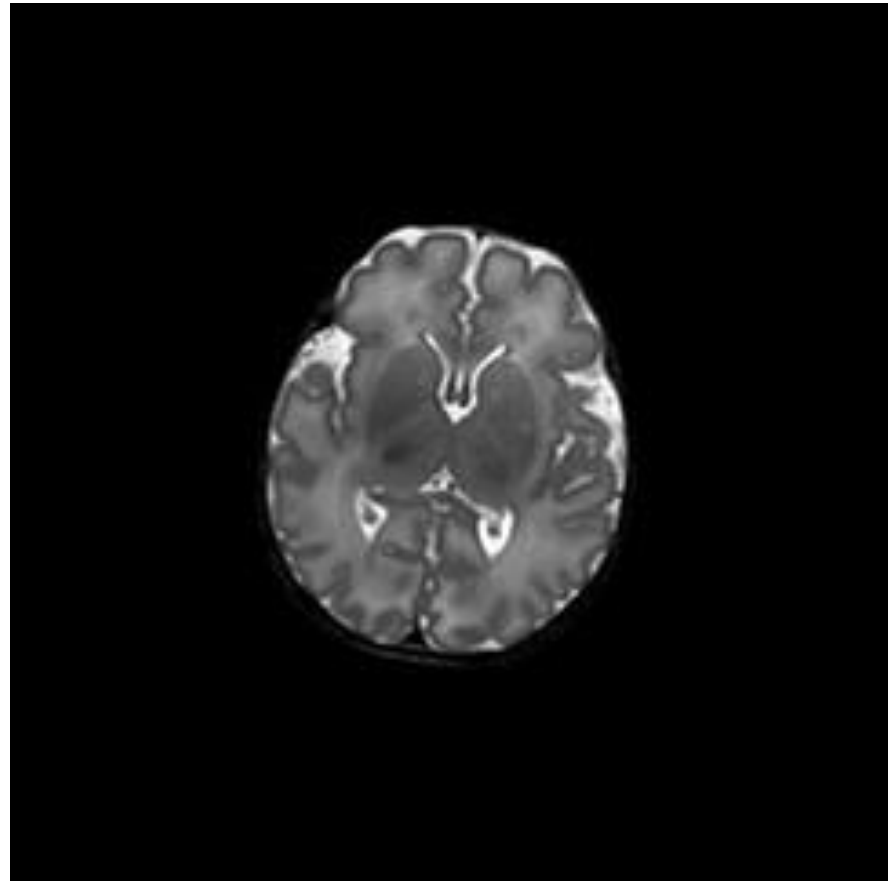
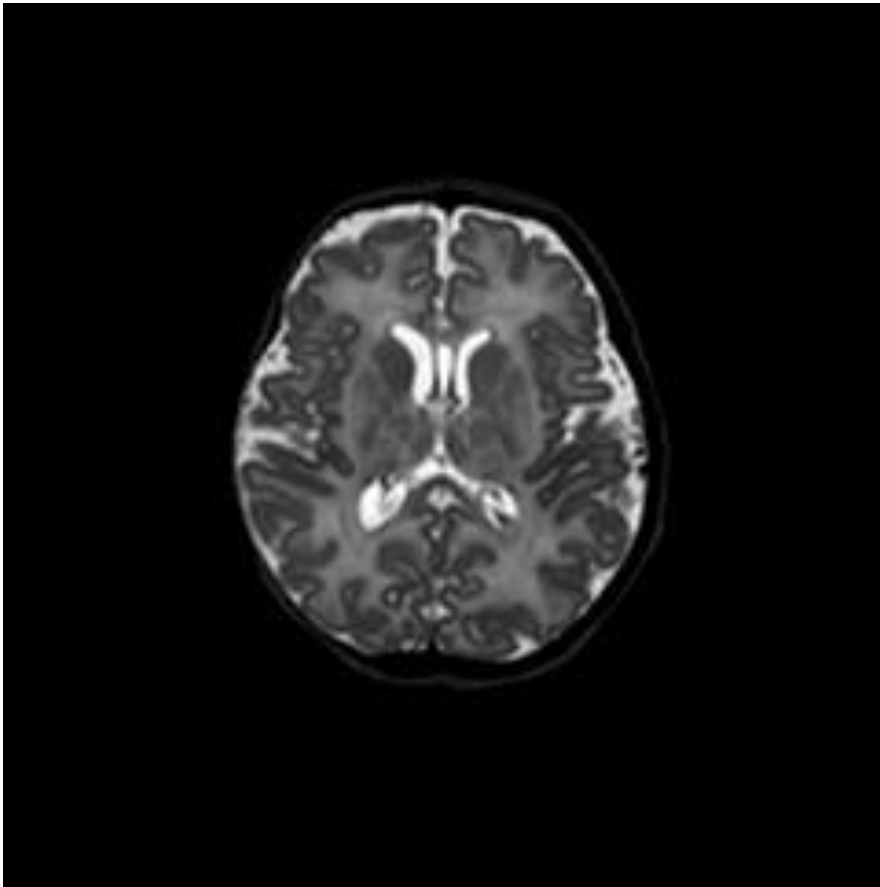
Brain development from 24 to 40 weeks gestation

