Why should we consider NAVA ventilation in preterm infants?

MIĘDZYNARODOWA KONFERENCJA NAUKOWO-SZKOLENIOWA
"NEONATUS 2015„ 24-25 września 2015r.

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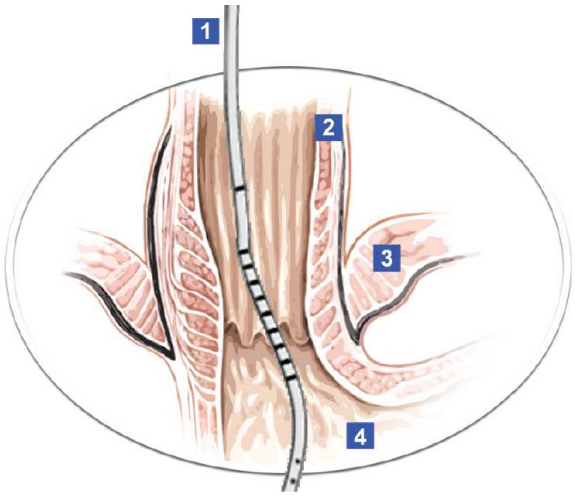
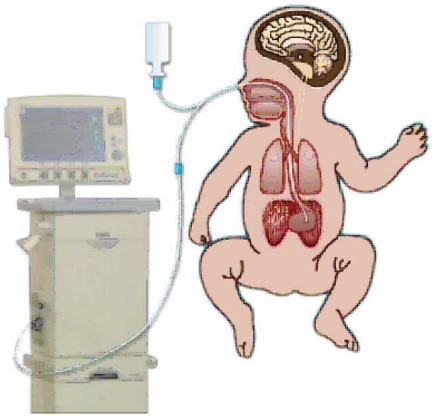
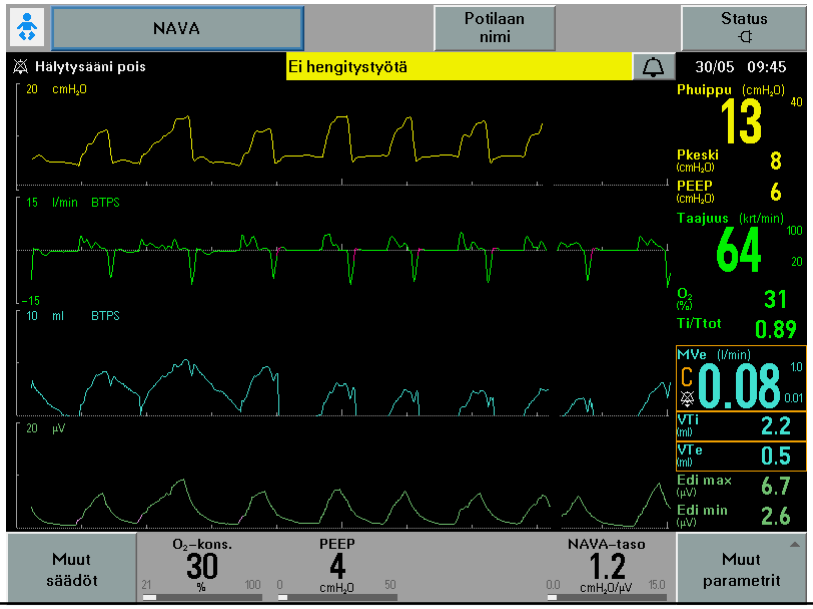
NAVA = Neurally Adjusted Ventilation Assist





Muscular contraction of the diaphragm is always preceded by an electrical impulse and this electrical activation is controlled by nerve stimuli, and ultimately by the respiratory center in the brain.

Edimax goal 5-15 µV



Edimax goal 5-15 µV

Edimin close to baseline

CLINICAL PROTOCOL. CATEGORY: NEONATAL ICU

NEURALLY ADJUSTED VENTILATORY ASSIST, NAVA

Focus

This clinical protocol describes the rationale and patient selection involved in using invasive and non-invasive NAVA[a] with newborn patients.

Rationale

The neural signals for breathing are reflected by the measured electrical activity of the diaphragm (Edi). A validated and standardized method for measuring Edi signals has been described in newborn and premature infants[1-4] and involves the use of microelectrodes placed on a conventional naso/orogastric feeding tube (Edi Catheter). NAVA operates on neural and pneumatic trigger, the one which appears first will be assisted. The Edi signal is used to determine both the time and amount of assistance given by the ventilator for each single breath. Further, due to the recognition of the trigger signal already at the level of the diaphragm, the patient-ventilator synchrony is improved during NAVA ventilation[1,3,4].

