St. Marien KINDER Krankenhaus

aEEG and NIRS in the clinical setting (NICU)

espnic
European Society of Paediatric and Neonatal Intensive Care

MCN
MEDIZINCAMPUS
Niederbayern

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Disclosure

No conflict of interest to disclose.

What is Neuromonitoring ?

Labratory biomarkers, Microdialysis

Ultrasound, TCD, MRI, fMRI, CT

Clinical, e.g. Scores

Near-infrared spectroscopy (NIRS),

Cardiac output, oxygenation, blood pressure, ICP, CPP etc.

EEG, cEEG,

aEEG

bispectral index monitor (BIS)

density spectral array (DSA)

Somatic evoked potentials

Use right tools or all at once to see more…

Neuromonitoring	Clinics	CUS	aEEG/EEG/EP	NIRS	MRI
neonatal seizures	±	+	++	–	++
Asphyxia/HIE	++	+	++	+	++
Intracranial bleeding/ IVH/PHH	±	++	++	+	+
congenital heart disease	+	+	++	++	+
extremely preterm infant (<28wks)	+	++	++	±	+
Stroke (arterial/venous infarction)	±	+	+	–	++
Enzephalitis/Meningitis	+	±	++	–	+
cerebral malformation	+	+	+	–	++
metabolic disease	+	±	+	–	+

aEEG - Useful indications

Perinatal asphyxia / HIE

Monitoring for seizures or clarifying apneas

Monitoring of antiepileptic drugs / sedation / relaxation

Course of Encephalopathy, e.g. metabolic diseases, Meningoencephalitis etc.

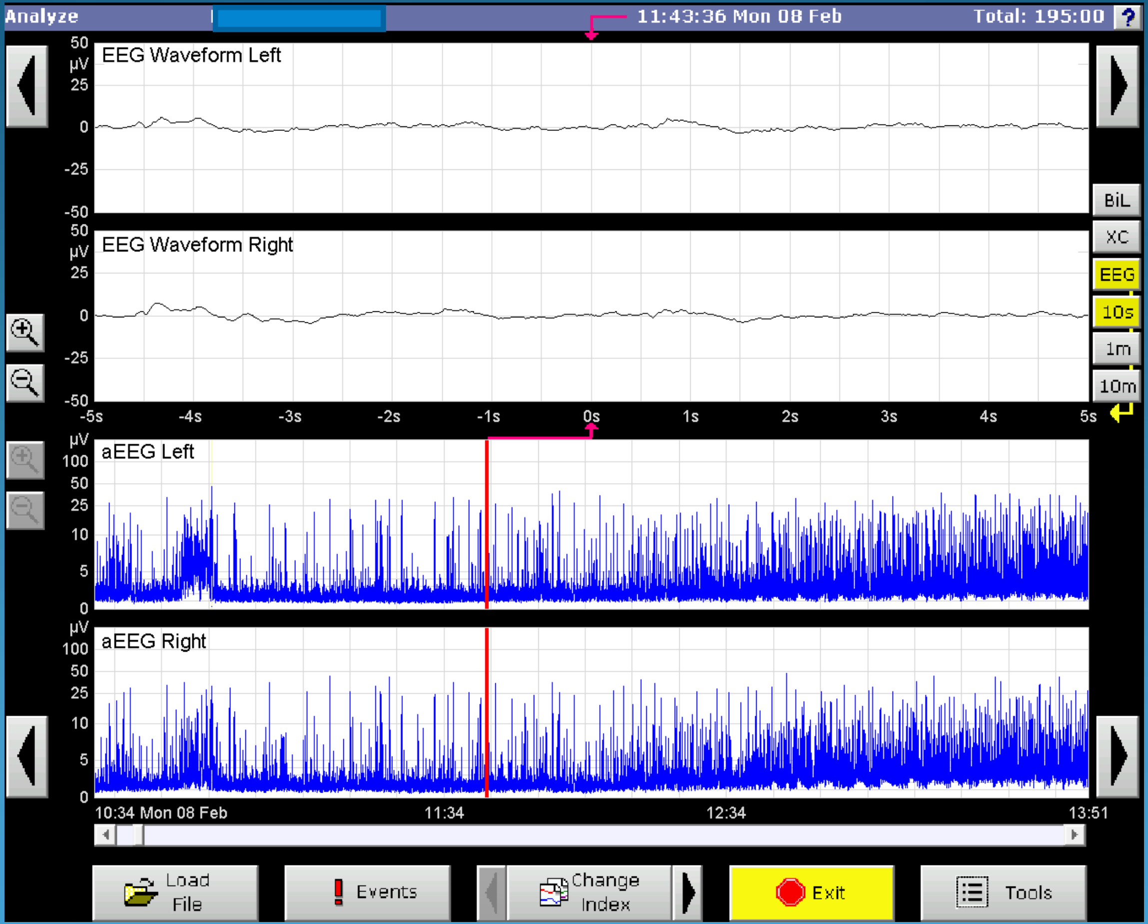
Monitoring of VLBW preterms (brain maturation, outcome prediction)

Monitoring of PHVD

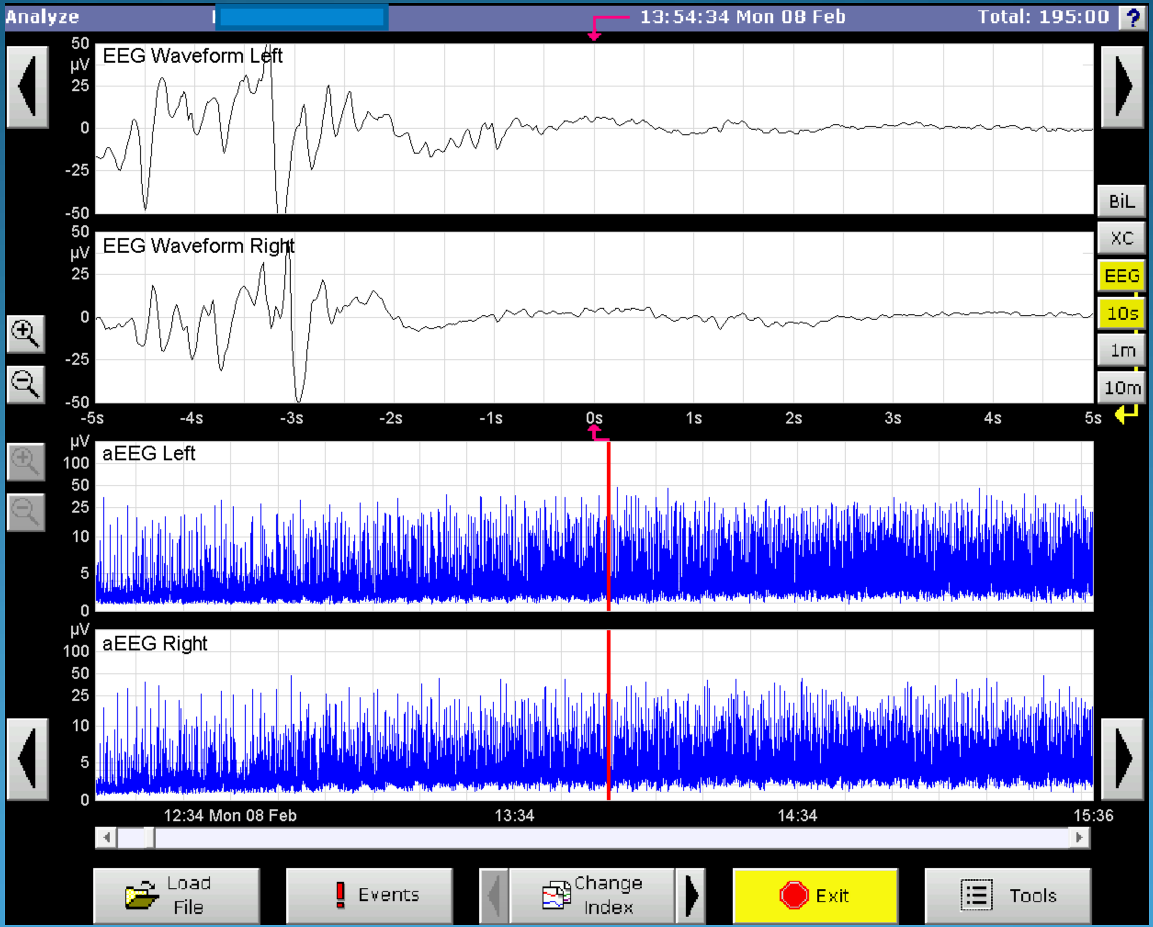
postoperative, especially after cardiac surgery (together with NIRS)

Cyclicity (somnology, minimal handling)

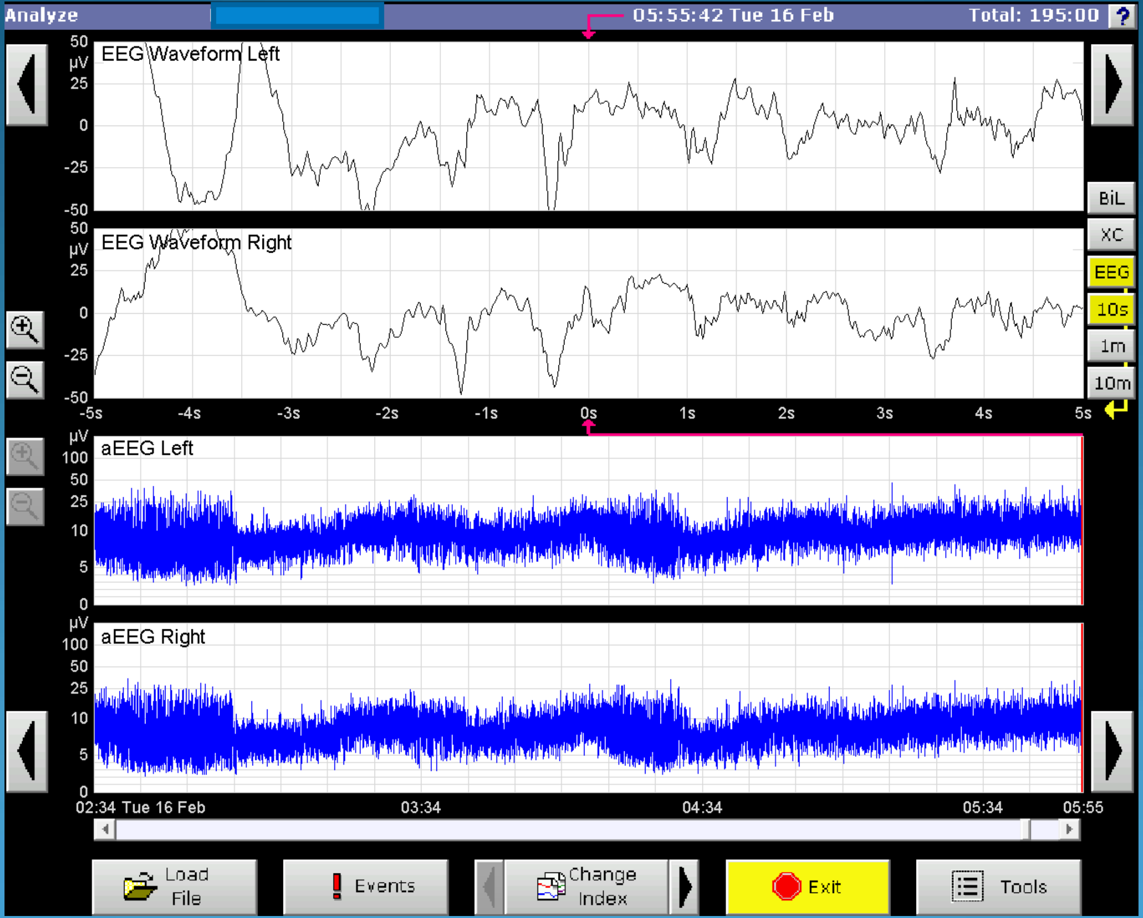
Example for Asphyxia



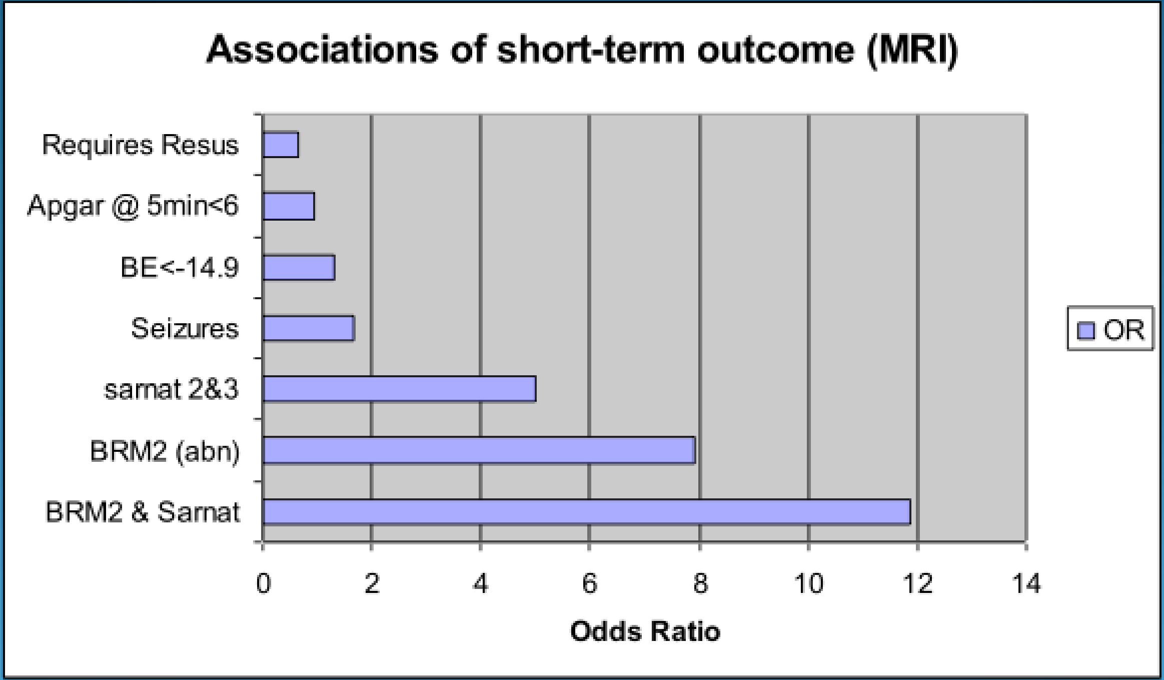
Example for Asphyxia



Example for Asphyxia



In search of a predictive value…



Lavery et al,2006, abstract-PSANZ

1) al Naqeeb N, Edwards AD,Cowan FM, Azzopardi D (1999) Assessment of neonatal enzephalopathy by amplitude-intergrated electroencephalography. Pediatrics 103:1263–1271
17) Hellström-Westas L,Rosén I, Svenningsen NW (1995) Predictive value of early continuous amplitude integrated EEG recordings on outcome after severe birth asphyxia in full term infants.Arch Dis Child 72:F34–F38
45) Toet MC,Eken P,Groenendaal F, de Vries LS (1998) Comparison of amplitude integrated EEG in birth asphyxiated term neonates between 3 and 6 hours after birth. Pediatr Res 43, Part 2 of 2; Abstr 1902

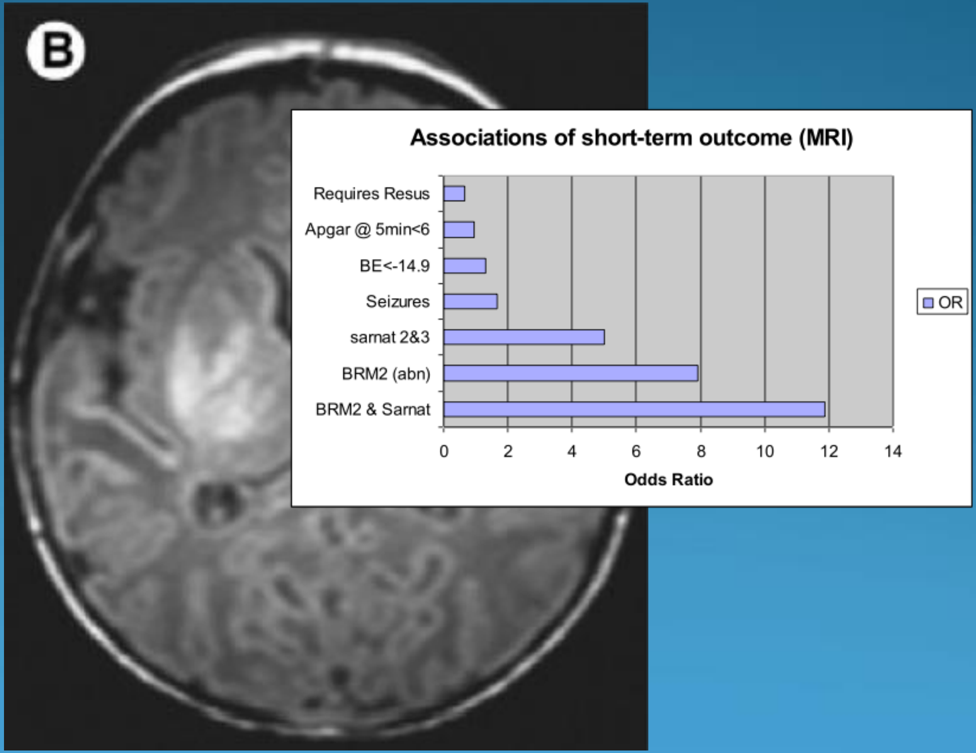
Combining the studies above:

61 patients with normal aEEG after asphyxia

56 had no impairment and good outcome

5 had severe impairment or outcome death

Be careful in cases with isolated damage to basal ganglia



Recovery time with vs. without cooling

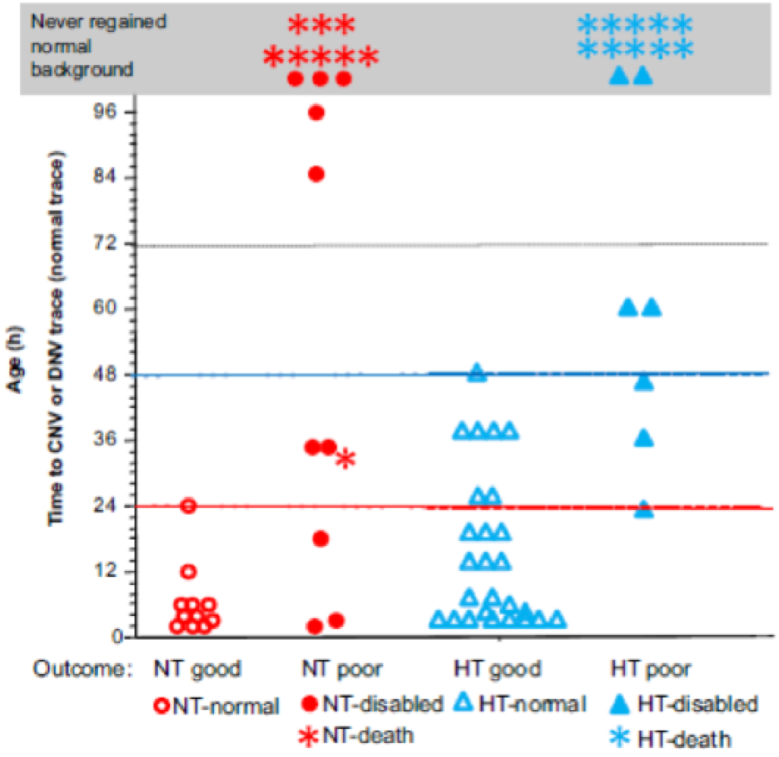
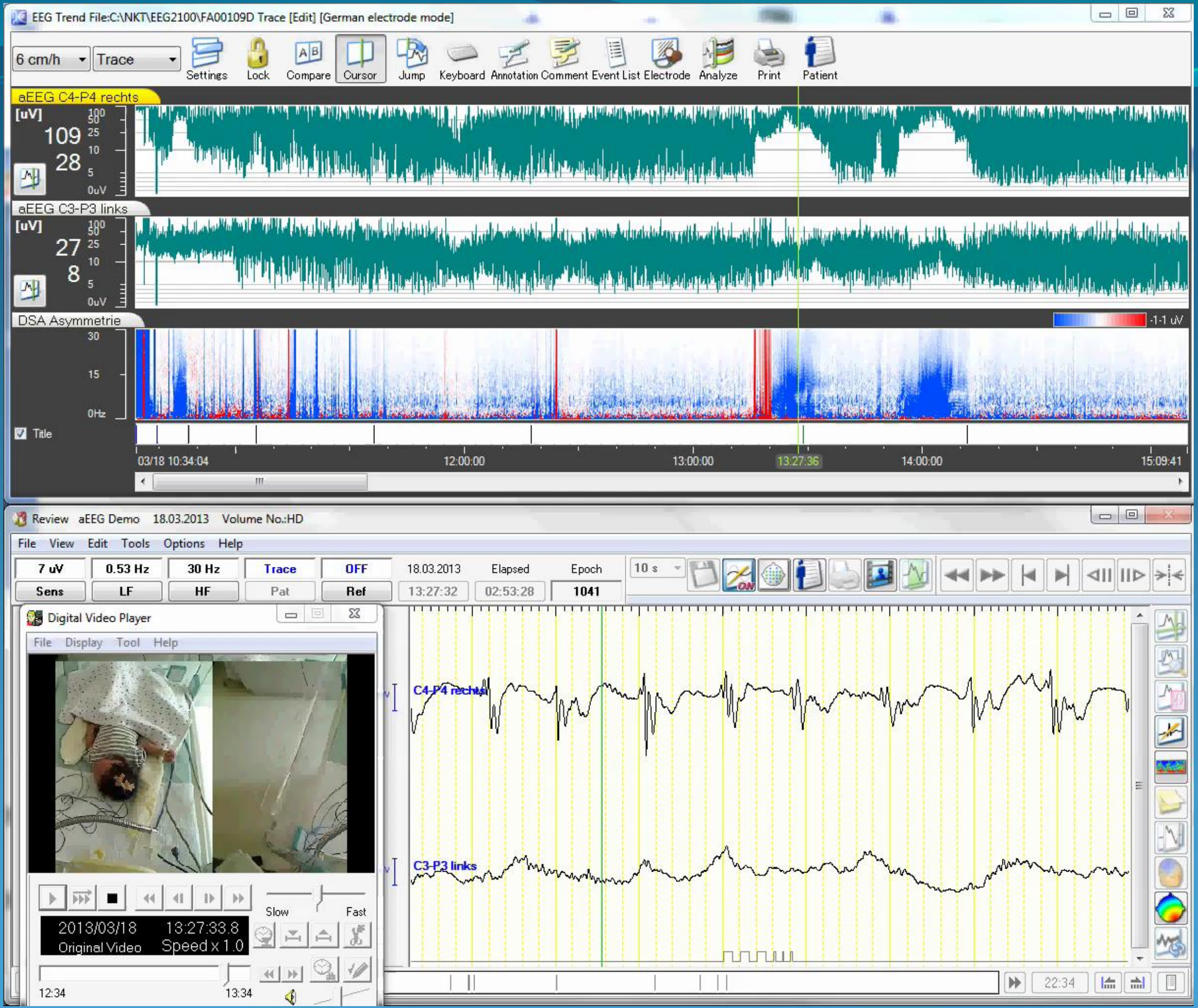


Fig. 1. Time to regain normal amplitude-integrated electroencephalogram trace is shown on the *y*-axis and infants who did not regain a normal trace within the recording time are plotted above the graph. Symbols that define outcome are listed below the *x*-axis. CNV, continuous normal voltage; DNV, discontinuous normal voltage (Reproduced with permission from Thoresen et al.[18]).


EEG Trend File:C:\NKT\EEG2100\FA00109D Trace [Edit] [German electrode mode]
6 cm/h
Trace
Settings
Lock
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Keyboard
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Event List
Electrode
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Patient
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28
aEEG C3-P3 links
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DSA Asymmetrie
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Title
03/18 10:34:04
12:00:00
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13:27:36
14:00:00
15:09:41
Review aEEG Demo 18.03.2013 Volume No.:HD
File View Edit Tools Options Help
7 uV
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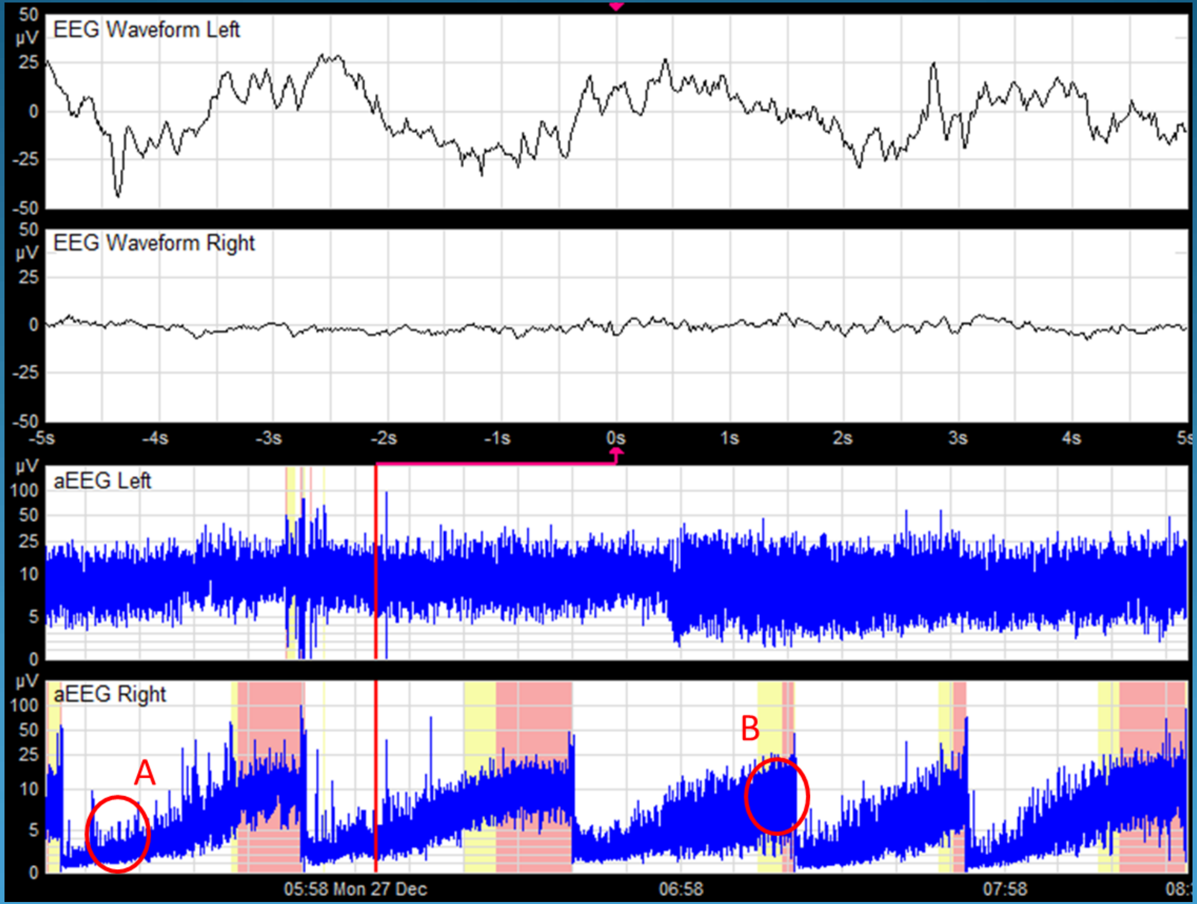
C4-P4 rechts
C3-P3 links
22:34

Mild asphyxia

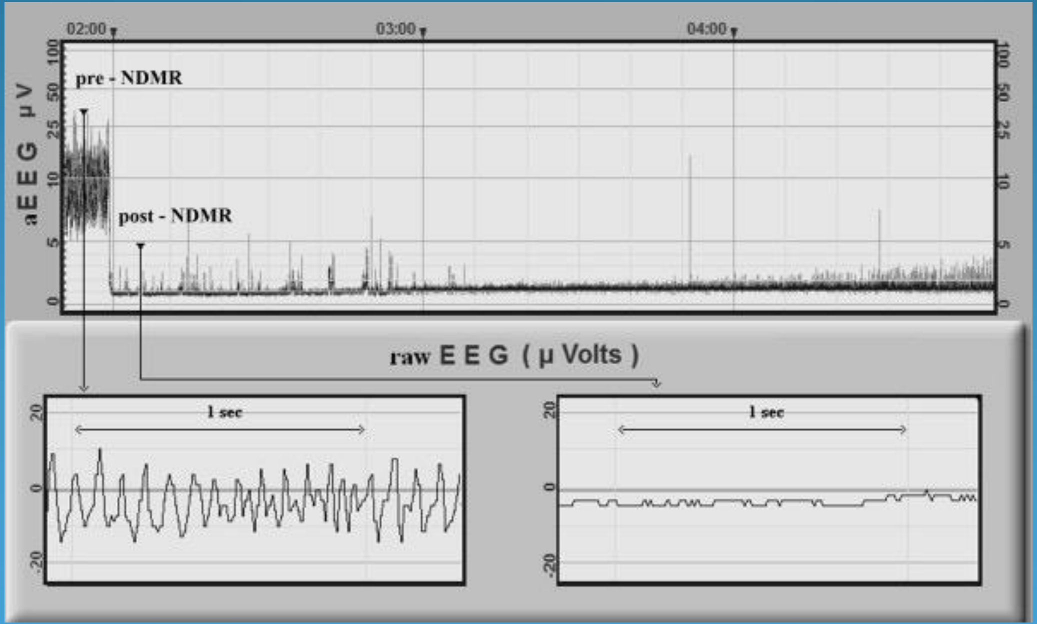


BMC Pediatr. 2013 Nov 22;13:194. doi: 10.1186/1471-2431-13-194.

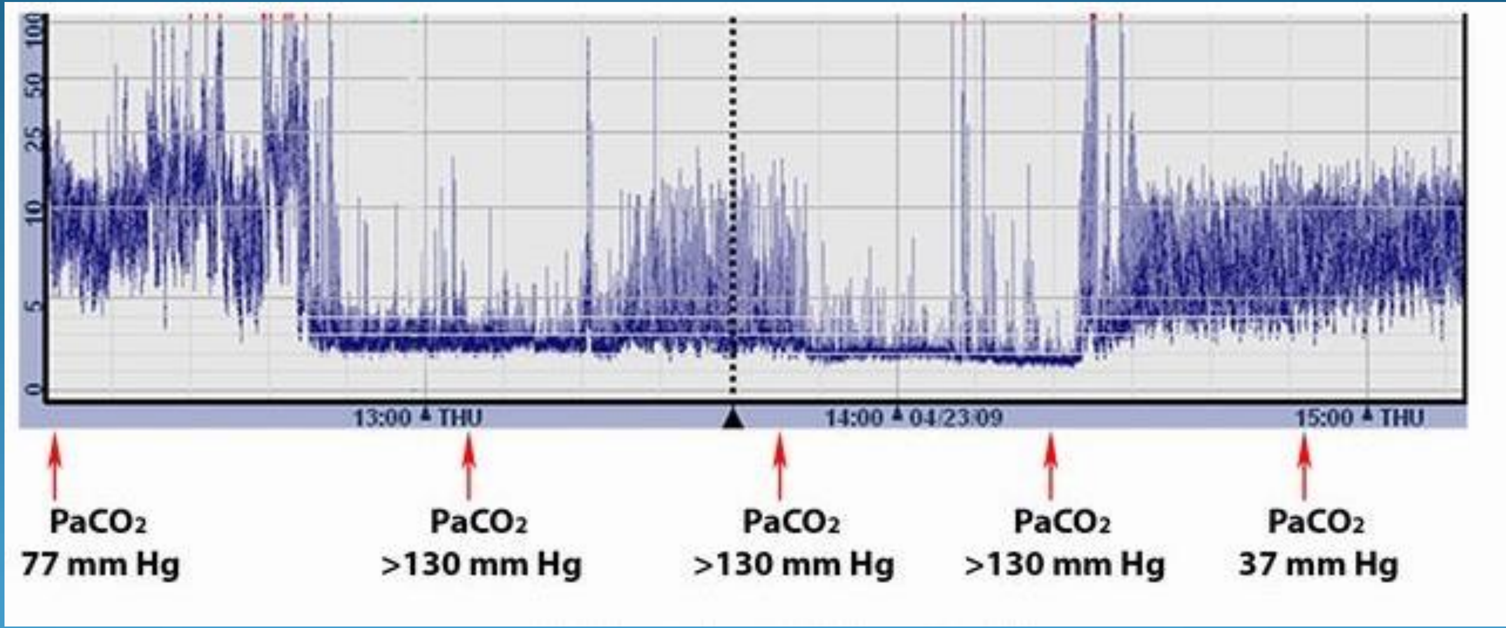
Prevalence and etiology of false normal aEEG recordings in neonatal hypoxic-ischaemic encephalopathy.

Marics G[1], Csekő A, Vásárhelyi B, Zakariás D, Schuster G, Szabó M.

„The occurrence of false normal aEEG background pattern is relatively high in neonates with HIE and hypothermia. High frequency EEG artifacts suggestive of shivering were found to be the most common cause of false normal aEEG in hypothermic neonates while high voltage ECG artifacts are less common."



Correlates with CO_2



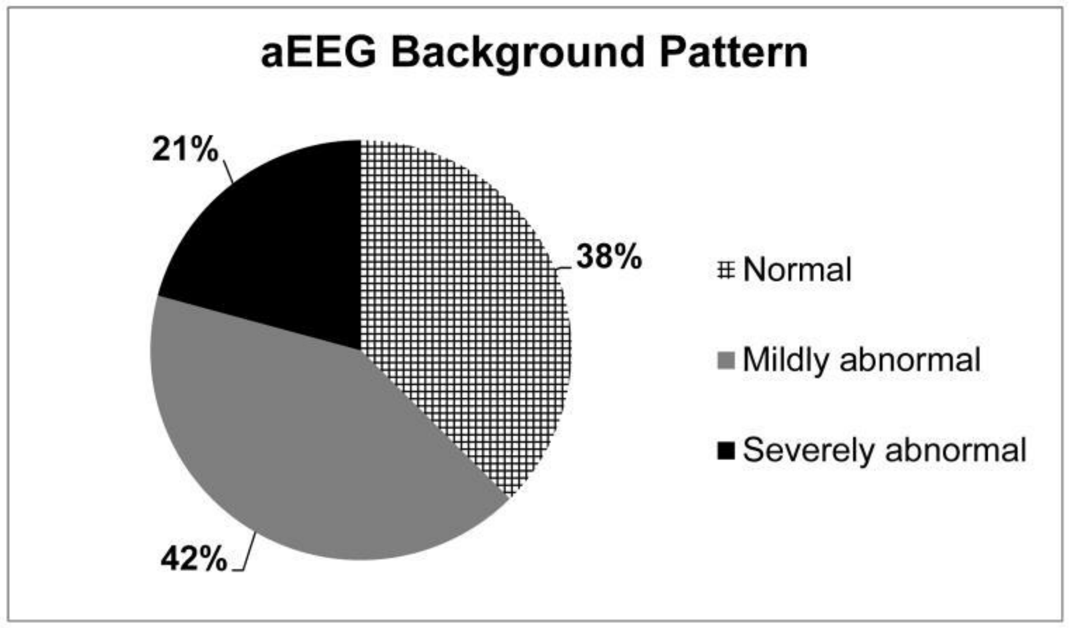
Lauren C Weeke et al. Arch Dis Child Fetal Neonatal Ed 2017;102:F383-F388

The cardiac surgery patient

Pediatr Neurol. 2015 Jun; 52(6): 599–605. PMID: 25838043
Published online 2015 Mar 5. doi: 10.1016/j.pediatrneurol.2015.02.026

Amplitude-integrated EEG in newborns with critical congenital heart disease predicts preoperative brain MRI findings

Sarah B. Mulkey, MD,[a] Vivien L. Yap, MD,[b] Shasha Bai, PhD,[a] Raghu H. Ramakrishnaiah, MBBS, FRCR,[c] Charles M. Glasier, MD,[c] Renee A. Bornemeier, MD,[a] Michael L. Schmitz, MD,[d] and Adnan T. Bhutta, MBBS[e]



Background aEEG pattern in 24 CHD newborns

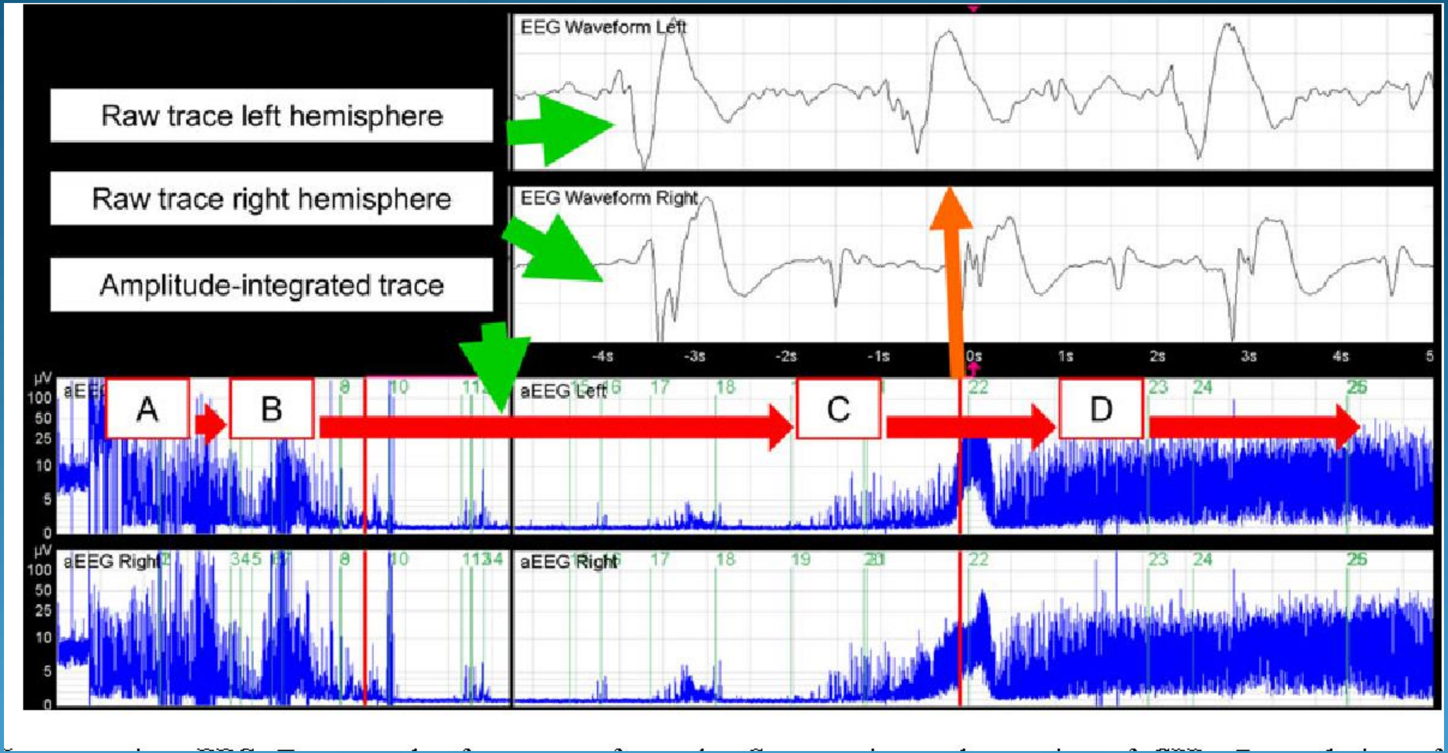
DOI: 10.1007/s00134-012-2608-y • Corpus ID: 24090328