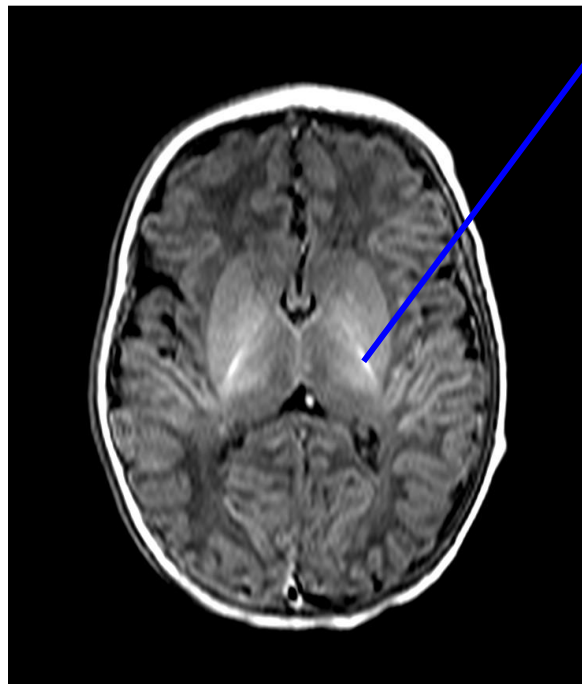
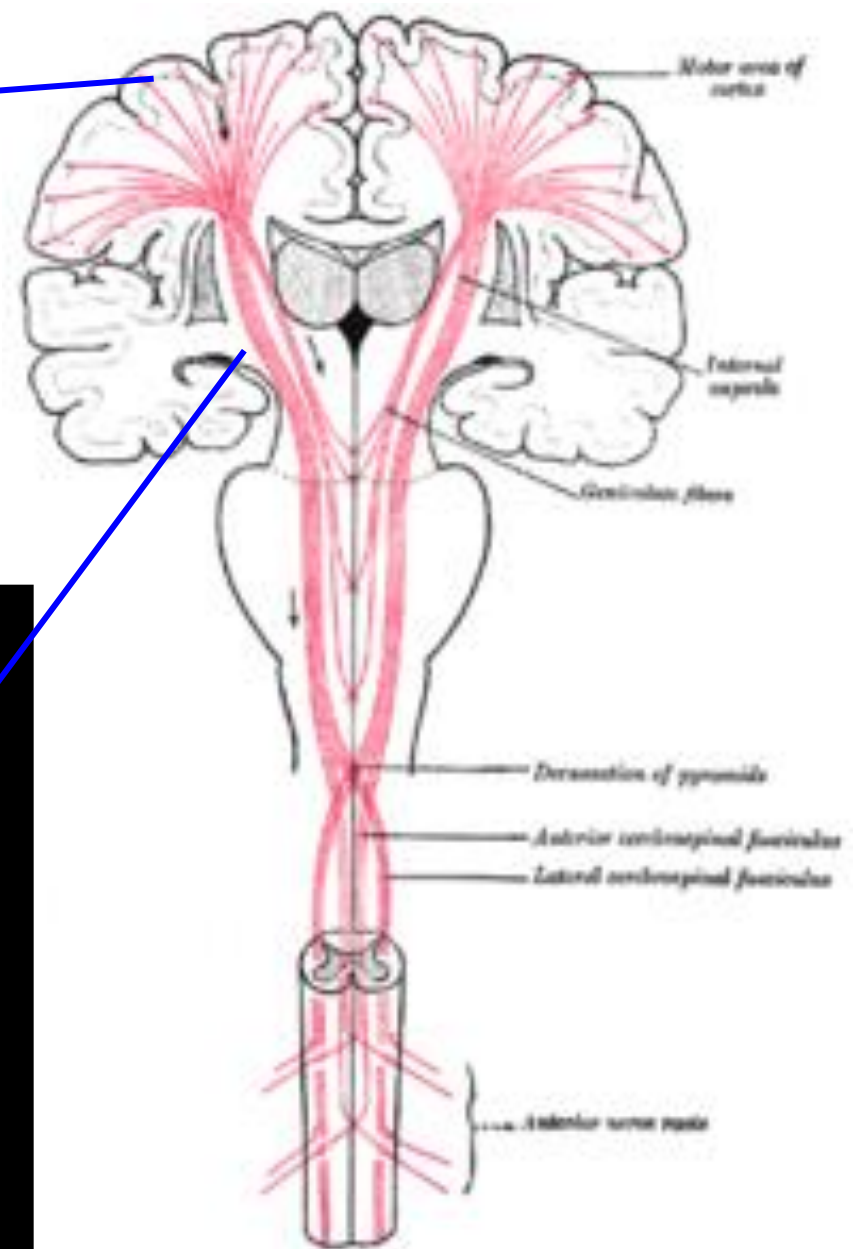
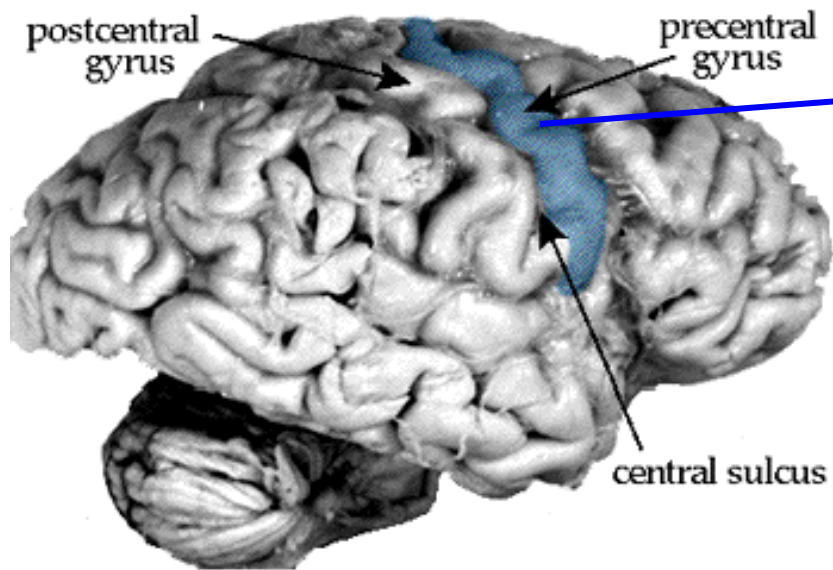