The Edi max represents the maximal electrical activity of the diaphragm for a particular breath while Edi min represents the electrical activity of the diaphragm between inspiratory efforts – baseline.

The maximum pressure provided during a single breath is:

Peak inspiratory pressure (cmH_2O) = NAVA level ($cmH_2O/\mu V$) x (Edi max – Edi min (μV)) + PEEP (cmH_2O)

Patient selection

Sufficient respiratory effort is required for NAVA ventilation. This is dependent upon the maturity of the infant's respiratory center, the ability to respond to variations in blood CO_2 and lung mechanical state in addition to a higher responsiveness to the inspiratory inhibitory reflex.

NAVA in practice

1. Insertion of catheter

- Choose appropriate catheter size and calculate the insertion length (NEX length) according to the formula provided. Dip the catheter with water. Run the Edi module test and connect the Edi cable to the Edi catheter. Open the "neural access" menu on the ventilator and select "Edi catheter positioning". Check the Edi catheter position (P wave disappears in the lowest lead and the two middle leads are highlighted blue during active inspiration).

2. Setting the initial NAVA level

- Option 1. Set the NAVA level initially to 1 $cmH_2O/\mu V$ and optimize the level as described below.
- Option 2. Open the "neural access" menu on the ventilator and select "NAVA preview". Two pressure curves appear in the upper window: a yellow one, that represents the actual pressure delivery, and a gray one that provides an estimation of the pressure delivered (based on actual Edi and NAVA level) if the patient was switched to NAVA at this time. Adapt the NAVA level so that the estimated pressure curve (gray) resembles the actual pressure curve (yellow). If satisfactory, press "Accept". Press "NAVA" in "Select ventilation mode". The NAVA level that appears is based on the level selected in the preview window.

3. Optimizing the NAVA level

- Optimize the NAVA level according to Edi max, which should be targeted between 5-15 μV.

  - If Edi max is < 5 μV, decrease the NAVA level.

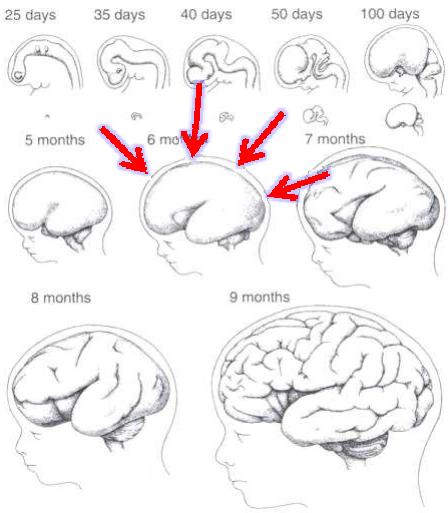
  - If Edi max is > 15 μV, increase the NAVA level.

  The changes in NAVA level should be 0.1-0.2 $cmH_2O/\mu V$ at a time. The changes in NAVA level are mediated in a

Soukka H, Lehtonen L: A practical guideline www.criticalcarenews.com

Why should we consider NAVA ventilation in preterm infants?

To protect the vulnerable brain of a preterm infant.
A critical period for brain development – environment matters



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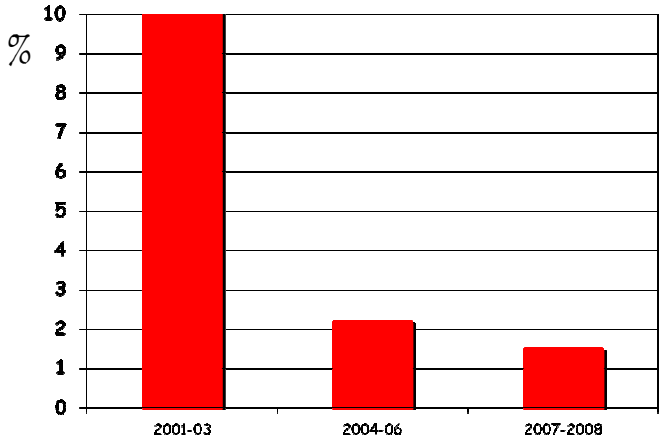
Lehtonen L, 14.6.2013

More gentle treatment strategies →
CP in VLBW infants (%) decreased
Turku University Hospital



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Cognitive development in infants born below 32 GA
at 5 years of age. The PIPARI Study.