Perioperative amplitude-integrated EEG and neurodevelopment in infants with congenital heart disease

J. Gunn, J. Beca, +2 authors L. Shekerdemian • Published 2012 • Medicine • Intensive Care Medicine

Perioperative monitoring

(full term infants)



A: induction, B: cooling, C: rewarming, D: end surgery

DOI: 10.1007/s00134-012-2608-y • Corpus ID: 24090328

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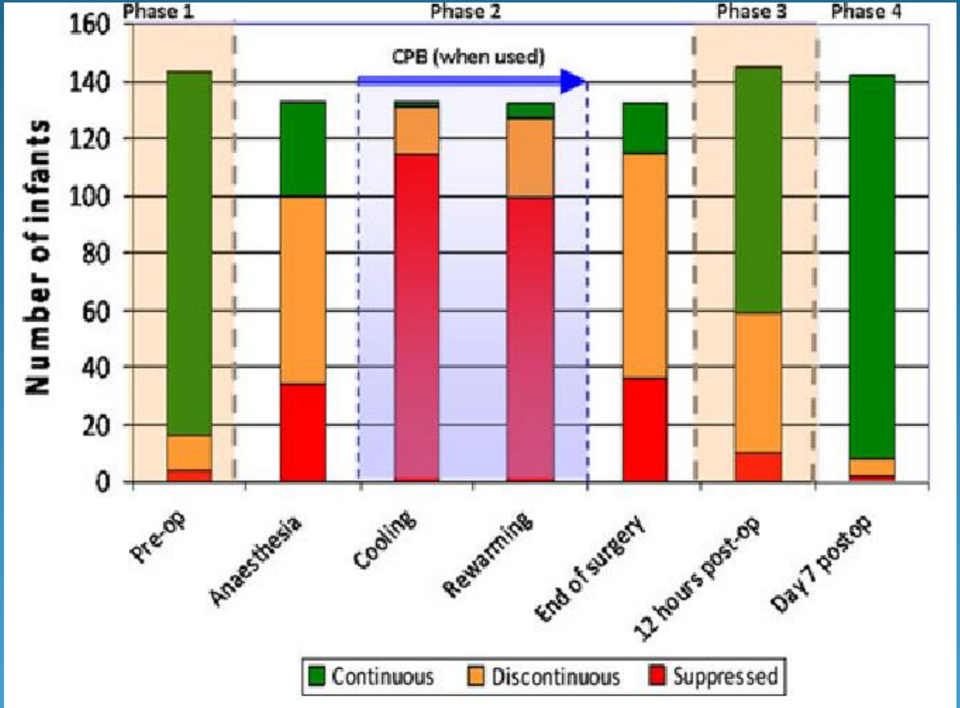
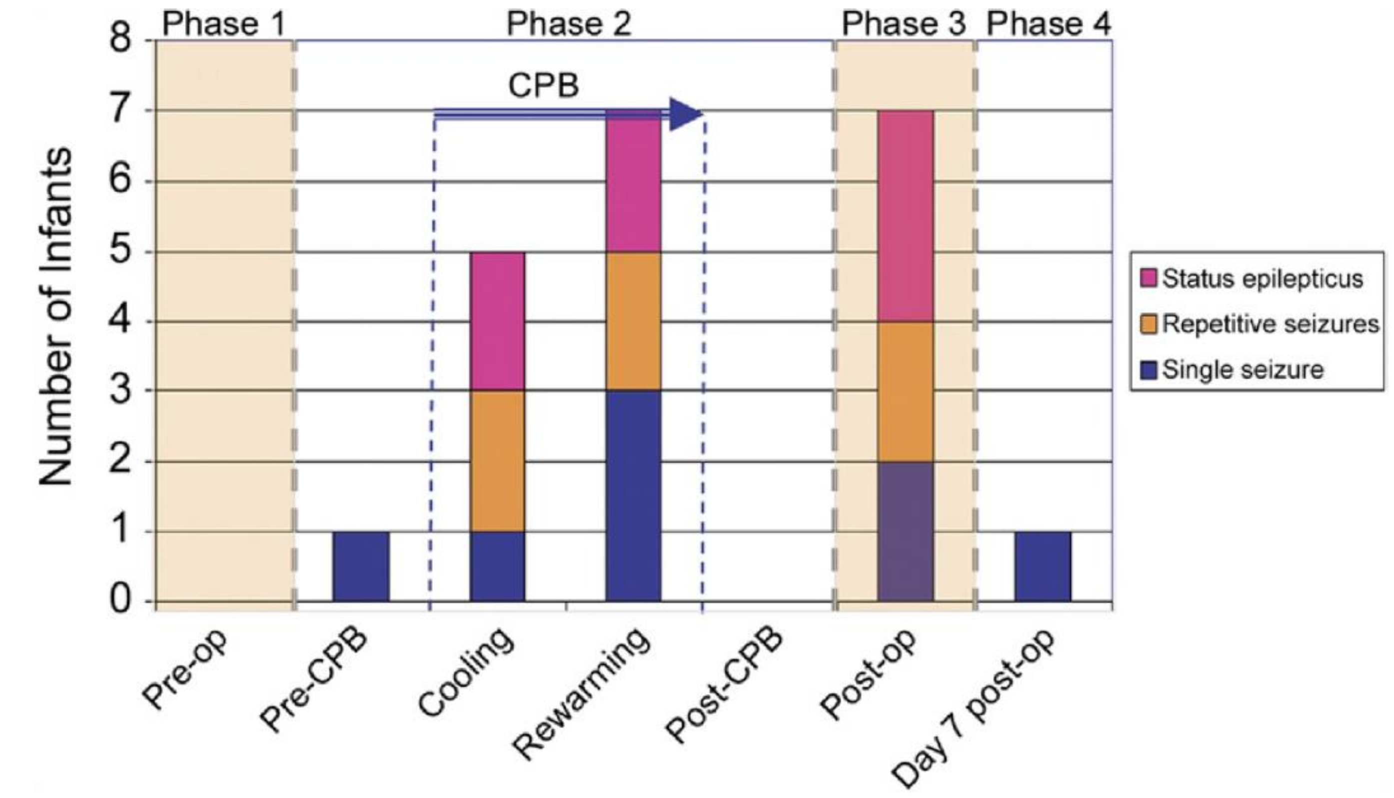


Amplitude-Integrated Electroencephalography and Brain Injury in Infants Undergoing Norwood-Type Operations

Julia K. Gunn, PhD, John Beca, MBChB, Daniel J. Penny, PhD, Stephen B. Horton, PhD, Yves A. d'Udekem, PhD, Christian P. Brizard, MD, Kirsten Finucane, MBChB, Monika Olischar, MD, Rodney W. Hunt, PhD, and Lara S. Shekerdemian, MD

Norwood palliation HLHS

Timing of seizure activity



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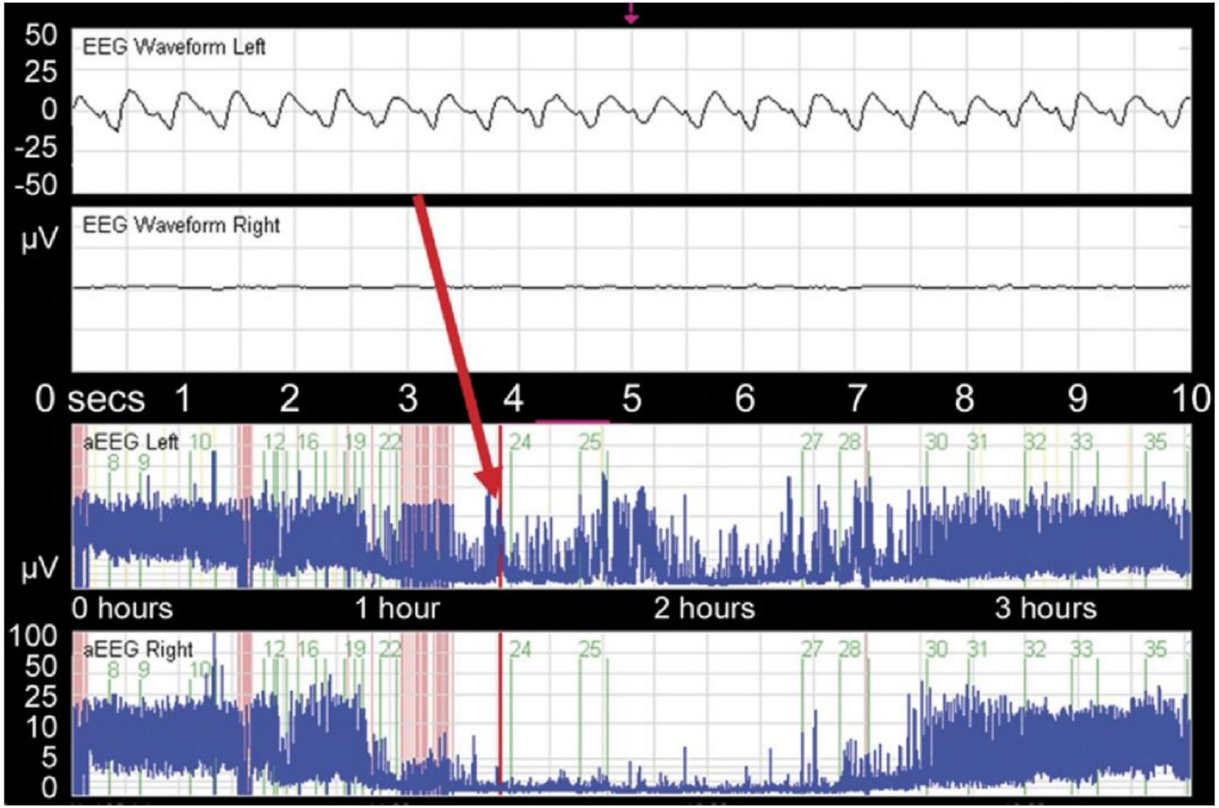
Intraoperative example



Prediction of outcome ?

Intensive Care Med. 2012 Sep;38(9):1539-47. doi: 10.1007/s00134-012-2608-y. Epub 2012 Jun 1.

Perioperative amplitude-integrated EEG and neurodevelopment in infants with congenital heart disease.

Gunn JK[1], Beca J, Hunt RW, Olischar M, Shekerdemian LS.

Perioperative seizures were common in this cohort of infants but did not impact on 2-year neurodevelopmental outcome. Delayed recovery in aEEG background was associated with increased risk of early mortality and worse neurodevelopment.

DOI: 10.1007/s00134-012-2608-y • Corpus ID: 24090328

Perioperative amplitude-integrated EEG and neurodevelopment in infants with congenital heart disease

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Outcome prediction

(full term infants)

Two-year outcome	aEEG recovery by 48 hours post-CPB	Abnormal aEEG at 48 hours post-CPB	p-value
Mean cognitive score	94.3 [95%CI 91.8, 96.8]	83.5 [95%CI 72.2, 94.8]	0.017
Cognitive score <70	3/111 (3%)	2/10 (20%)	0.008
Mean language score	94.3 [95%CI 91.3, 97.4]	81.3 [95%CI 70.9, 91.7]	0.016
Language score <70	7/111 (6%)	3/10 (30%)	0.009
Mean motor score	97.7 [95%CI 95.4, 100.1]	85.9 [95%CI 75.6, 96.2]	0.005
Motor score <70	1/111 (1%)	1/10 (10%)	0.031
Two year mortality	12/126 (10%)	8/19 (42%)	<0.001
Post-operative ECMO	5/121 (4%)	5/19 (26%)	<0.001

Identified risk factors for neurologic damage

TGA (D-TGA with VSD higher as with IVS

HLHS

Coarctation of the aorta

Duration of cardiopulmonary bypass

Galli et al. Periventricular leukomalacia is common afer neonatal cardiac surgery. J Thorac Cardiovasc Surg 2004;127:692-704.

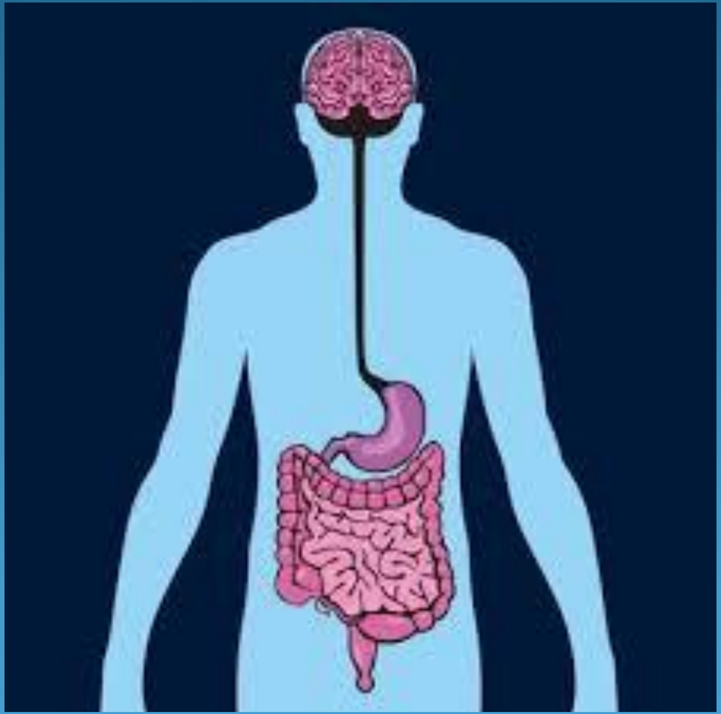
Bellinger DC, Jonas RA, Rappaport L, Wypij D, Wernovsky G, Kuban KC, et al. Developmental and neurological status of children afer heart surgery with hypothermic circulatory arrest or low-flow cardiopulmonary bypass. N Engl J Med 1995; 332: 549–555.

Remaining problem to get this into „evidence based data“

Heterogenous group of malformations and of hemodynamic situations

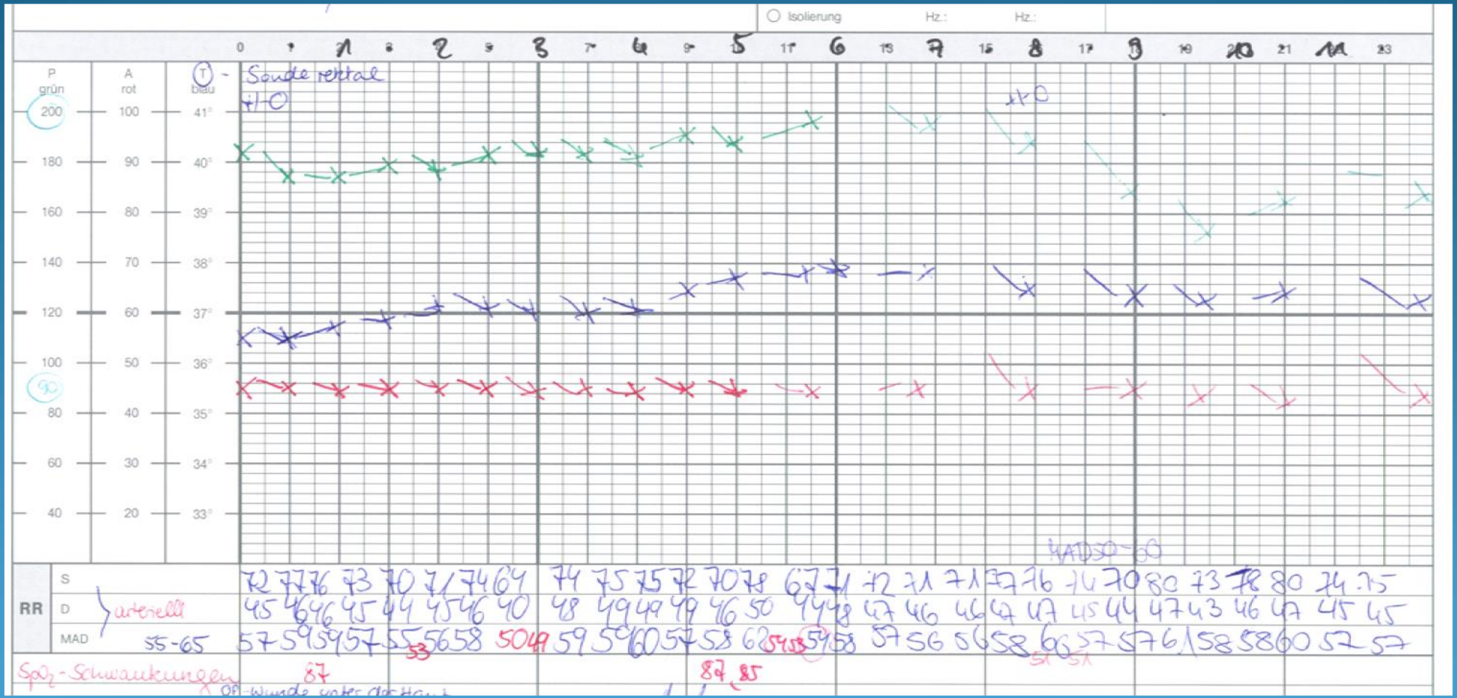
-> heterogenous operations
-> heterogenous neurological risk
-> heterogenous progression of pathological findings (e.g. timing of seizures)