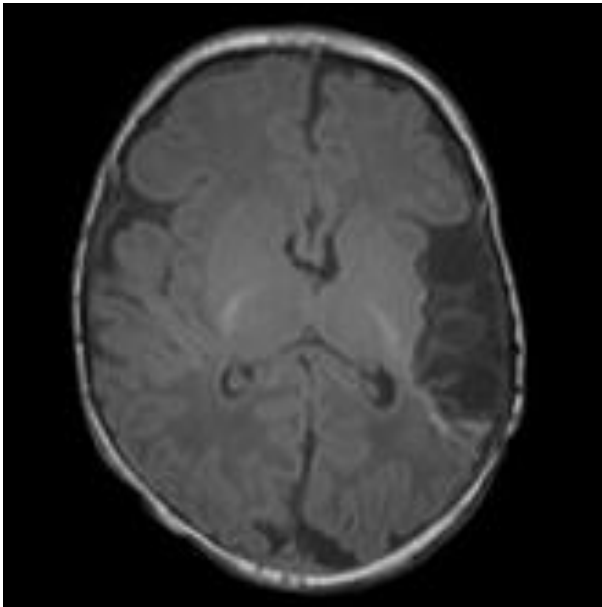
Can neurologists
say anything
useful about
prognosis?

Imaging: Two newborns with HIE

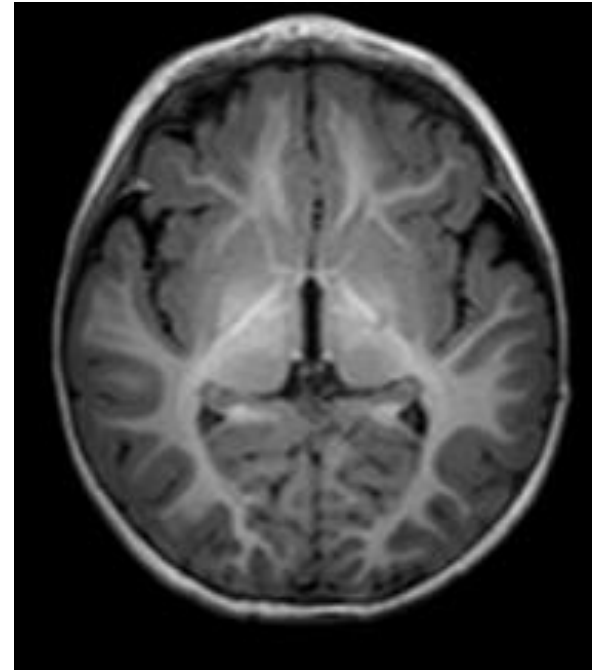




Imaging & Prognosis



No hemiplegia



Hemiplegia

Neuroprotection: Developmental Care

“(Although) Nursing has been limited to signify little more than the administration of medicines.....It ought to signify the proper use of air, light, warmth, cleanliness, quiet, and the administration of diet.”