WPPSI-R	mean (SD)
IQ	104 (16)
VIQ	104 (15)
PIQ	102 (17)

Lehtonen L, 2014

The developmental outcome of a preterm infant is impaired by

- Hypoxia or hyperoxia or fluctuation
- Hypo/hypercarbia or fluctuation
- Long ventilator treatment
- Hypotension or fluctuations of BP
- Poor nutrition/growth
- Hypoglycaemia
- Infections and inflammation
- Pain and pain medication
- Postnatal dexamethasone (and other drugs?)
- Sleep deprivation and stress
- Separation from the parents
- Parents' stress/depression

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When a newborn has breathing problems, there are physiological compensation mechanisms to ensure the brain oxygenation

pCO_2 ↑

pO_2 ↓

→ Cerebral Blood Flow ⇧

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In case of hyperventilation, the brain suffers from ischaemia

pCO2 ↓

pO2 ↑

→ Cerebral Blood Flow ⇩

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Potential for brain protection

1. No iatrogenic hyperventilation
   the infant is normoventilated by own regulation
   (Stein et al)

pCO2 ↓ → Cerebral Blood Flow ⇩

pO2 ↑ → Cerebral Blood Flow ⇩

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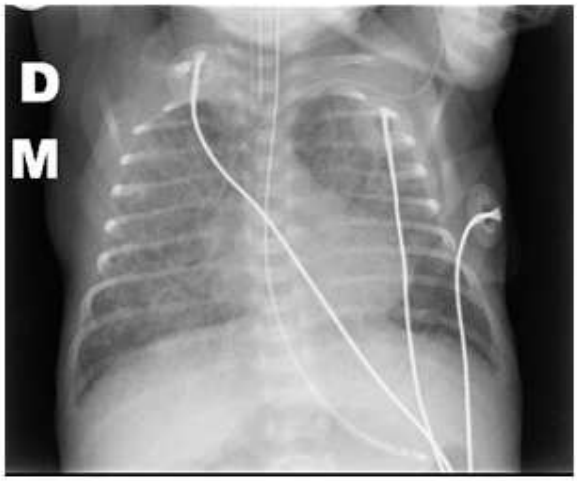
Babyboy born at 23+6 weeks (bw 720g).

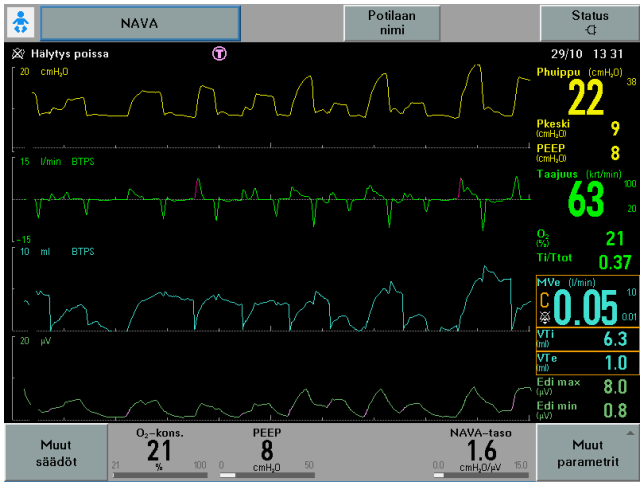
RDS, developing BPD, PDA



A 30-day-old boy born at 23+6 weeks.

Switched to NAVA when 23 days old. Stable and comfortable.

pH 7.35-7.43/ pCO2 5.41-6.69 kPa



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Potential for brain protection

1. No iatrogenic hyperventilation
   the infant is normoventilated by own regulation (Stein et al)

2. Less exposure to brain toxic medications
   less pain medication/sedatives are needed
   Kallio et al, 2014
   less dexamethasone (own data)