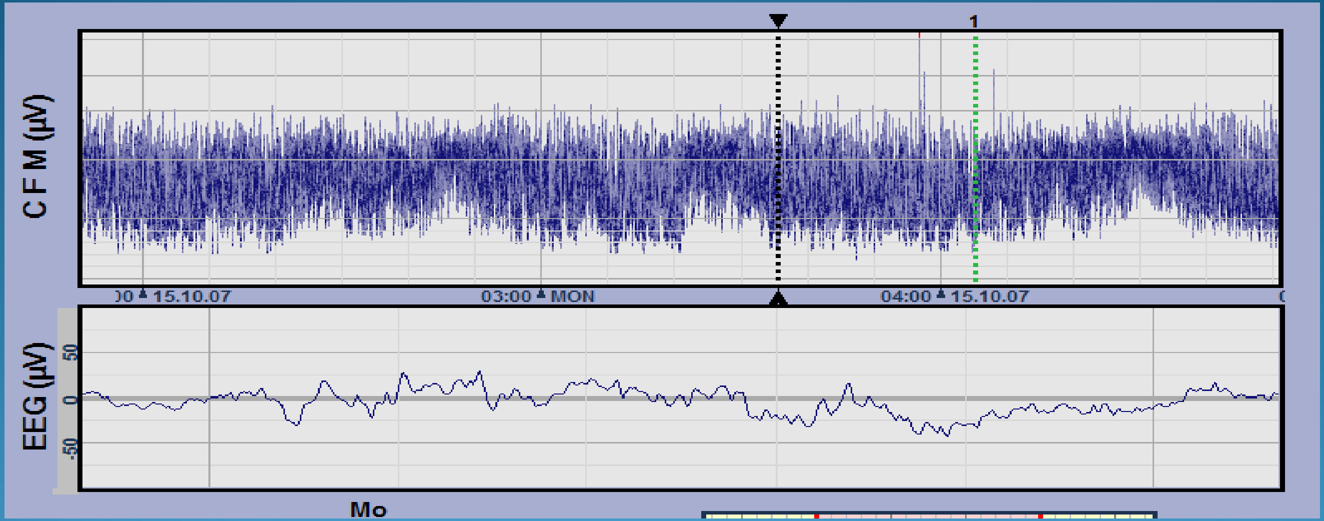
„Other“ critically ill…



The gut to brain connection

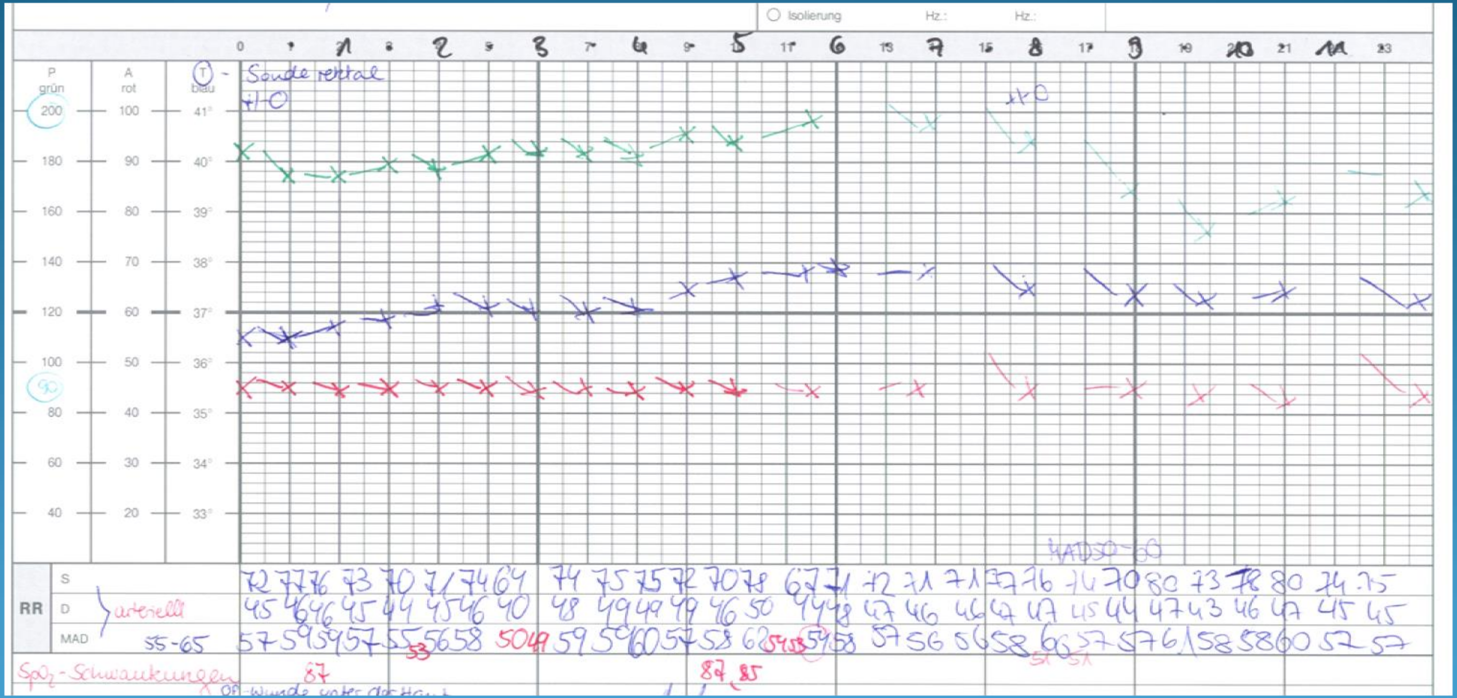
term infant, big abdominal wall defect, post-op night, intubated and muscle relaxed

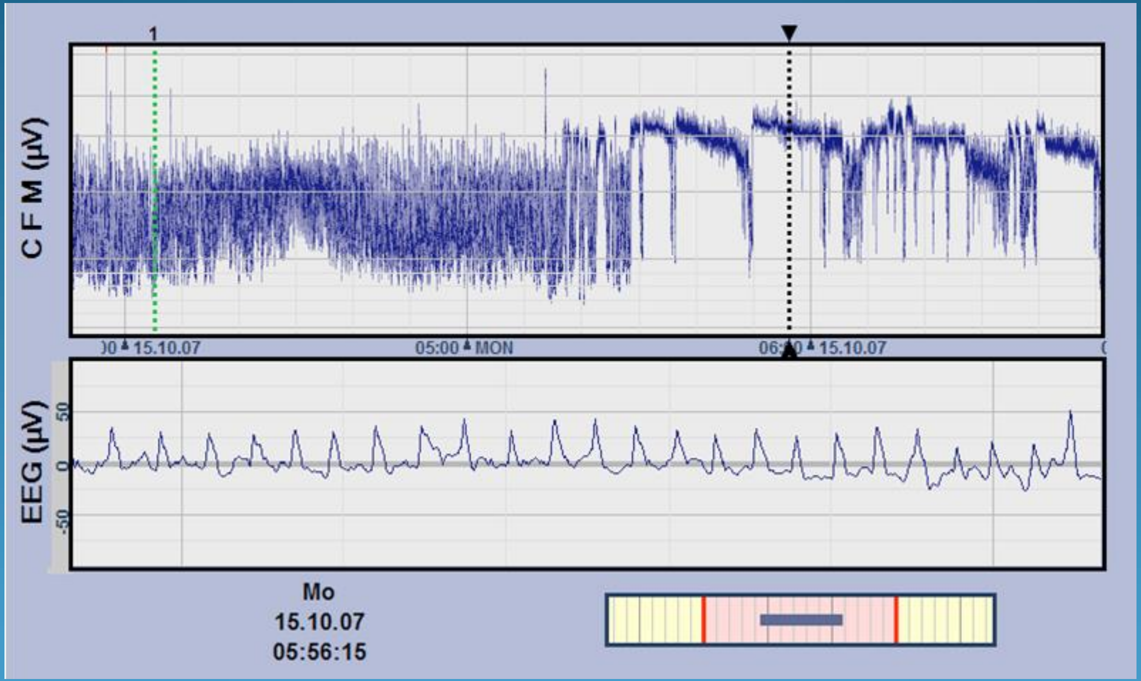




C F M (µV)
1
00 15.10.07
03:00 MON
04:00 15.10.07
EEG (µV)
50
0
-50
Mo

term infant, big abdominal wall defect, post-op night, intubated and muscle relaxed





1
C F M (µV)
)0 15.10.07
05:00 MON
06:00 15.10.07
EEG (µV)
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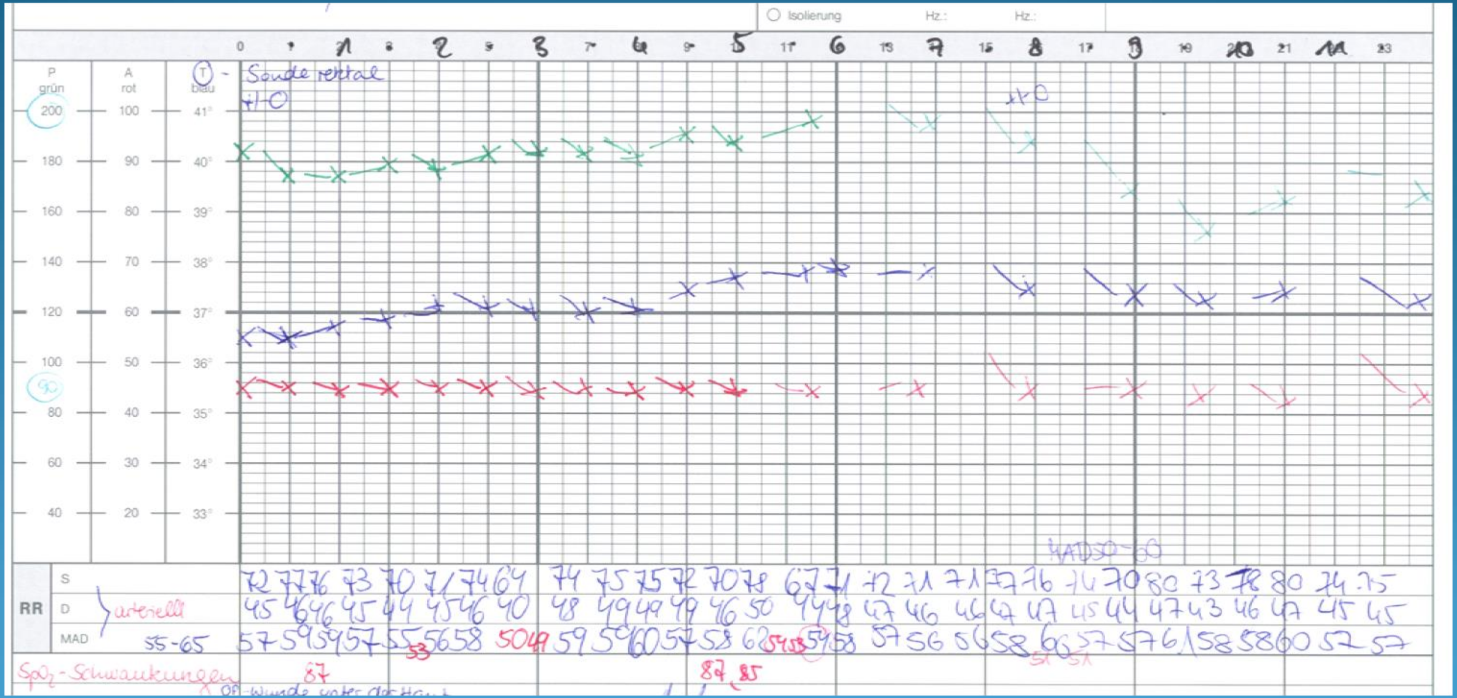
-50
Mo
15.10.07
05:56:15

term infant, big abdominal wall defect, post-op night, intubated and muscle relaxed



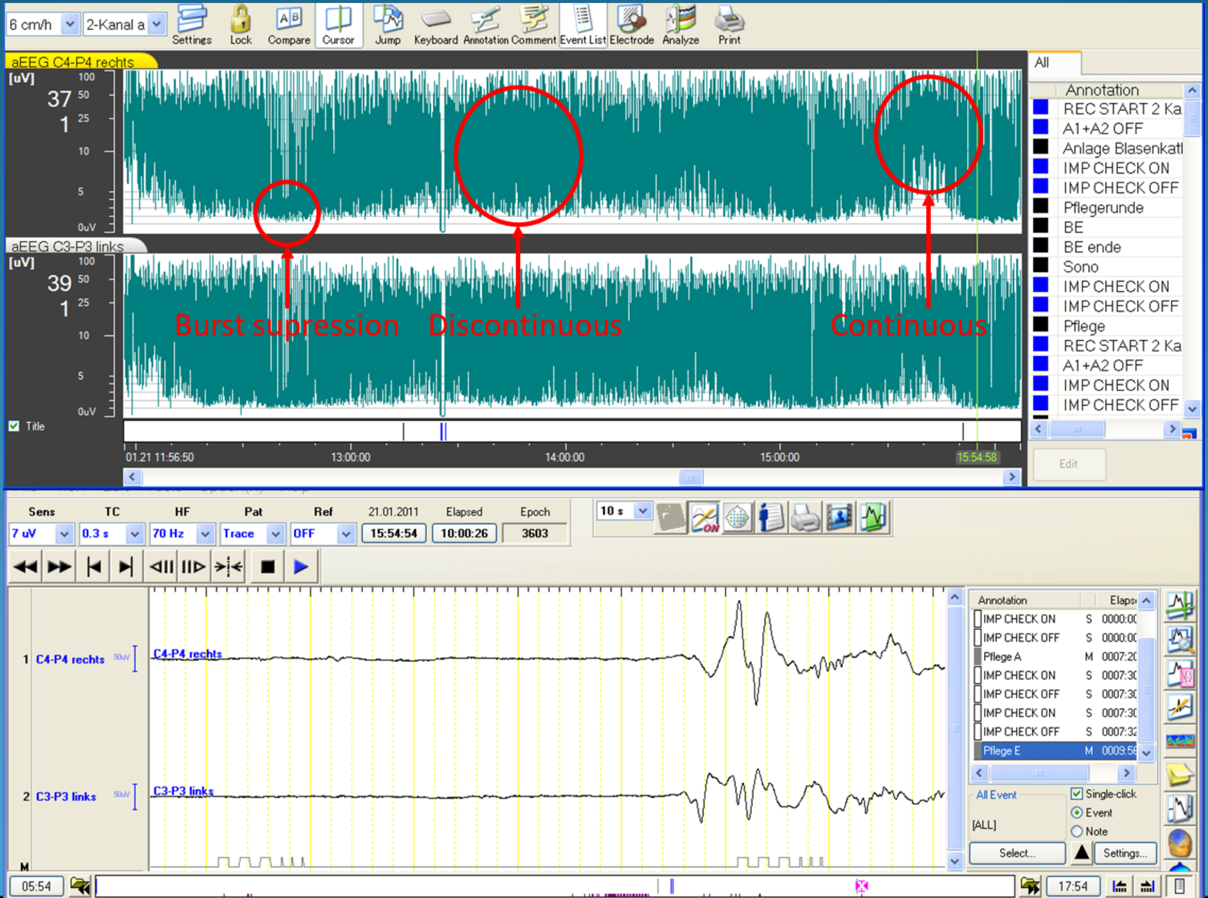
Qualitatively the value of aEEG or any other neuromonitoring for patients during and after surgery can be answered

„YES, it certainly has a value !“

An **evidence based statement** in numbers or statistics regarding additional information, influence on therapy or outcome in the different groups, is and will stay difficult

The aEEG in preterms

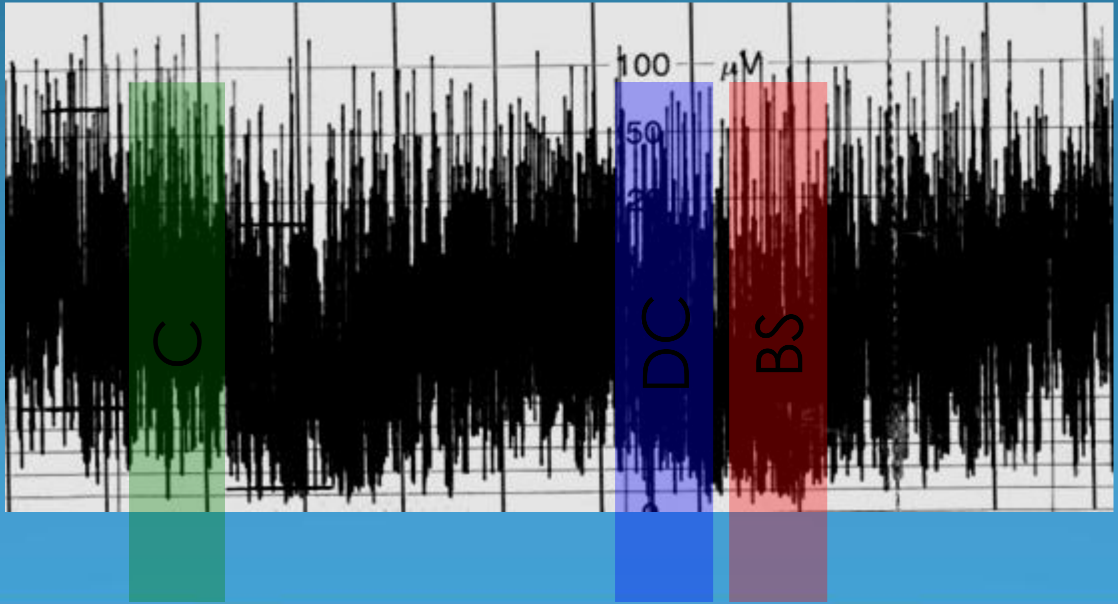
Assessment in preterms



Example for classification

27 SSW

- *Burst Suppression Pattern* = 40 Min. = 33% (Norm)
- *Discontinuous Pattern* = 70 Min. = 58% (Norm)
- *Continuous pattern* = 10 Min. = 9% (Norm)



The aEEG in preterms

Standard values for 24th-25th week of gestational age					
Pattern	**Median**	**5.**	**25.**	**75.**	**95.**
Burst suppression (discontinuous low voltage)	55.6%	0%	46.2%	70%	88.5%
Discontinuous (discontinuous high voltage)	33.3%	11.5%	17.6%	54%	100%
Continuous	0%	0%	0%	8.7%	14.8%

Standard values for 26th-27th week of gestational age					
Pattern	**Median**	**5.**	**25.**	**75.**	**95.**
Burst suppression (discontinuous low voltage)	34%	0%	3.3%	59%	79.8%
Discontinuous (discontinuous high voltage)	56.4%	5.9%	31.4%	65%	95.9%
Continuous	5.9%	0%	0%	21%	58.6%

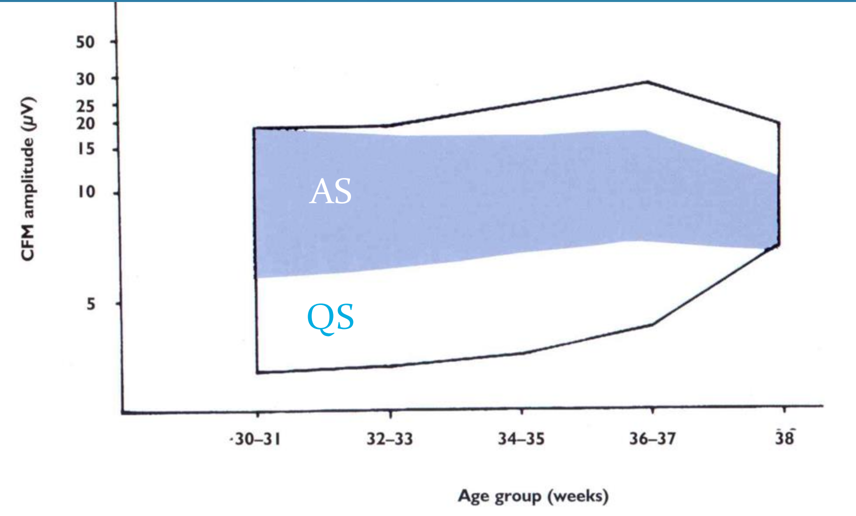
Standard values for 28th-29th week of gestational age					
Pattern	**Median**	**5.**	**25.**	**75.**	**95.**
Burst suppression (discontinuous low voltage)	7.1%	0%	0%	32%	82.6%
Discontinuous (discontinuous high voltage)	51.8%	2.9%	26.2%	74%	100%
Continuous	16.9%	0%	0%	67%	76.9%

Cyclicity (Sleep-Wake-Cycling, SWC)

Dependant on gestational age

In quiet sleep (QS) linear corrrelation between height of lower amplitude and maturity

Immature cyclicity can be seen even in the most immature preterms (e.g. 24th week of gestational age)



AS „ActiveSleep “

QS „Quiet Sleep“

[from Thornberg und Thiringer 1990. Aus: Hellstrom-Westas, de Vries, Rosen. Atlas of aEEG in the Newborn]

Extra- vs. intrauterine maturity

Maturing of aEEG background activity is increased compared with more mature, but younger infants at same postmenstrual age

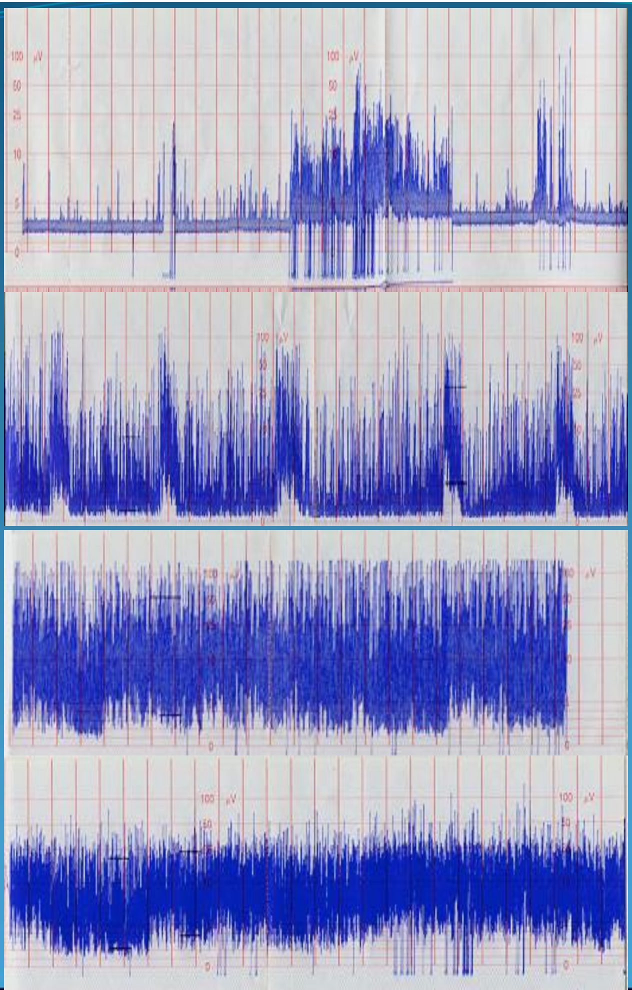
Increased maturity ?