Florence Nightingale, 1859

Teaching: Team Training

- Med Students, Peds Residents, Neuro Residents, NICU Fellows, Visiting Trainees
- Neuro NICU Training course
 - >70 team members graduated to date
- Quarterly Skills Workshops
 - Neuro examination of the neonate
 - Use of therapeutic hypothermia
 - aEEG use and interpretation
- Weekly Perinatal Case Conference
- “5-minute Friday” team teaching
- Regional Outreach (MCCPOP)



Research

NNICU Database

Page 1 of 10

NNICU Database Admission Data

Study ID

NNICU Admission Data

LPCH Admit Year and Month (YYYY-MM) [Found in H&P or Discharge Summary](#)

(Please enter just year and month in this field)

Date and time of birth [Found in Delivery Summary or H&P](#)

(Enter exact date and time of birth in this field.)

Date of LPCH Admission [Found in Discharge Summary](#)

(Enter date)

Date of NNICU admission [Found in NNICU database \(excel\)](#)

(Enter date)

Date of LPCH discharge [Found in Discharge Summary](#)

(Enter date)

Length of NNICU Admission (Calculated)

(This field will automatically calculate)

wusthoff

[Home](#)[WebAuth Login](#)[Log in with WebAuth](#)

The Neurologic Exam for Neonates with Suspected Encephalopathy

Best viewed using Firefox or Chrome. May not be compatible with all versions of Internet Explorer.

Encephalopathy is defined by the presence of one or more signs in at least three of the following six categories:

- level of consciousness
- spontaneous activity
- posture
- tone
- primitive reflexes
- autonomic nervous system

When findings are mixed, the extent of encephalopathy is determined by which category describes the majority of signs. If signs were equally distributed, categorize based on the level of consciousness.

Diagnostic Table

	Normal	Mild Encephalopathy	Moderate Encephalopathy	Severe Encephalopathy
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Diagnostic Table

	Normal	Mild Encephalopathy	Moderate Encephalopathy	Severe Encephalopathy
Level of consciousness	When awake, alert, fixes on visual stimuli (see example)	Irritable, hyperalert, poor feeding, excess crying alternating with sleeping	Lethargic (see example)	Stupor or coma
Spontaneous activity	Frequent spontaneous movements (see example)	Increased, jittery (see example)	Decreased activity	No activity (see example)
Posture	Extremities flexed in toward the trunk (see example)	Slight flexion, slight extension (see example)	Distal flexion, complete extension (see example)	Decerebrate
Tone	Normal (see example)	Normal or slightly increased (see example)	Hypotonia (focal or general) (see example)	Flaccid (see example)
Primitive	Strong	Uncoordinated	Weak or	Absent

Care After the Neuro NICU

- High Risk Infant Follow Up
 - Standard for all Neuro NICU grads
 - In-depth developmental evaluations
- Neurology Follow Up
 - Offered to all Neuro NICU grads
 - With Neonatal Neurologist or the inpatient consulting physicians
- Outpatient Neonatal Neurology Clinic
 - Referrals accepted from outside NICUs
 - Outpatient referrals for neonates and young infants

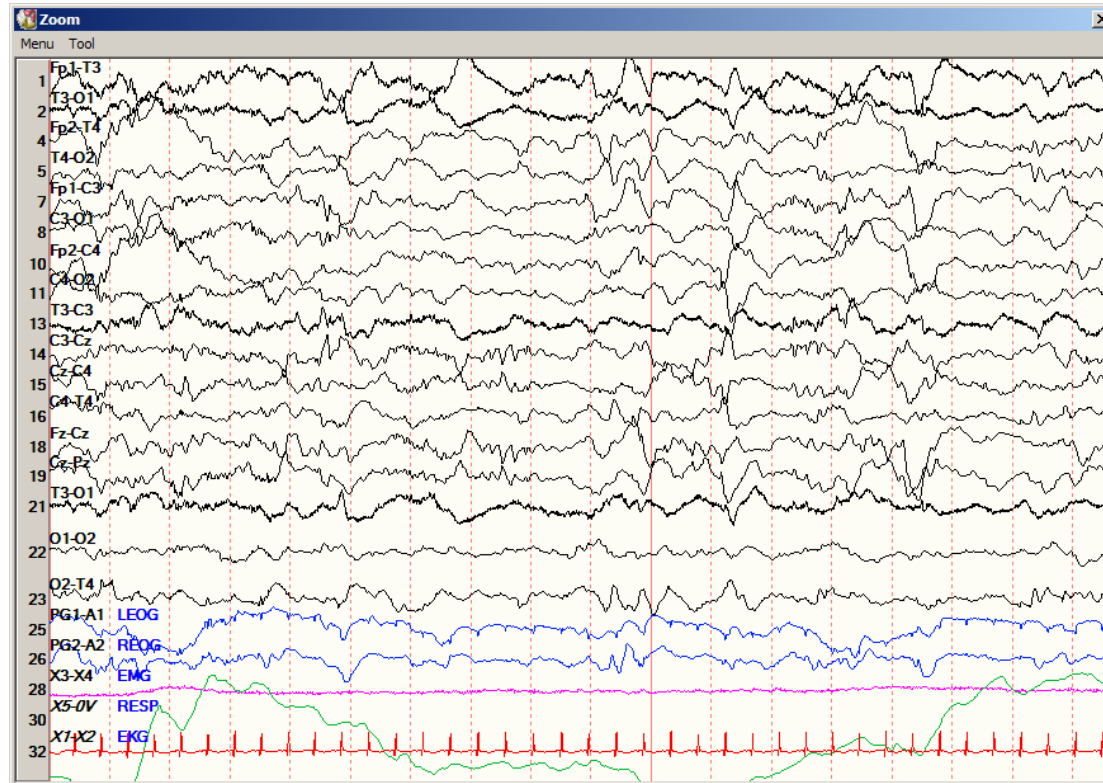
Back to Our Case...