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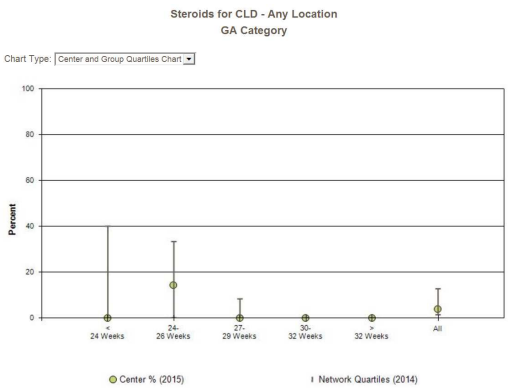
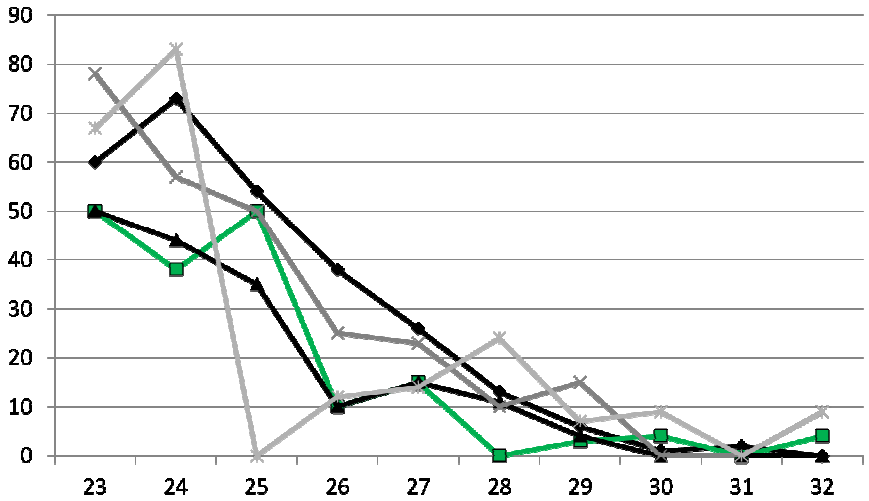
Less postnatal dexamethasone

The proportion of 22-27 GA infants receiving postnatal dexamethasone in Turku University Hospital

in 2004-2010	25%
in 2011	22%
in 2012	10%
in 2013	9%
In 2014	10%
In 2015	7%



Steroids for BPD in 5 university hospitals in Finland in years 2008 to 2010



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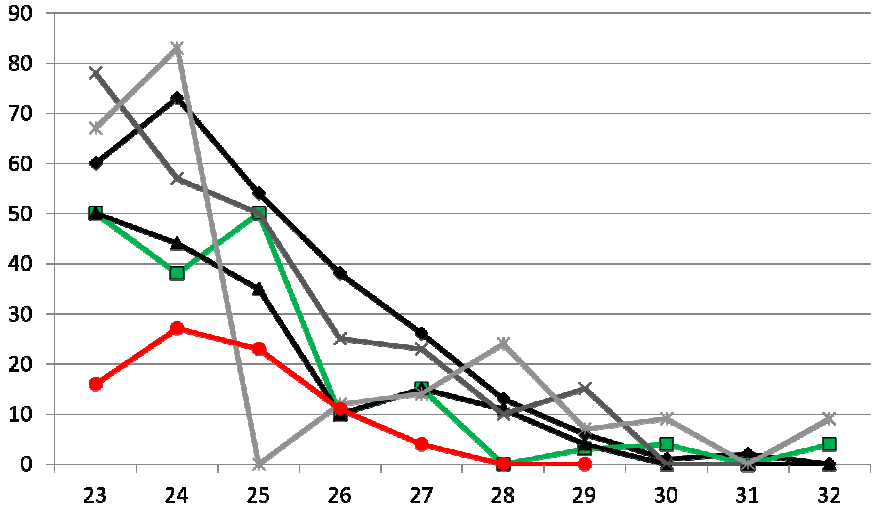
Steroids for BPD in 5 university hospitals in Finland in years 2008 to 2010

+ Turku University Hospital in 2011 to 2014



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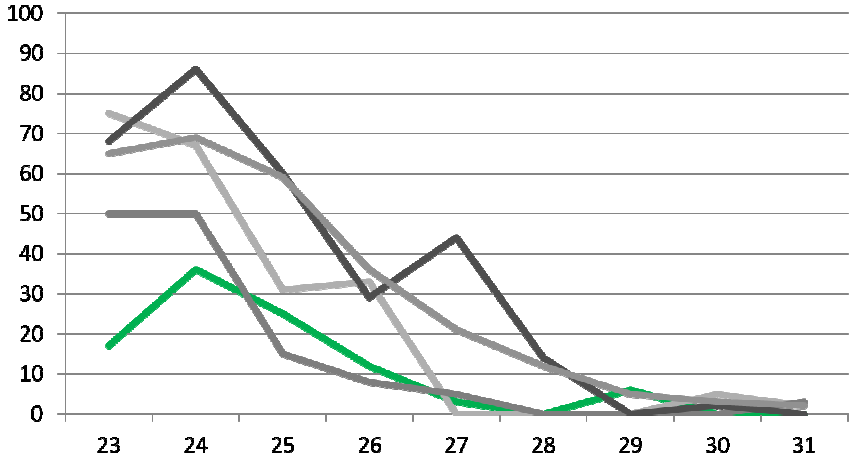
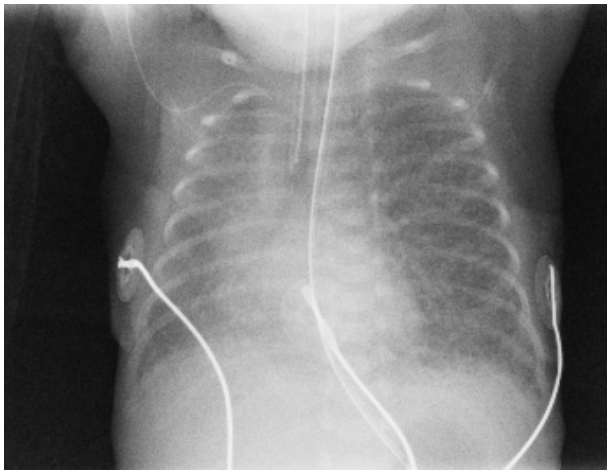
Steroids for BPD in 5 university hospitals in Finland in years 2010-13