Because of

stress, pain, other sensory stimulation ?

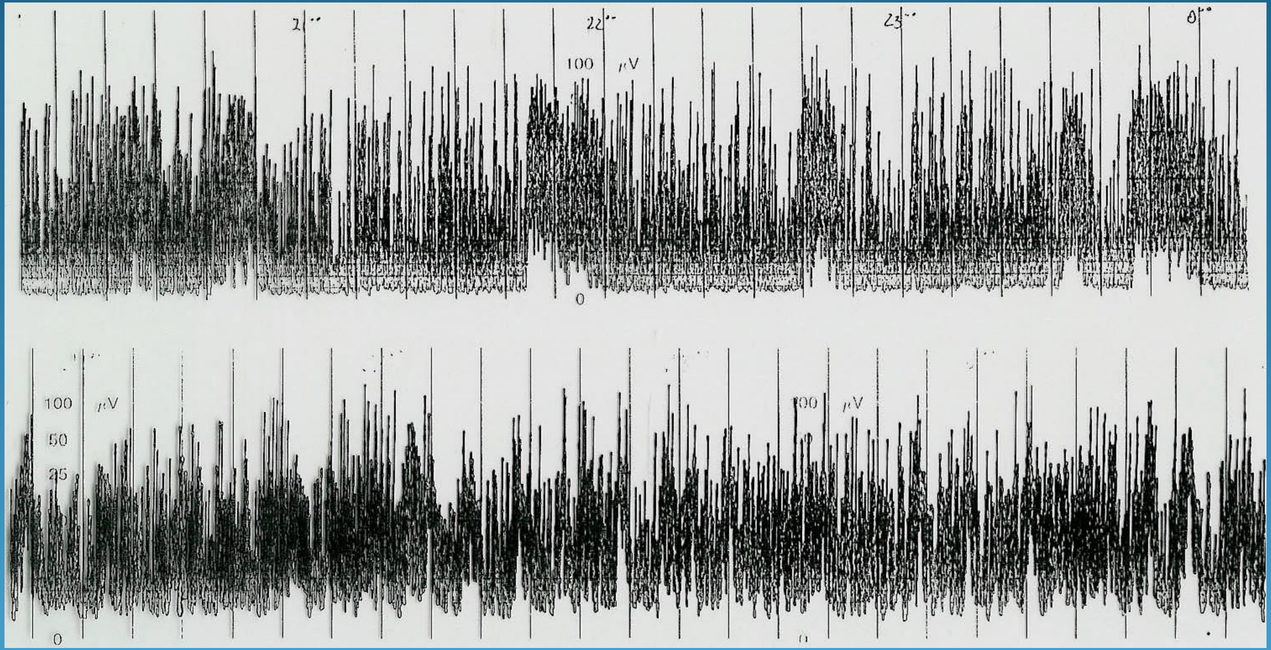
Light, sounds, touching ?

Sisman J et al, J Perinatol 2005
Klebermass K et al, Biol Neonat 2006
Herbertz S et al, Acta Paediatrica 2006
Soubasi V et al, Early Human Dev 2009



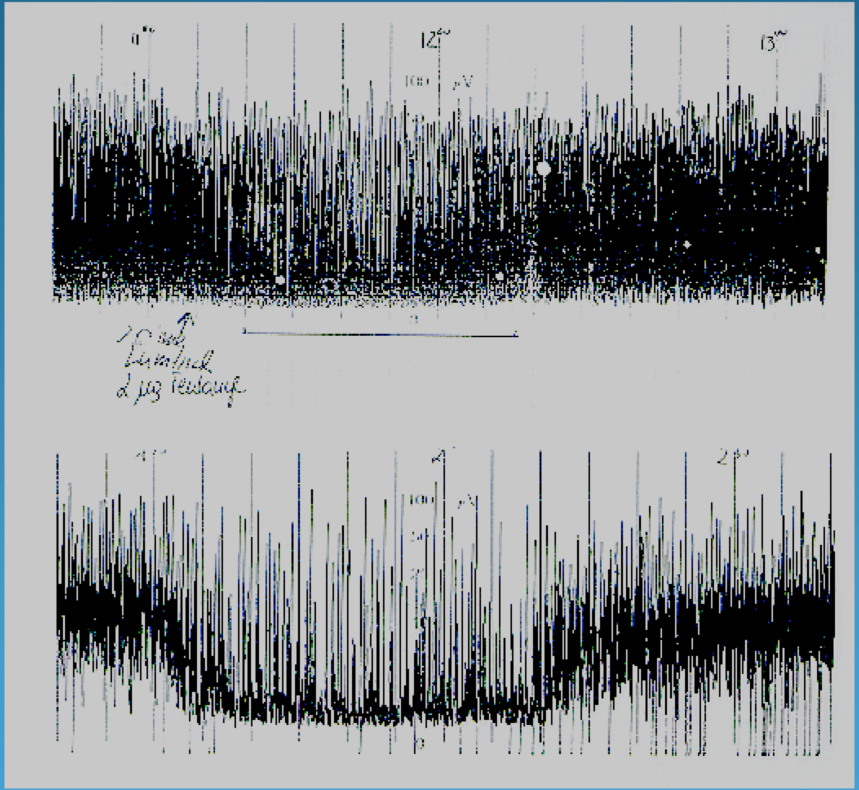
Developing aEEG in IVH

Seizures in preterms



Can be more difficult to detect because of more discontiuous background activity

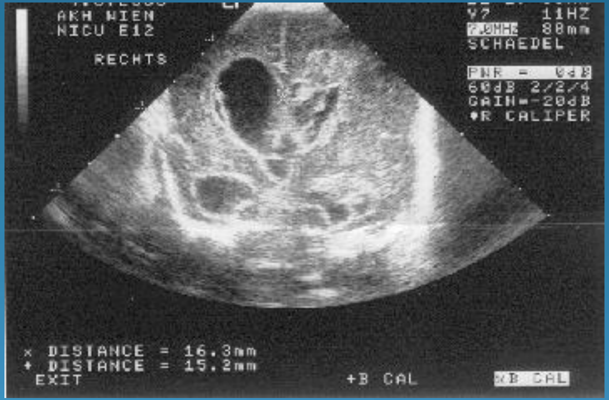
Surveillance of sedation



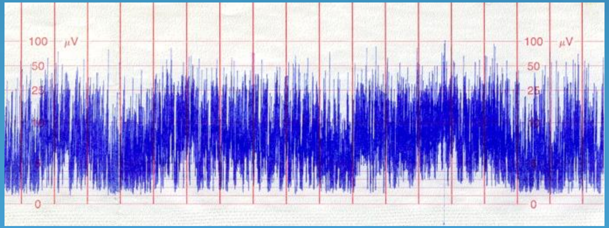
Posthemorrhagic ventricular dilation (PHVD)

28. week GA, IUGR,
Apgar 1/7/8, 846g

at 2. DOL IVH III° right, and III+° left, at 5. DOL beginning ventricular dilation

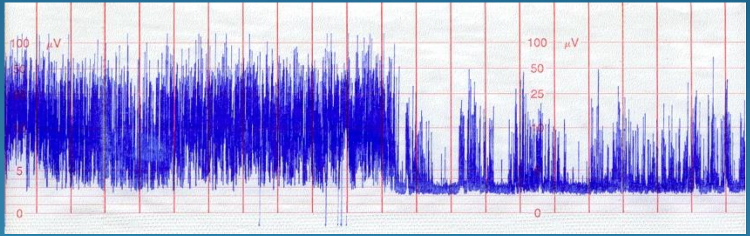


aEEG almost age appropiate

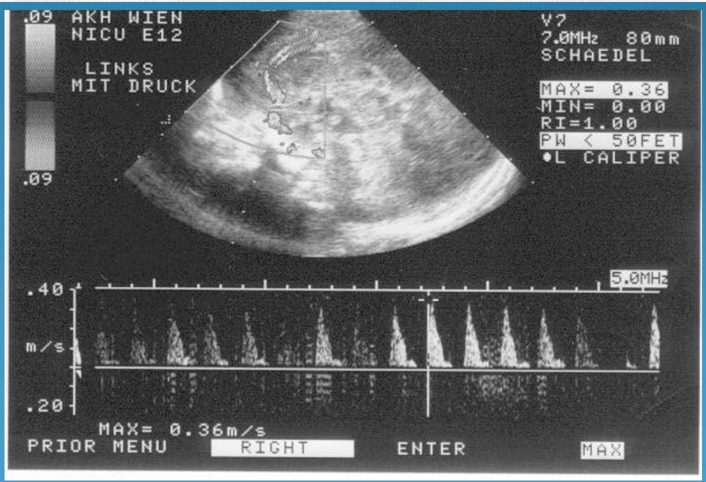


PHVD

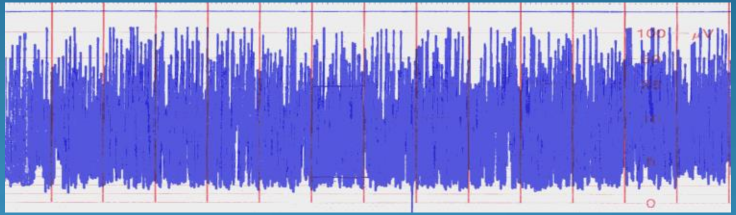
at 20. DOL suddenly flattening of aEEG in monitoring, clinical status unchanged

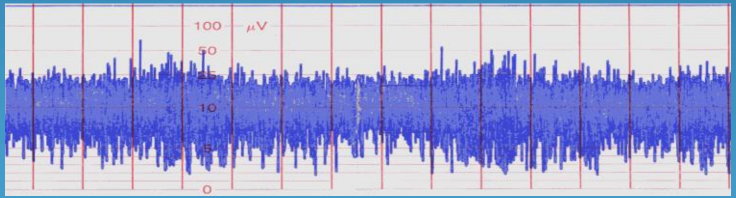


consequently ultrasound was performed: increase of RI to 1,0, 6 hours later beginning seizure activity



Changes (=worsening) of aEEG with increasing cerebral pressure – reversible after depressurizing





PHVD and aEEG

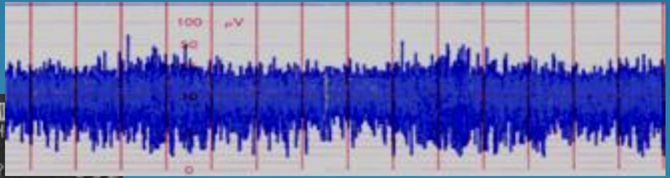
Changes in brain activity in aEEG earlier than critical ventricular dilation in ultrasound or doppler of the vessels

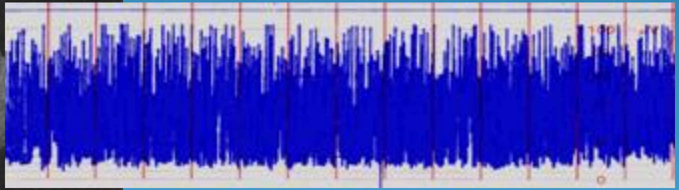
When shall we depressurize?
Morphological or functional decision?

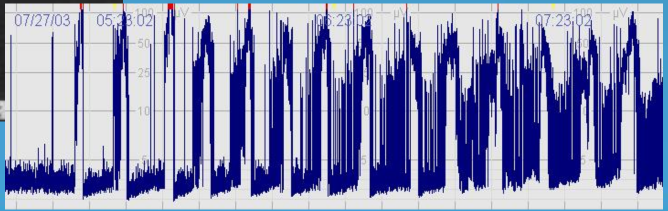
Role of aEEG as help for finding best point in time for intervention?!

The future for treating PHVD is

Morphology AND Function







Outcome prediction of VLBW

K. Klebermaß-Schrehof

Outcome 3 yrs	aEEG normal	aEEG mildly abnormal	aEEG severely abnormal	Sleep-Wake-Cycles	Seizure activity
Normal (N=61)	**93% (57/61)**	5% (3/61)	2% (1/61)	**98% (60/61)**	3% (2/61)
Mildly impaired (n=21)	48% (10/21)	38% (8/21)	14% (3/21)	76% (16/21)	0% (0/20)
Severely impaired (n=61)	**8% (5/61)**	7% (4/61)	85% (52/61)	**11% (7/61)**	43% (26/61)

Normal aEEG: age appropiate patterns, SWC, no seizure activity
Abnormal aEEG: Flattening or increased discontinuity, no SWC, seizure activity
if 2/3 of recording = severely abnormal aEEG
if 1/3 of recording = mildly abnormal aEEG

The aEEG in preterms

Table 5. *Sensitivity, specificity, PPV, and NPV for aEEG pattern (summed score) and all its components (background activity, appearance of SWC, occurrence of seizures on aEEG) and CUS in relation to outcome at 3 y of age in aEEG recordings obtained within the first 2 wk of life in recordings with and without sedative/analgetic/anticonvulsive medication*

	aEEG	Background activity	SWC	Seizures	CUS
Wk 1 + 2					
Sensitivity (95% CI)	0.81 (0.71–0.89)	0.75 (0.64–0.84)	0.64 (0.53–0.74)	0.31 (0.21–0.42)	0.68 (0.57–0.78)
Specificity (95% CI)	0.93 (0.84–0.98)	0.96 (0.88–0.99)	0.98 (0.91–0.99)	0.96 (0.88–0.99)	0.86 (0.75–0.94)
PPV (95% CI)	0.94 (0.86–0.98)	0.96 (0.89–[illegible])	[illegible]	[illegible]	0.87 (0.76–0.94)
NPV (95% CI)	0.79 (0.67–0.87)	0.74 (0.63–[illegible])	[illegible]	[illegible]	0.67 (0.55–0.77)
Wk 1 + 2 no sed. med.					
Sensitivity (95% CI)	0.61 (0.43–0.76)	0.47 (0.30–[illegible])	[illegible]	[illegible]	0.47 (0.30–0.64)
Specificity (95% CI)	0.98 (0.90–0.99)	0.98 (0.90–[illegible])	[illegible]	[illegible]	0.89 (0.78–0.95)
PPV (95% CI)	0.95 (0.78–0.99)	0.94 (0.72–0.99)	0.96 (0.79–0.99)	0.77 (0.39–0.97)	0.73 (0.62–0.81)
NPV (95% CI)	0.79 (0.68–0.88)	0.74 (0.62–0.83)	0.33 (0.18–0.50)	0.65 (0.53–0.75)	0.72 (0.60–0.82)

aEEG-score, summed score; seizures, appearance of repetitive seizures on aEEG; background activity, age adequate according to reference values (22); wk 1 + 2, data of the first 2 wk were analyzed together and the one recording without sedative medication or the one obtained earlier was taken into account. Wk 1 + 2 no sed. med., data obtained within the first 2 wk of life and only recordings obtained without any sedative/analgetic/anticonvulsive medication were taken into account.

Sensitivity 81%

Specifity 93%

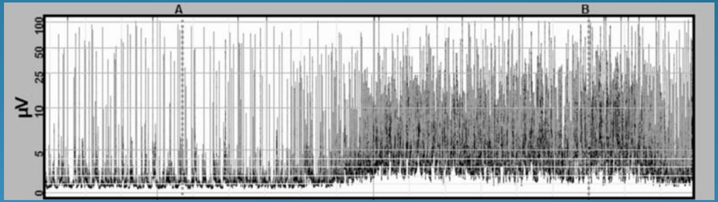
Better than cerebral ultrasound....

Klebermass K et al., Pediatr Res. 2011 Jul;70(1):102-8

The aEEG in preterms

aEEG can be influenced by …

- Blood pressure
- Sepsis
- Acidosis, Glucose
- CO_2
- and more …



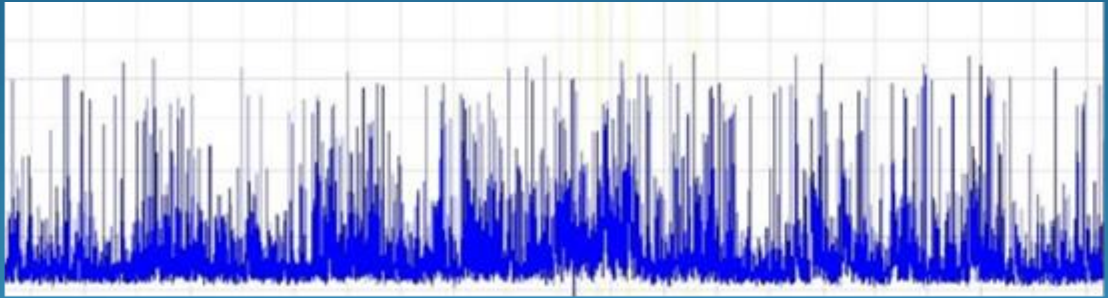
2 day old preterm 24th week GA.,
Supressed activity: pH, 6.84; pCO_2 105 mm Hg
Normal activity: pH, 7.14; pCO_2 44 mm Hg

Greisen G et al, Acta Paeditr Scand 1988

Helderman JB et al., Early Hum Dev. 2010

Granot S et al, Eur J Pediatr 2012

The story of a 24th week of GA, 1st day of life



Early low cardiac output is associated with compromised electroencephalographic activity in very preterm infants.

West, et.al., Pediatr. Res Apr;59(4 Pt 1):610-615.