A Newborn with Seizures

- 41-week boy readmitted on day 5 with suspected seizures, lethargy
 - Normal pregnancy, maternal UTI at 36 weeks
 - Delivery vacuum-assisted with 3 pop-offs → “difficult” delivery
 - One day of phototherapy for jaundice, then discharged home
 - Day 4- sleepier, feeding less
 - Day 5- two shaking episodes → parents called 911
- Are these seizures?
 - What is the cause?
 - How can we customize treatment?

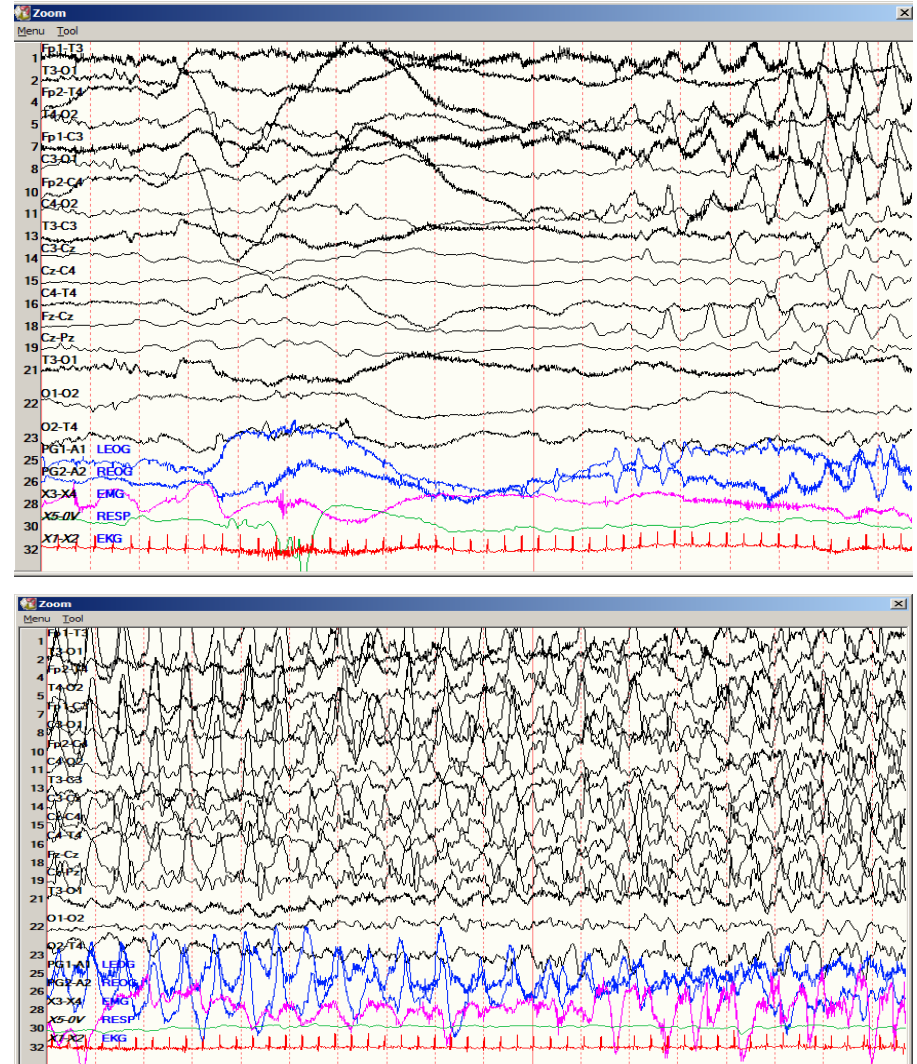
EEG Monitoring

- First hour: Abnormally slow background with sharps
- Next hour: More of the same