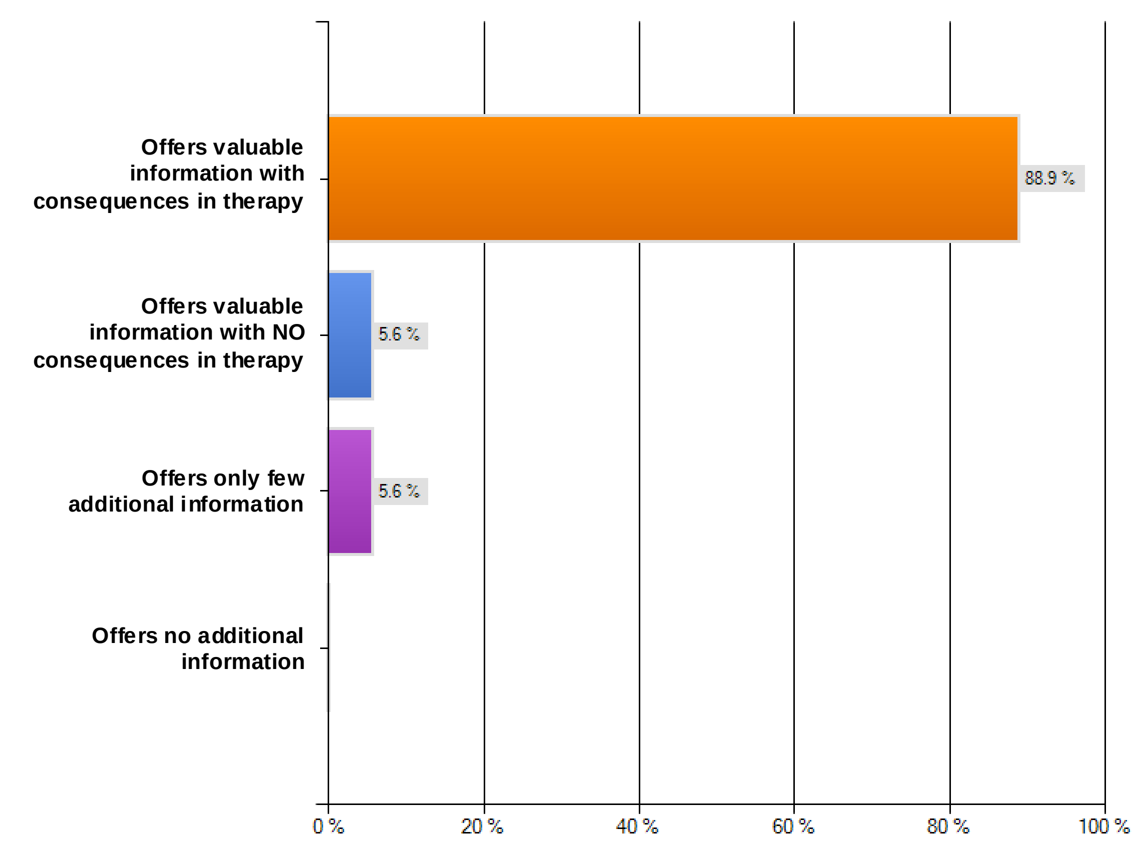
aEEG measurements in the first 48 hours of life are related to SVC flow and treatment with inotropes at 12 hours of life in extremely preterm infants.

Pediatr Res. 2013 Jun 20. doi: 10.1038/pr.2013.104. [Epub ahead of print]

Notice these aEEG changes in preterm infants
Flattening of the amplitude height
Increased discontinuity or burst suppression pattern
Loss of sleep-wake cycles
Seizure activity
Side difference in background activity

Is aEEG a success ?

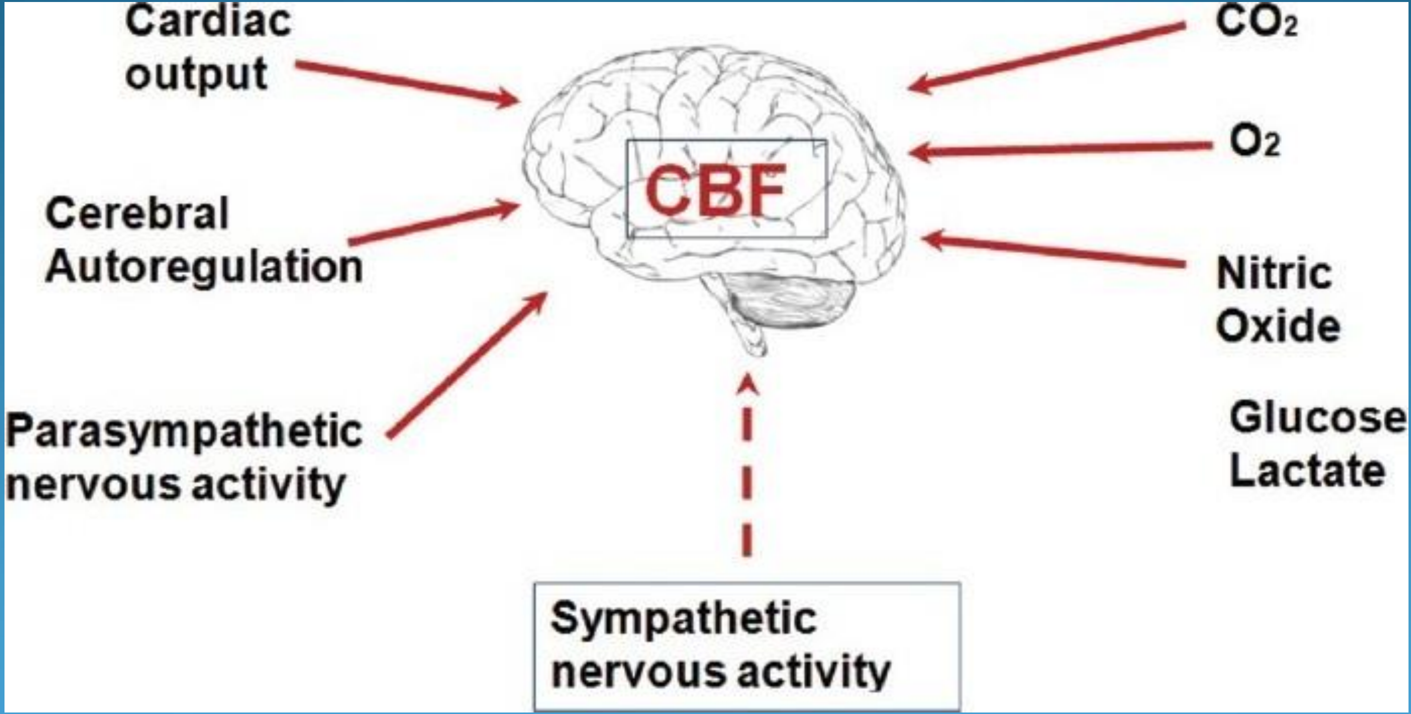
and why ?



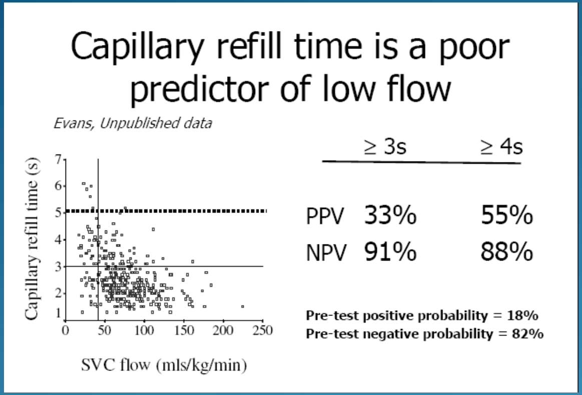
from „Current use of aEEG in Germany“

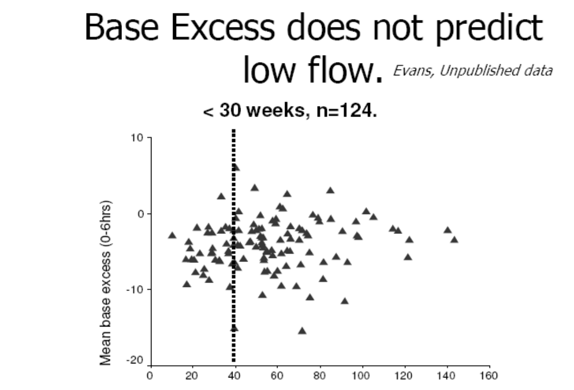
Annual Meeting of German Neonatal and Pediatric Intensive Care Society 2012, (c) Schettler

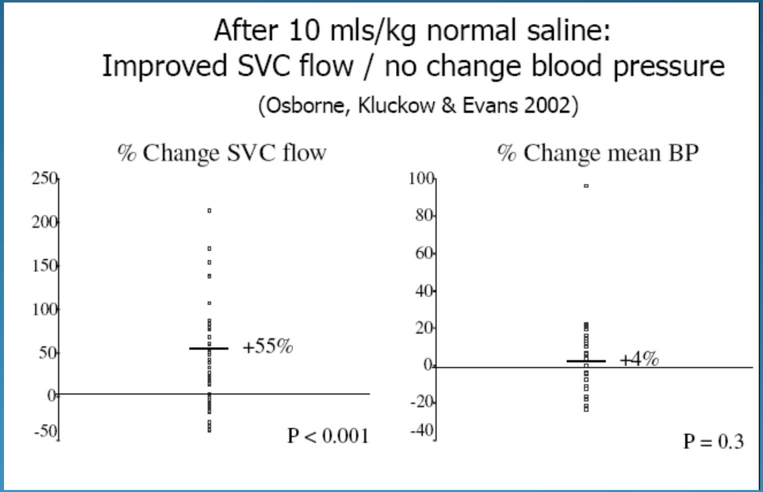
cerebral blood flow



How to tell if cerebral blood flow is good ?







In a subgroup of 10 patients, variation of pump flow between 1.0 and 2.0 L/min/m2 did not significantly affect regional CBF

Early low blood flow
Associated with compromised aEEG

West et al Pediatr Res 2006

Table 3. *Comparison between quantitative EEG measurements in infants in the lowest quartile of right ventricular outflow and blood pressure 12 hours after birth and the remainder of the study cohort*

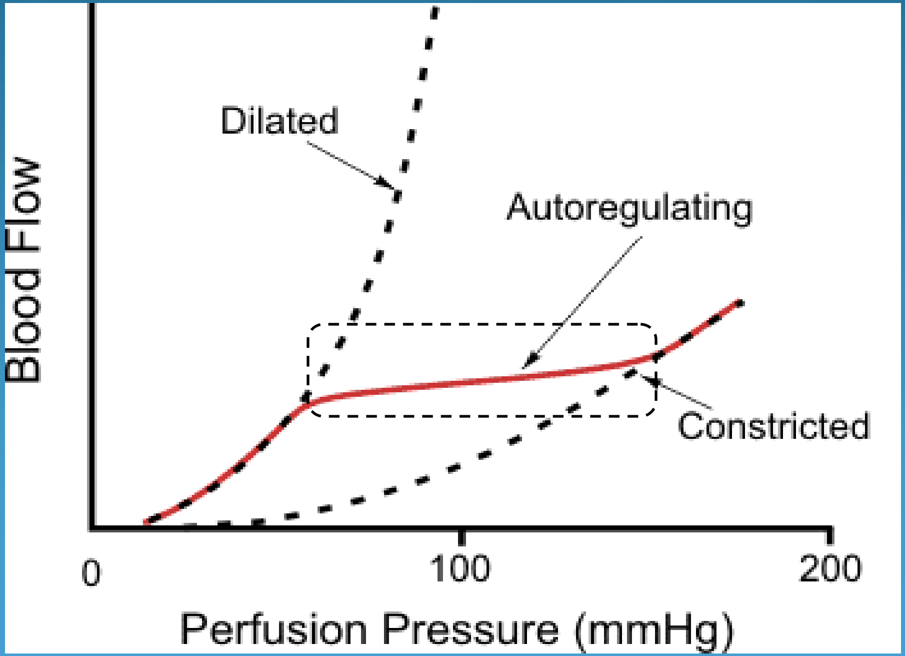
	Minimum amplitude (µV)		Median amplitude (µV)		Continuity thresholds (%/min) 10 µV		25 µV		50 µV	
	12 h	24 h	12 h	24 h	12 h	24 h	12 h	24 h	12 h	24 h
RVO 12 h										
Lowest quartile (<2.82 mL/kg/min)	1.3* (1.0–1.5) (n = 6)	1.5* (1.1–3.7) (n = 8)	3.3* (2.5–5.0) (n = 6)	4.6* (3.8–7.6) (n = 8)	84* (69–100) (n = 6)	96* (91–100) (n = 8)	42* (29–68) (n = 6)	64* (56–96) (n = 8)	20 (14–42) (n = 6)	31* (26–63) (n = 8)
Remainder (≥2.82 mL/kg/min)	2.2 (1.5–6.5) (n = 21)	2.5 (1.3–6.7) (n = 22)	5.1 (3.4–11.4) (n = 21)	7.4 (3.1–11.9) (n = 22)	100 (91–100) (n = 21)	100 (94–100) (n = 22)	67 (29–100) (n = 21)	79 (52–97) (n = 22)	37 (12–85) (n = 21)	52 (15–71) (n = 22)
MAP 12 h										
Lowest quartile (<31 mm Hg)	1.7 (1.0–2.1) (n = 5)	2.0 (1.1–2.7) (n = 6)	4.1 (2.8–4.6) (n = 5)	5.2* (4.5–9.7) (n = 6)	91* (69–96) (n = 5)	100 (91–100) (n = 6)	29* (12–85) (n = 5)	69 (56–90) (n = 6)	23* (14–28) (n = 5)	36 (31–67) (n = 6)
Remainder (≥31 mm Hg)	2.1 (1.0–6.5) (n = 19)	2.3 (1.4–6.7) (n = 21)	5.1 (2.5–11.4) (n = 19)	6.7 (3.1–11.9) (n = 21)	100 (70–100) (n = 19)	100 (93–100) (n = 21)	49 (30–54) (n = 19)	78 (52–97) (n = 21)	39 (13–85) (n = 19)	52 (15–71) (n = 21)
DBP 12 h										
Lowest quartile (<25 mm Hg)	2.0 (1.3–2.3) (n = 7)	1.9 (1.4–2.7) (n = 7)	4.1 (2.8–5.0) (n = 7)	5.1 (3.1–9.7) (n = 7)	96* (69–100) (n = 7)	100 (94–100) (n = 7)	53* (30–68) (n = 7)	68 (52–90) (n = 7)	24* (13–42) (n = 7)	35 (15–67) (n = 7)
Remainder (≥25 mm Hg)	2.2 (1.0–6.5) (n = 17)	2.4 (1.1–6.7) (n = 20)	5.2 (2.5–11.4) (n = 17)	7.1 (3.8–11.9) (n = 20)	100 (70–100) (n = 17)	100 (91–100) (n = 20)	70 (29–100) (n = 17)	79 (56–97) (n = 20)	39 (16–85) (n = 17)	52 (24–71) (n = 20)

Results are median (range).

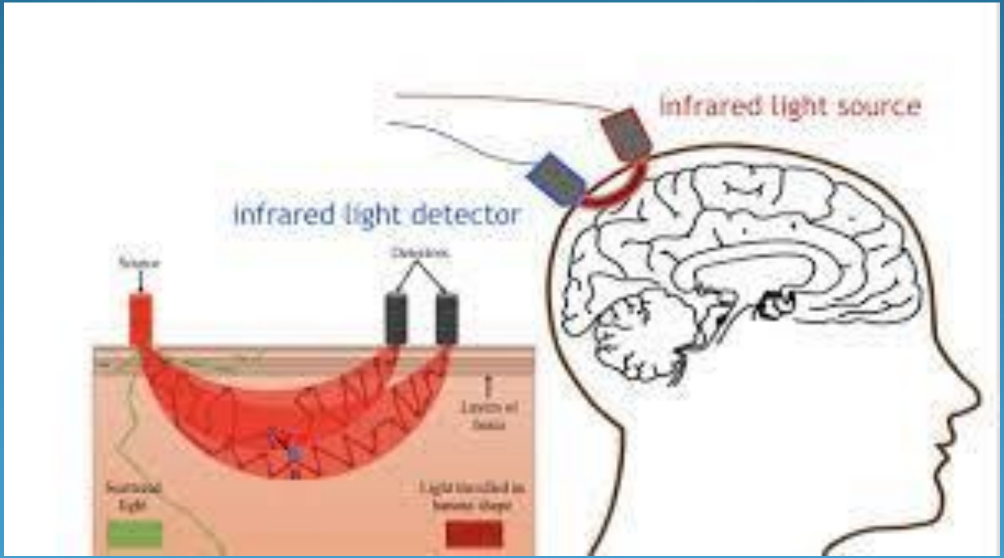
* $p < 0.05$ lowest quartile compared with remainder.

DPB, diastolic BP.

That´s what autoregulation is for… but if it is not working ?

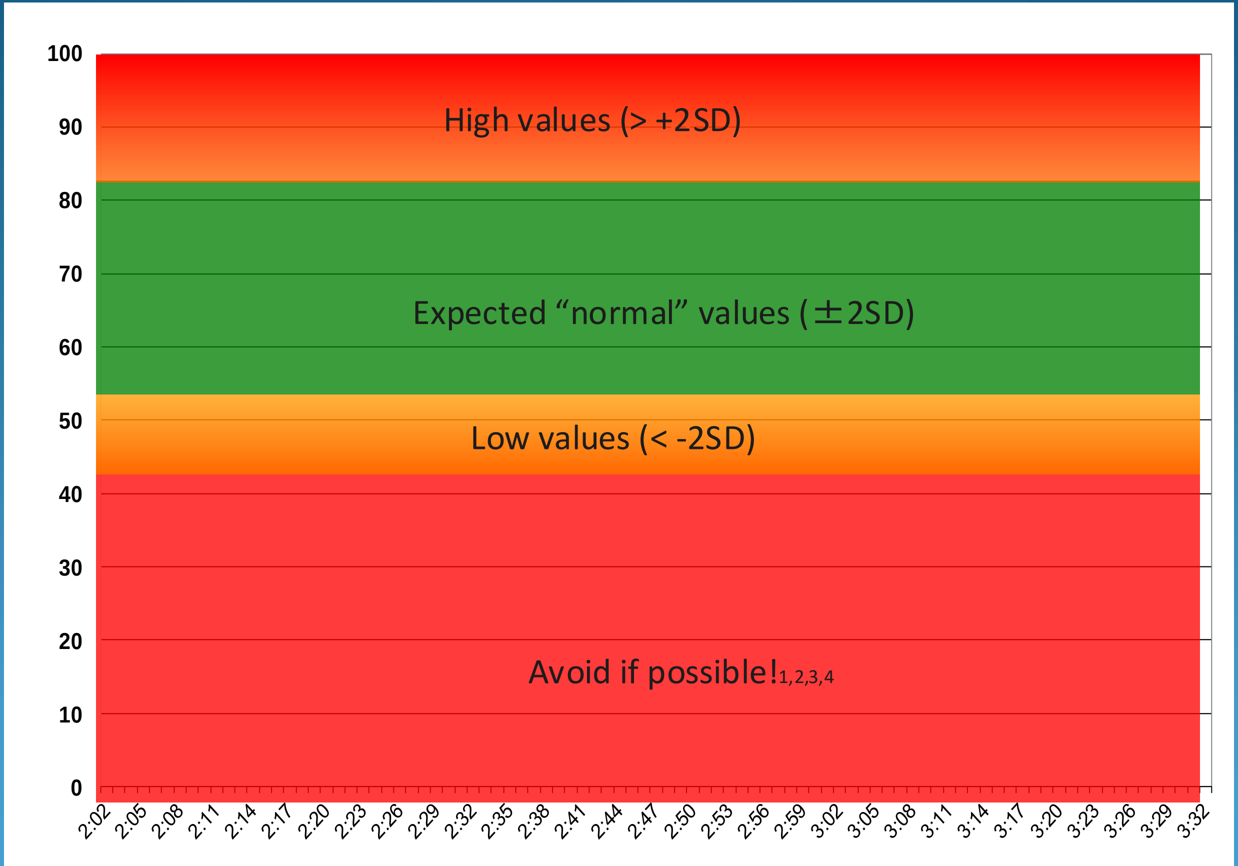


What about NIRS ?