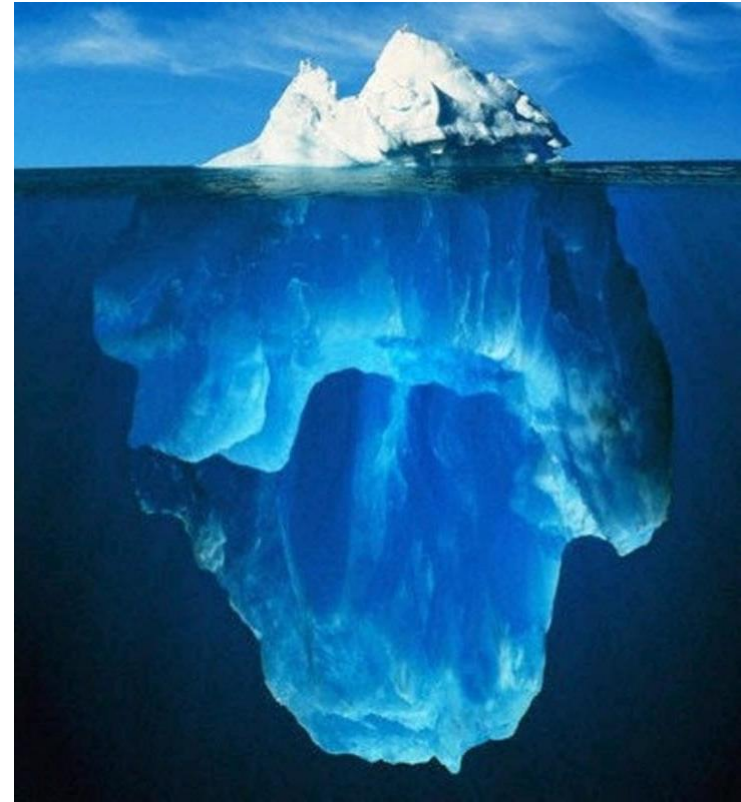
EEG Clues

- Seizures confirmed on EEG
- 5 seizures over the next 24 hours; 3 are identified at the bedside, 2 are recognized only on video EEG.
- Multiple medications given, with seizure frequency gradually improving
- Still encephalopathic
- Why?

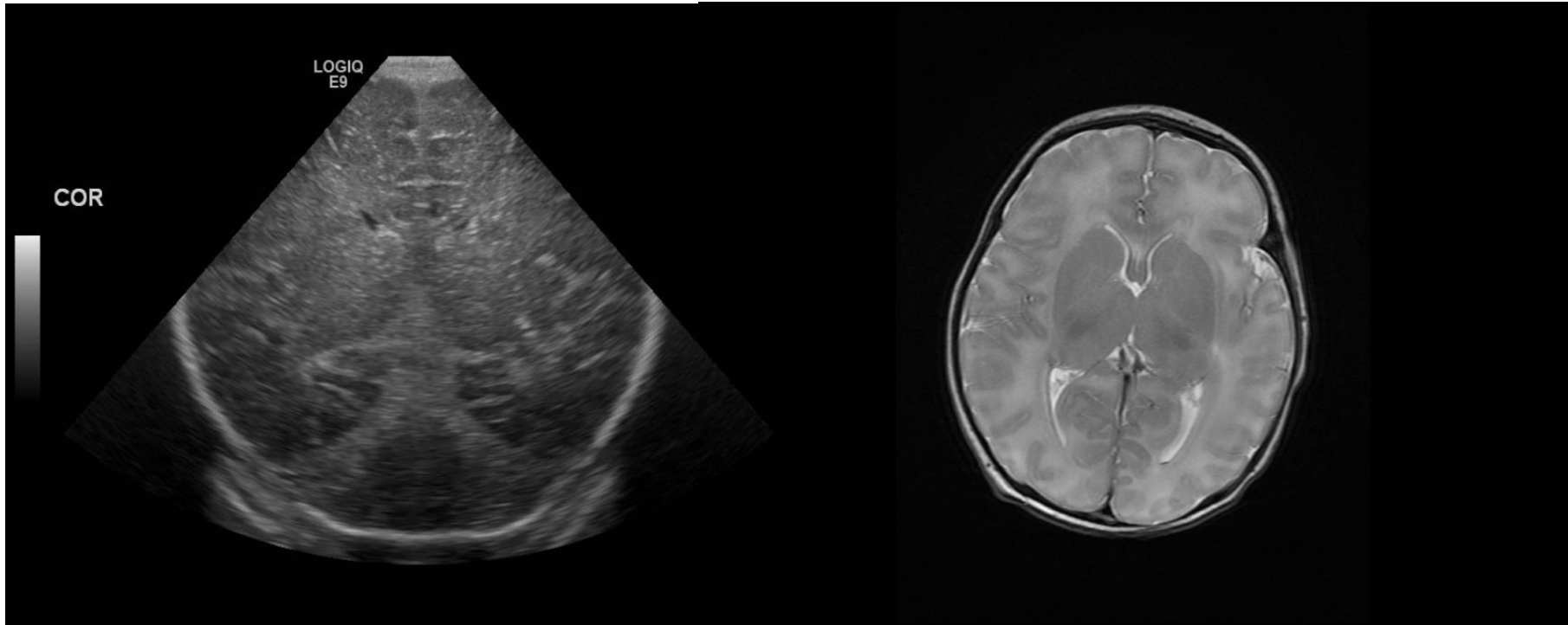


Most Neonatal Seizures are Symptomatic

- ~80% of neonatal seizures are symptomatic of acute brain injury
- Common causes:
 - Cerebral hypoxia-ischemia (~50% in US)
 - Stroke/hemorrhage (15-30%)
 - Infection
 - Malformations
 - Electrolytes/hypoglycemia
- ~20% due to early-onset epilepsy
 - KCNQ2 mutations most common
 - Brain malformations/other syndromes



Neuroimaging



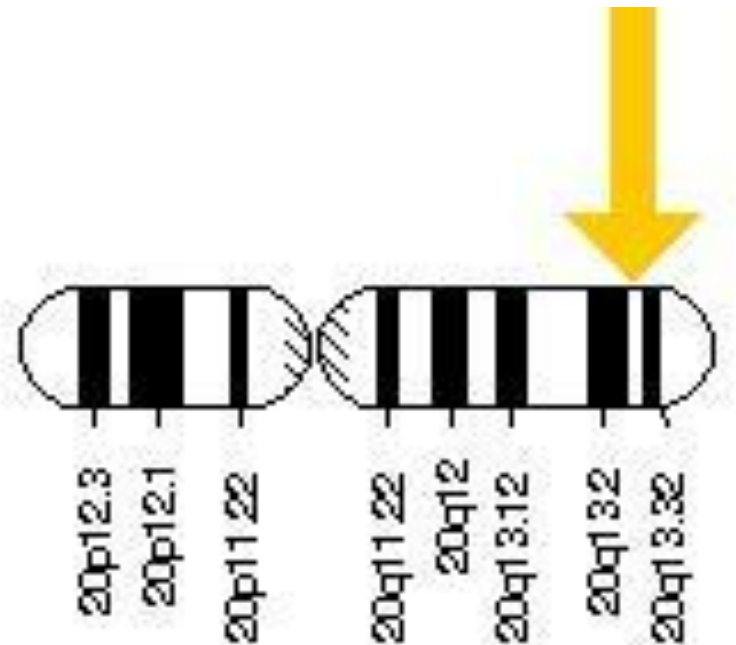
- Brain imaging normal
- Lab studies normal
- Evaluation for infection negative

Talking with Parents

- Parents very concerned that vacuum assisted delivery related to seizures
- Mother had been offered C-section, but wanted to try for vaginal delivery, which led to VAVD
- Parents worry that their decision had caused baby harm
- Father's nephew (patient's cousin) has ADHD and mild developmental delays
- Father learns his own brother (patient's uncle) had "mild seizures" as a young child, which he outgrew before adulthood

Genetic Testing Performed

- Based on this history, a provisional diagnosis of Benign Familial Neonatal Seizures (BFNS) is made
- Genetic testing confirms a heterozygous mutation in the KCNQ2 gene
- Known cause of BFNS



KCNQ2 and Neonatal Seizures

- BFNS occurs in <2/10,000
- Frequent, brief seizures start day 2-3
- Typically tonic or clonic seizures (not myoclonic)
- Often difficult to control
- Otherwise healthy baby
- Normal MRI, variable EEG findings
- Seizures spontaneously resolve ~4 months
- Most commonly caused by KCNQ2 mutations, less commonly KCNQ3 mutations

Ronen GM et al, Neurology 1993

Ronen GM et al, J Pediatr 1999

Wusthoff CJ, J Ped Epilepsy 2012

Outline

- Why a Neuro NICU?
- Models of Neonatal Neurology Care
- The LPCH Neuro NICU
- Improving brain care at your center

Improving Brain Care at Your Center

- Gather stakeholders
- Inventory strengths and assets
- Identify 1-3 targets for first round
- Start by building on strengths:
 - Cooling
 - Seizures
 - IVH
 - Nursing
 - Developmental care
 - Fetal Medicine
 - Genetics
 - Neurosurgery
 - Neuroradiology
 - HRIF/DB Peds
 - EEG
 - aEEG
 - NIRS
 - Ultrasound

Brain Care at Your Center

- Patients
 - Which patients?
 - When/for how long?
- People
- Technology
 - Neuroprotection
 - Neuromonitoring
 - Neuroimaging
- Training & Research
- Care after the NICU