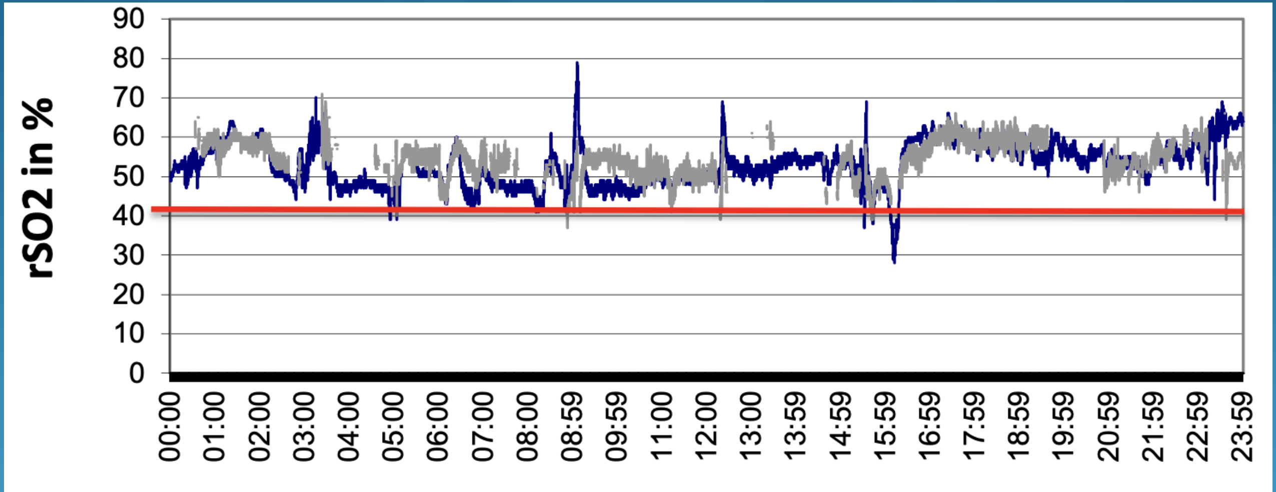
Interpretation of NIRS values

rScO_2 %



1) Hou, Physiol Meas 2007; 2) Kurth, J Cereb Blood Flow Metab 2005;
3) Dent, J Thorac Cardiovasc Surg 2002 4) Alderliesten T submitted

First of all: think about cerebral and somatic



Insufficient blood flow/cardiac output lowers both

Only reduced cerebral rSO2 can be a regional problem

Renal NIRS for open duct

Clinical Investigation | Published: 07 September 2016

Near-infrared spectroscopy for detection of a significant patent ductus arteriosus

Valerie Y. Chock, Laura A. Rose, Jeanet V. Mante & Rajesh Punn

Pediatric Research **80**, 675–680 (2016) | Cite this article

Low Rsat < 66% was associated with the presence of an hsPDA in the preterm infant. Csat may be preserved if cerebral autoregulation is largely intact. Bedside NIRS monitoring may reasonably increase suspicion for a significant PDA in the preterm infant.

Influencing factors

- **blood pressure**
- **CO/SvO_2**
- **Hb**
- **SaO_2**
- **$paCO_2$**

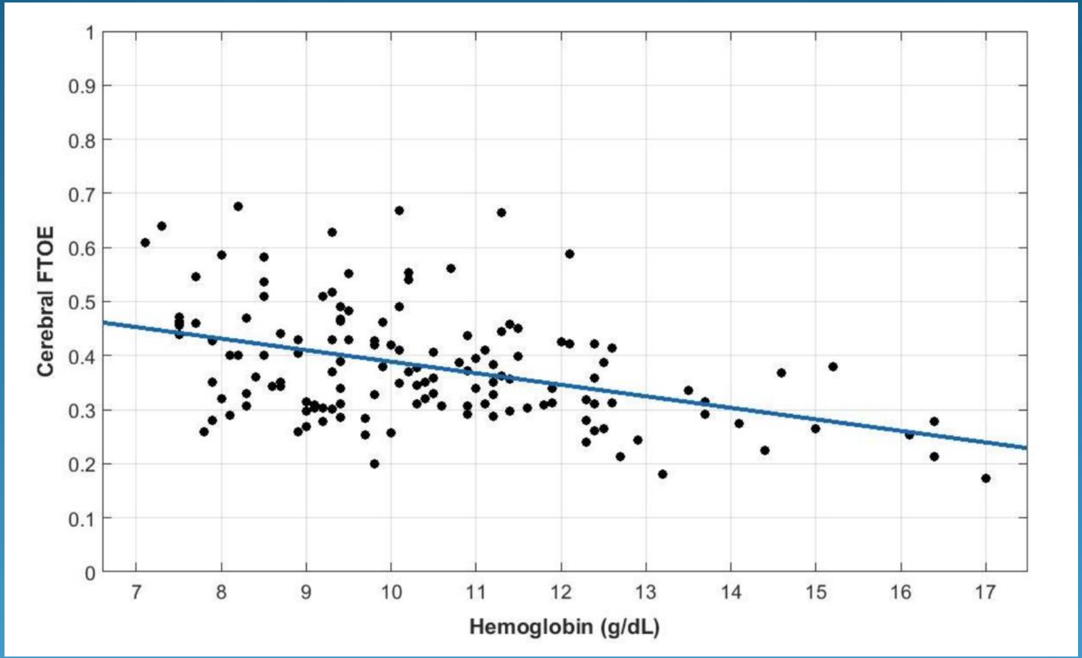
after CPB:
cardiac stunning
capillary leakage syndrome
arrhythmias
relevant blood loss

need of:
inotropes
vasopressores
volume
blood products

after CPB:
lung impairment
capillary leakage syndrome – lung edema

- **mechanical obstruction of cerebral perfusion**
- **cerebral O_2 consumption (fever, seizures etc.)**

Influence of Hemoglobin levels

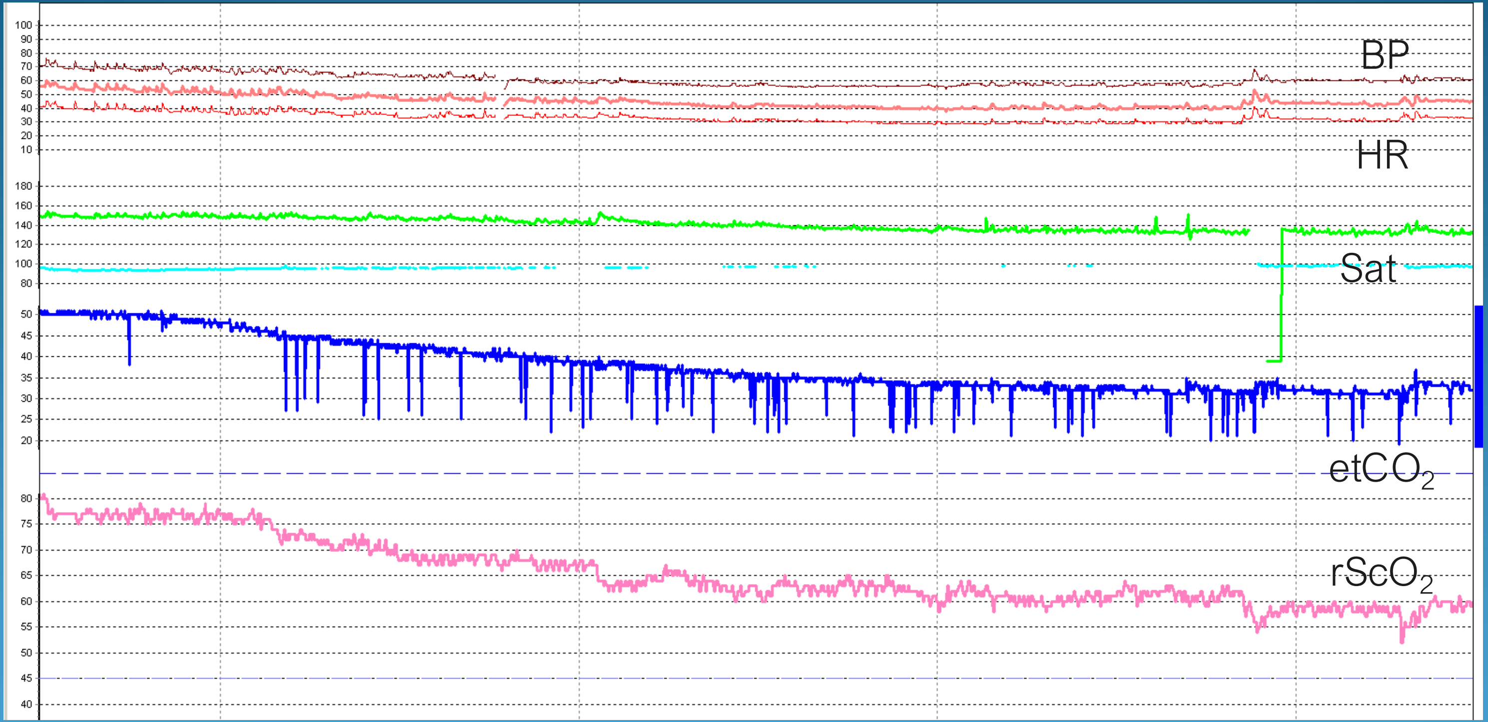


Using Cerebral NIRS Measures for an Individualized Approach to RBC Transfusions in Premature Infants

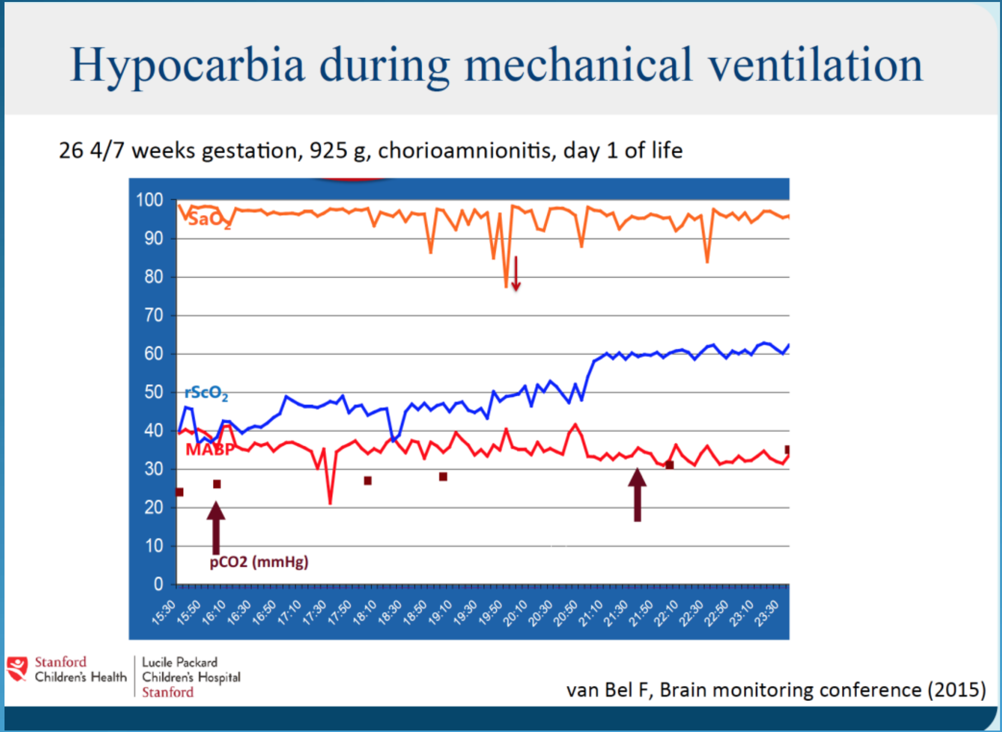
Halana V. Whitehead MD- Washington University School of Medicine
Akhil Maheshwari MD- Johns Hopkins University School of Medicine
Amit M. Mathur MD – Washington University School of Medicine
Zachary A. Vesoulis MD – Washington University School of Medicine

Scatter plot illustrating the correlation between hemoglobin and cerebral fractional tissue oxygen extraction (cFTOE)

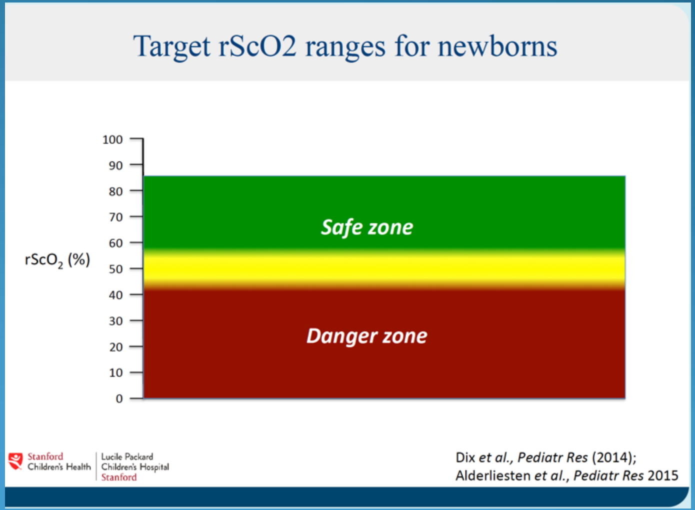
rScO2 dependent on CO2



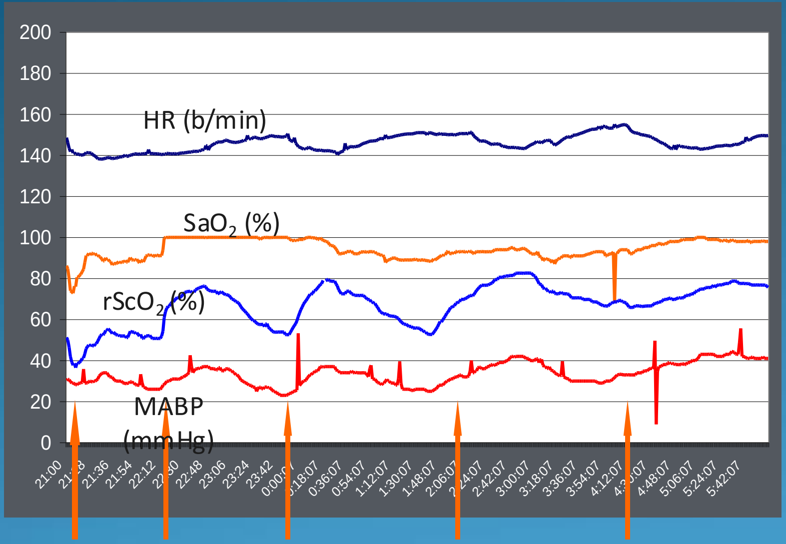
CO2 influences cerebral oxygenation

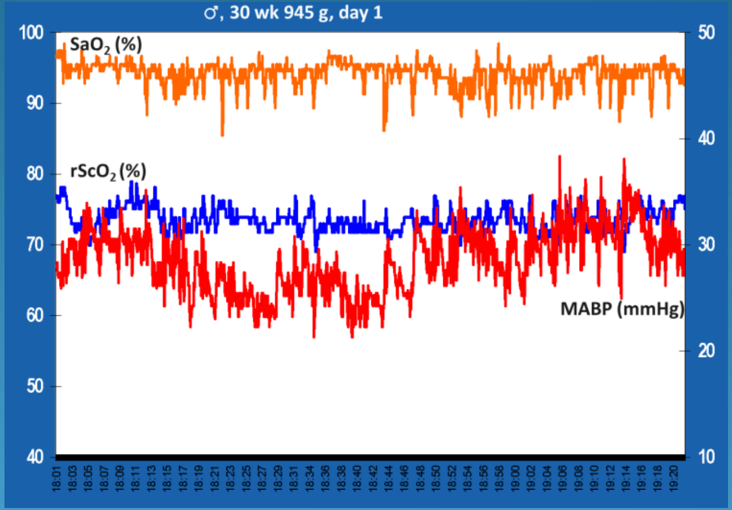


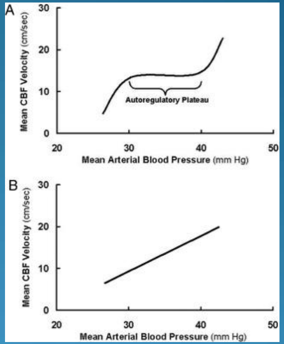
rScO2: regional cerebral oxygen saturation



Uses of NIRS – Estimator of autoregulatory ability







no autoregulation

with autoregulation

(Caicedo 2012; Brady 2010)

Modes of ventilation matter…

Observational Study > J Pediatr Surg. 2016 Mar;51(3):349-53.
doi: 10.1016/j.jpedsurg.2015.07.021. Epub 2015 Aug 10.

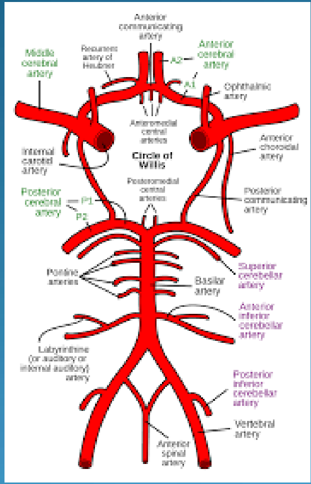
Effects of ventilation modalities on near-infrared spectroscopy in surgically corrected CDH infants

Andrea Conforti [1], Paola Giliberti [2], Francesca Landolfo [2], Laura Valfrè [2], Claudia Columbo [2], Vito Mondi [2], Irma Capolupo [2], Andrea Dotta [2], Pietro Bagolan [2]

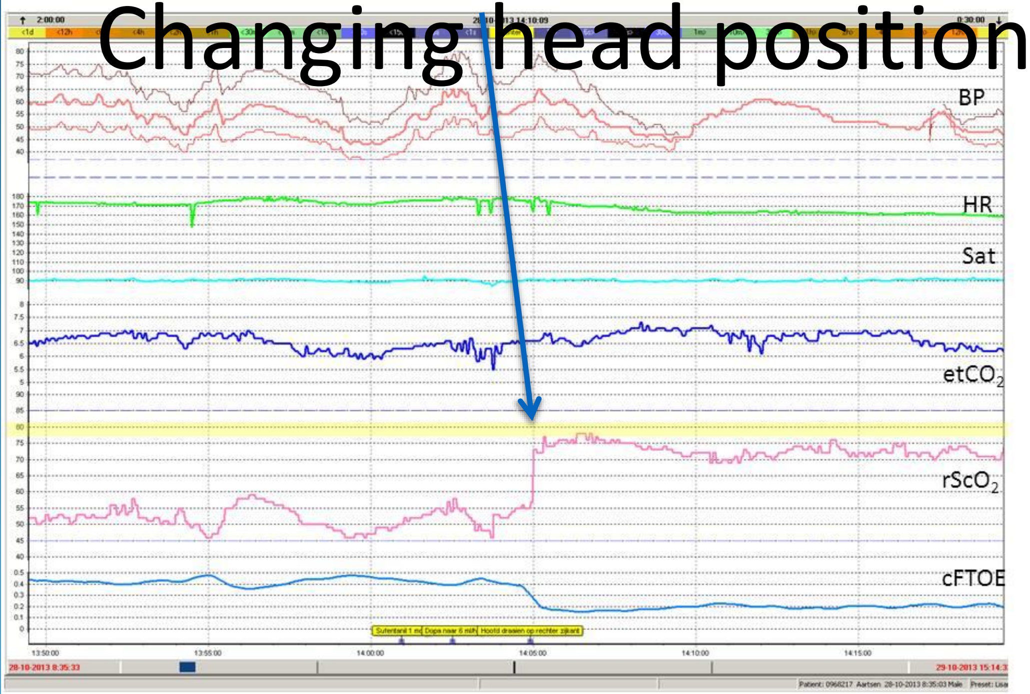
No intraoperative difference between HFOV and CMV (conventional mechanical ventilation)

BUT: Patients ventilated by HFOV need a longer time interval to recovery normal rSO2C values, than those ventilated by CMV. This may be owing to a different impact of HFOV on patients' hemodynamic status with a higher impairment on total venous return and its negative consequences on cardiac output.