References

- Lena Hellström-Westas, Linda S. de Vries, Ingmar Rosen, eds. An Atlas of Amplitude-Integrated EEGs in the Newborn, Second Edition. (Encyclopedia of Visual Medicine Series) CRC Press, 2008.
- Glass HC, Wusthoff CJ, Shellhaas RA. Amplitude-Integrated Electroencephalography: The Child Neurologist's Perspective. J Child Neurol. 2013;28(10):1342-50.
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- Shah NA, Wusthoff CJ. How to Use: Amplitude-integrated EEG (aEEG). Archives of Disease in Childhood Education & Practice. Online ahead of print 2014 July 17.

<https://people.stanford.edu/wusthoff/neurologic-exam-neonates-suspected-encephalopathy-0>

More Information

- <http://neonatology.stanford.edu/ClinicalCare/NeuroNICU.html>

The screenshot shows a web browser window displaying the Stanford Neuro-NICU Clinical Care page. The browser's address bar shows the URL <http://neonatology.stanford.edu/Clinical-Care/Neuro-NICU.html>. The page features a navigation bar with links for HEALTH CARE, RESEARCH, EDUCATION, GIVE, and ABOUT. Below the navigation bar is the Stanford Medicine logo and the text "Division of Neonatal and Developmental Medicine In the Department of Pediatrics". The main content area is titled "CLINICAL CARE" and includes a sidebar with links to "About Us", "Clinical Care", "Fetal and Pregnancy Health Program", "ECMO", "Lucile Packard Children's Hospital Stanford", "Neuro-NICU", "Quality Improvement and Safety", "Satellite NICUs", "Education", "Research", "Outreach Education and Consultation", and "Resources". The main text area is titled "NEURO-NICU" and contains a paragraph describing the unit's mission and goals. To the right of the text is a photograph of three healthcare providers attending to a newborn in a NICU bed. Below the text is a section titled "PILLARS OF CARE" with two numbered items: 1. NEUROMONITORING and 2. NEUROASSESSMENT.

CLINICAL CARE

About Us
Clinical Care
Fetal and Pregnancy Health Program
ECMO
Lucile Packard Children's Hospital Stanford
Neuro-NICU
Quality Improvement and Safety
Satellite NICUs
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Research
Outreach Education and Consultation
Resources

NEURO-NICU

In April 2013, Stanford launched its Neuro-Neonatal Intensive Care Unit (Neuro-NICU), which is housed within the Level III Intensive Care Nursery at Lucile Packard Children's Hospital Stanford. Preterm and term newborns at risk for brain injury and future developmental problems are cared for by a specially trained team of care providers using advanced neurodiagnostic techniques and treatments. The goal is to provide a developmentally appropriate environment to optimize neurologic and developmental outcomes. The newborns admitted to the Neuro-NICU include infants with hypoxic ischemic encephalopathy, seizures, infants being evaluated for or treated with ECMO, grade III/IV intraventricular hemorrhage, hydrocephalus, extreme prematurity with gestational age ≤ 28 weeks, central nervous system (CNS) infections, CNS anomalies, metabolic disease, and cyanotic congenital heart disease.

We are one of a handful of such units in the nation. Led by medical director [Krisa Van Meurs, M.D.](#) and with neurology director [Courtney Wusthoff, M.D.](#), the Neuro-NICU was built out of a growing need to help babies not only survive but also thrive. Many babies who are born premature or suffer from encephalopathy immediately after birth are at risk for neurodevelopmental problems, ranging from mild to significant impairments.

Our multidisciplinary team works together not only at the bedside, but in regular meetings to direct the work of the Neuro-NICU and plan for the future. Our Steering Committee includes representation from the Departments of Family Centered Care, Rehabilitation Services, Social Work, Child Neurology, Neurophysiology, Neonatology, Developmental-Behavioral Pediatrics, and our High-Risk Infant Follow Up Clinic, as well as representatives from Nursing Administration, NICU Staff Nurses, Neonatal Nurse Practitioners, Clinical Nurse Specialists and Educators. Preparing for a baby's transition from the Neuro-NICU to her home is an important component of our care model. We have close relationships with subspecialty services, therapists and follow-up care providers that help to ensure optimal outcomes for our newborns.

If you are a physician, nurse or therapist and want to view our Neuro NICU Educational Materials, [click here](#).

PILLARS OF CARE

1. NEUROMONITORING: We routinely use non-invasive neuromonitoring such as near-infrared spectroscopy (NIRS), amplitude-integrated electroencephalography (aEEG), and continuous video electroencephalography (cVEEG or vEEG) for infants in the Neuro-NICU.
2. NEUROASSESSMENT: We train our team on the importance of a focused newborn neuro examination, using standardized assessment



•Questions?