Beware of circle of Willis variants



Changing head position

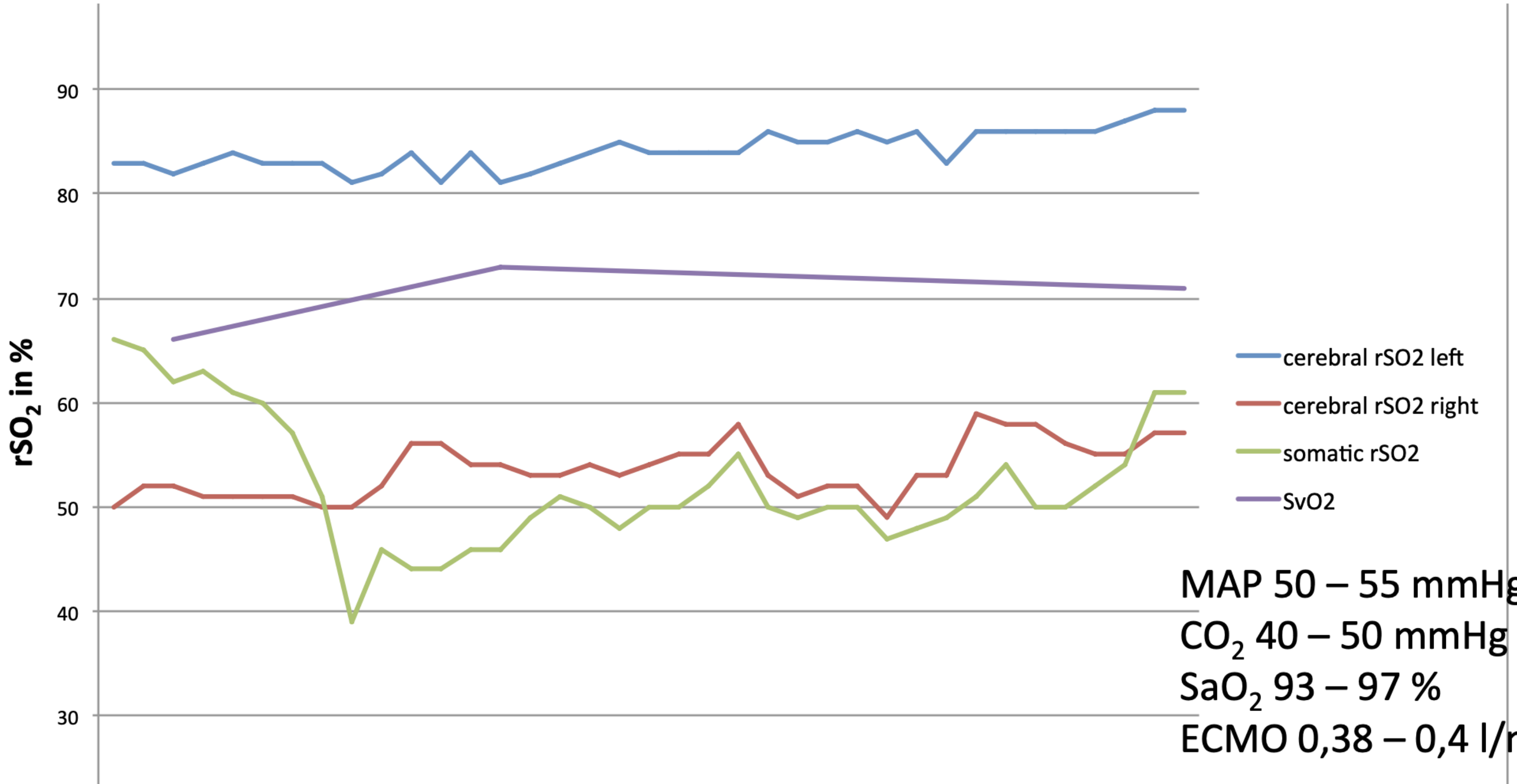


Incidence 15-30% adults

Krabbe, Radiology 1998
Van Kooij, Neonatology 2010

Bilateral cNIRS can be helpful

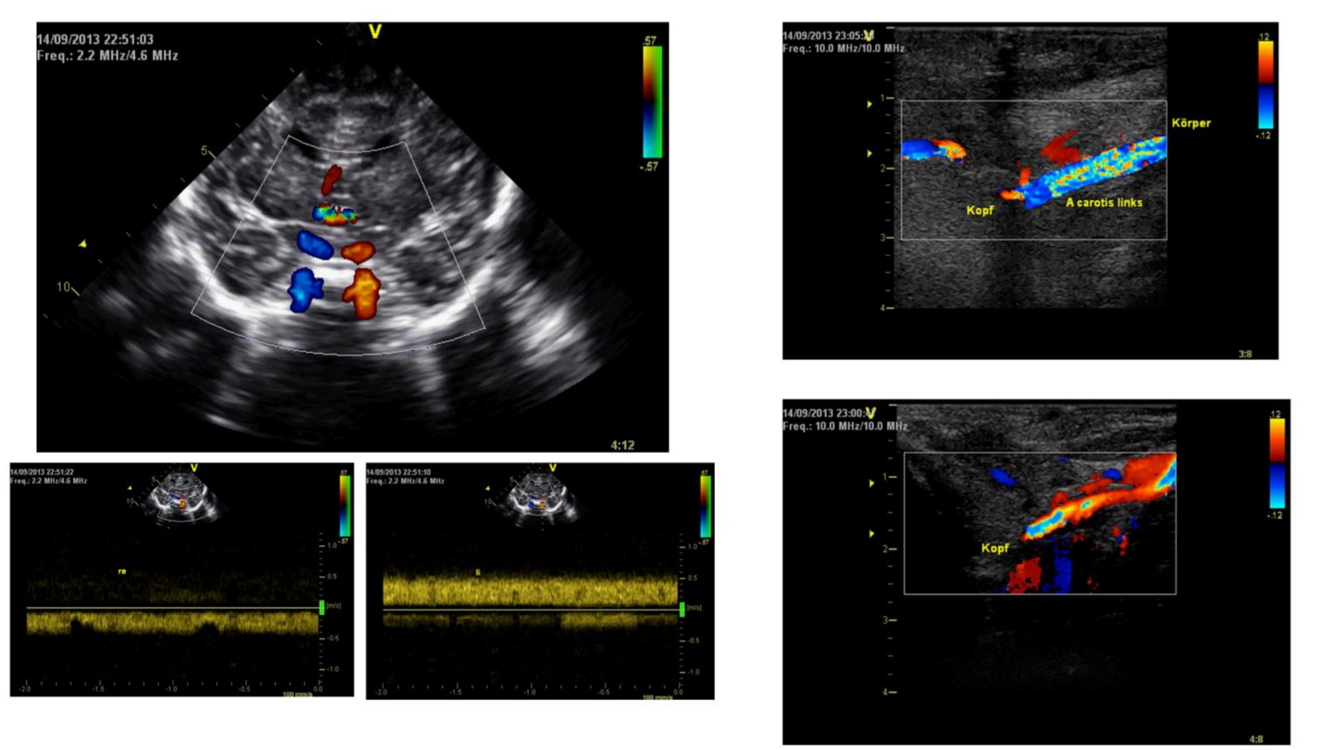
1 month old with CHD who went on ECMO after resucitation



MAP 50 – 55 mmHg
CO_2 40 – 50 mmHg
SaO_2 93 – 97 %
ECMO 0,38 – 0,4 l/min

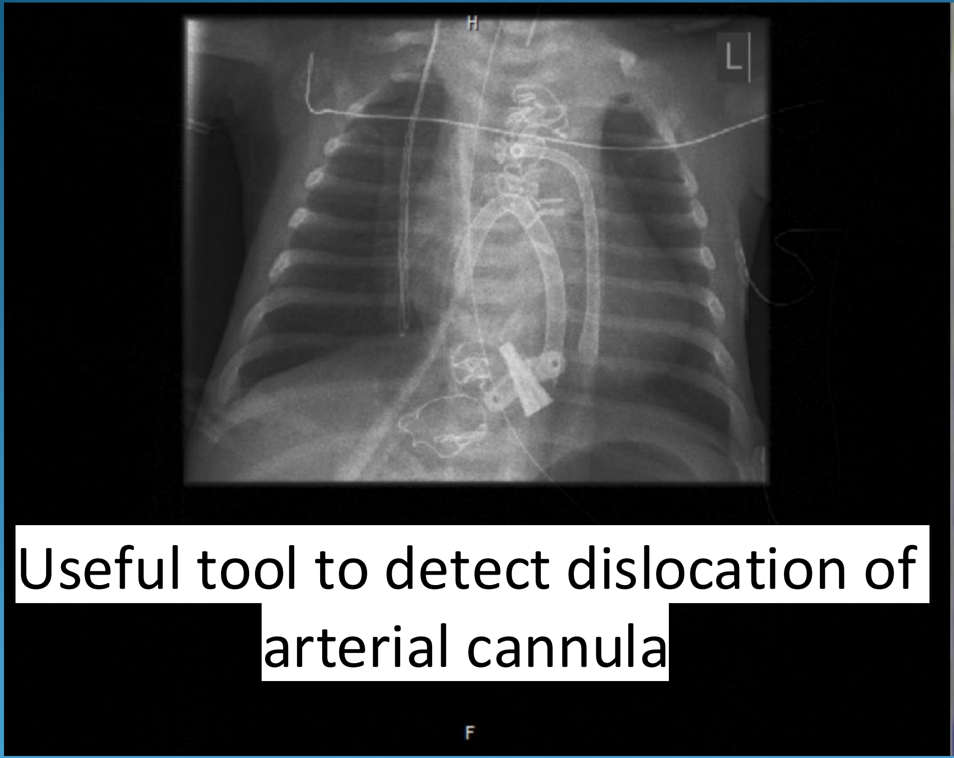
Bilateral cNIRS can be helpful

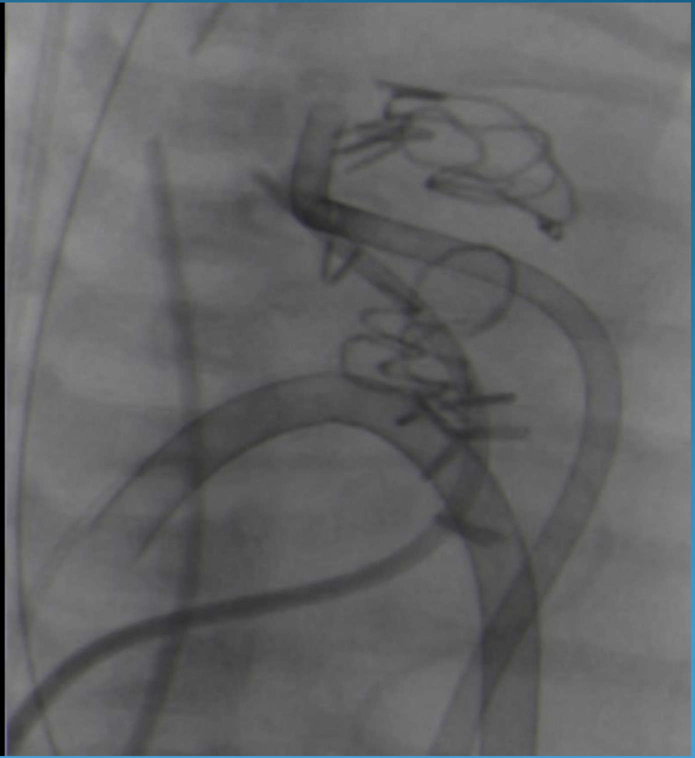
1 month old with CHD who went on ECMO after resucitation



Bilateral cNIRS can be helpful

1 month old with CHD who went on ECMO after resucitation



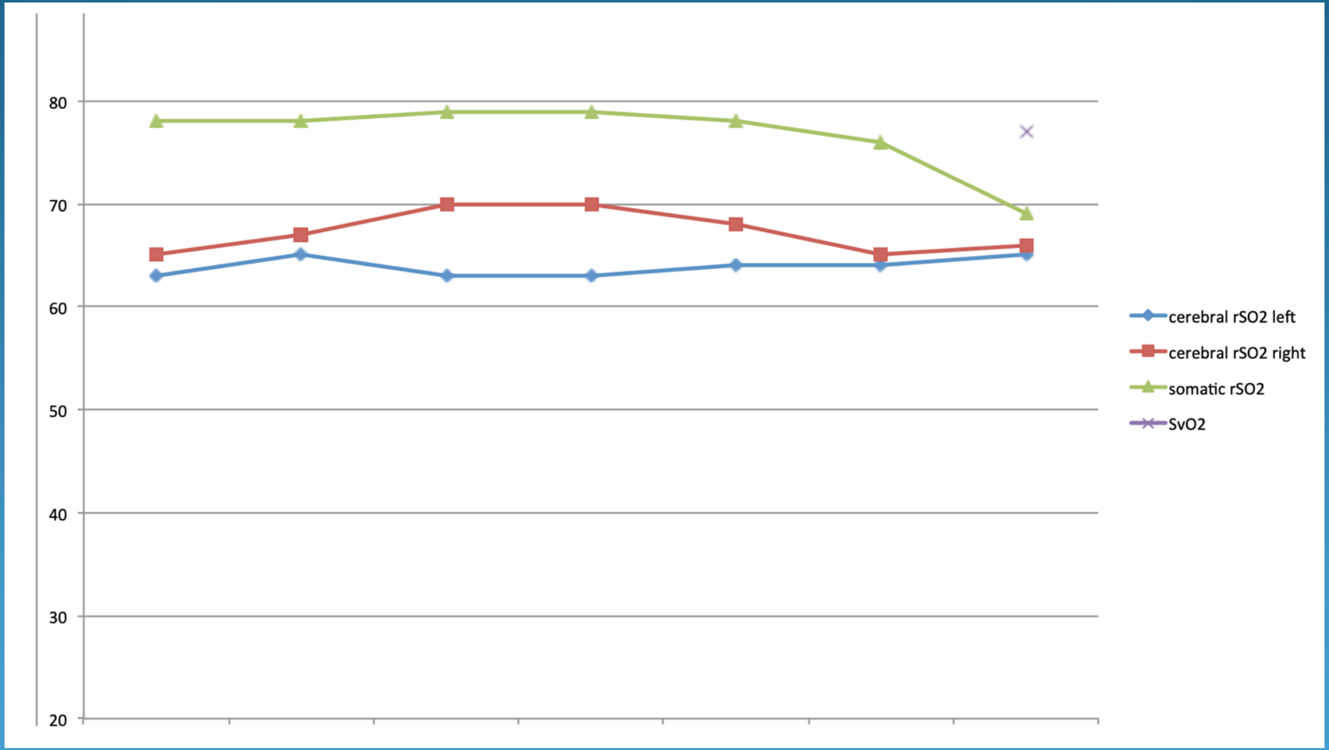


Useful tool to detect dislocation of arterial cannula

Case courtesy of Deutsches Herzzentrum München

Bilateral cNIRS can be helpful

1 month old with CHD who went on ECMO after resucitation



Case courtesy of Deutsches Herzzentrum München

Check and intervention plan

If $rScO_2$ is<55%

Low $rScO_2$ reflects low oxygen delivery so check:

arterial oxygen saturation

hemoglobin concentration
cerebral blood flow

MAP

PDA/shunts

pCO_2

If $rScO_2$ is>85%

High $rScO_2$ reflects high oxygen delivery so check:

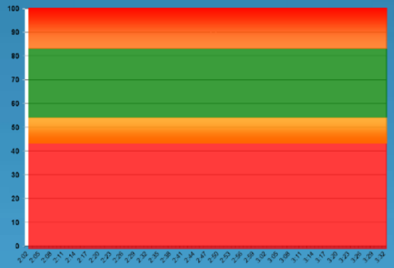
respiratory status

arterial oxygen saturation

MAP

pCO_2

blood glucose level



Pellicer 2014 Neonatology

SafeBoosC trials

- SafeBoosC-III trial was not able to show significant advantages of NIRS monitoring in the first 72h of life
- the SafeBoosC-II trial showed a decreased number in the burden of hypoxic events

Use right tools or all at once to see more…

Neuromonitoring	Clinics	CUS	aEEG/EEG/EP	NIRS	MRI
neonatal seizures	±	+	++	−	++
Asphyxia/HIE	++	+	++	+	++
Intracranial bleeding/ IVH/PHH	±	++	++	+	+
congenital heart disease	+	+	++	++	+
extremely preterm infant (<28wks)	+	++	++	±	+
Stroke (arterial/venous infarction)	±	+	+	−	++
Enzephalitis/Meningitis	+	±	++	−	+
cerebral malformation	+	+	+	−	++
metabolic disease	+	±	+	−	+

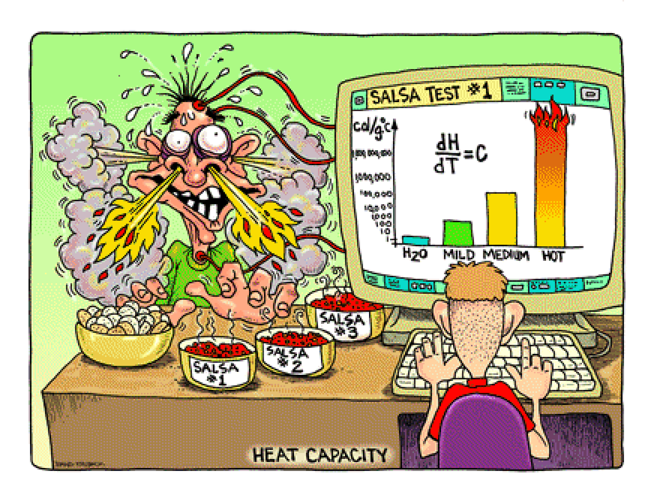
Combining rScO2 with aEEG provides us with additional information and can help to detect and prevent brain injury

Predictive values of $rScO_2$, aEEG score and the Combined score

12 hours	$rScO_2$	aEEG	Combined
Sensitivity (%)	46	100	100
Specificity (%)	86	69	87
PPV (%)	67	62	91
NPV (%)	73	100	100
24 hours	***rScO2***	***aEEG***	***Combined***
Sensitivity (%)	92	92	92
Specificity (%)	64	76	88
PPV (%)	57	66	80
NPV (%)	94	95	95
36 hours	***rScO2***	***aEEG***	***Combined***
Sensitivity (%)	90	77	77
Specificity (%)	65	73	86
PPV (%)	53	50	70
NPV (%)	96	90	90

Lemmers et al, Pediatr Res 2013

THANK YOU !



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European Society of Paediatric and Neonatal Intensive Care

St. Marien KINDER Krankenhaus

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