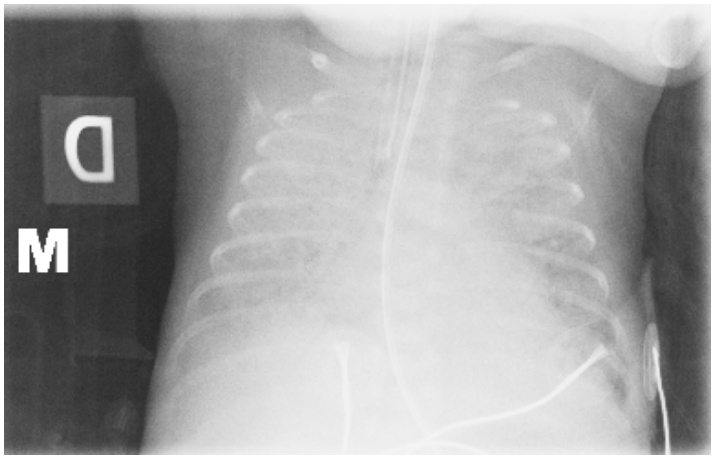
”Venla”
H 24+1, 520 g (-2.2 SD),
Apgar 2/4/4

Chorioamnionitis
PPROM 13 d

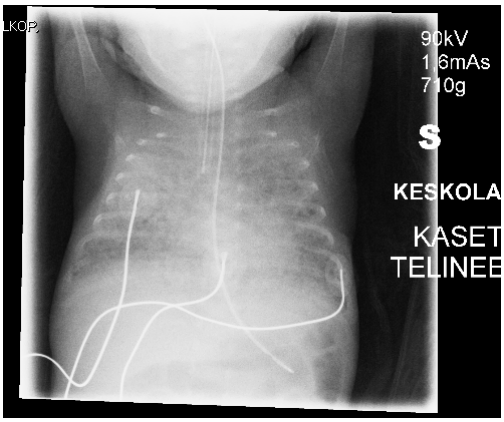
Chest x-ray @dol 7



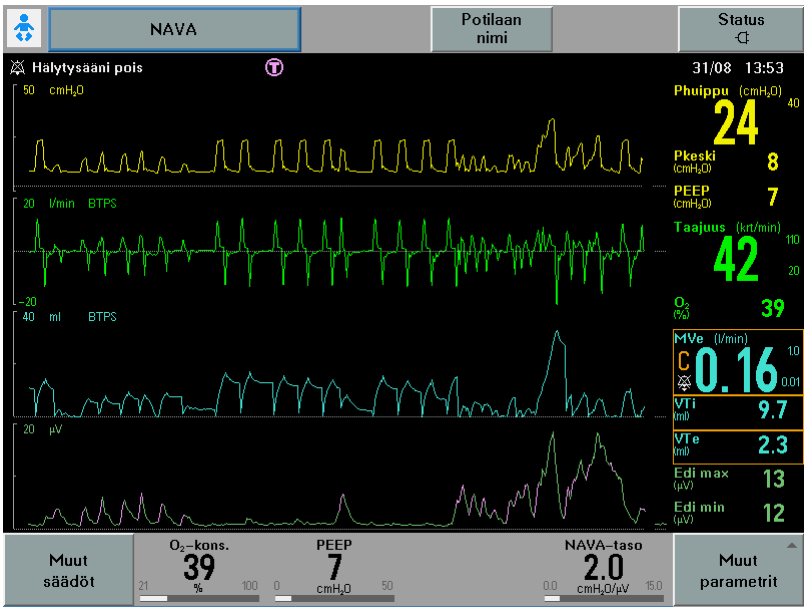
Chest x-ray @dol 13, PDA re-opened

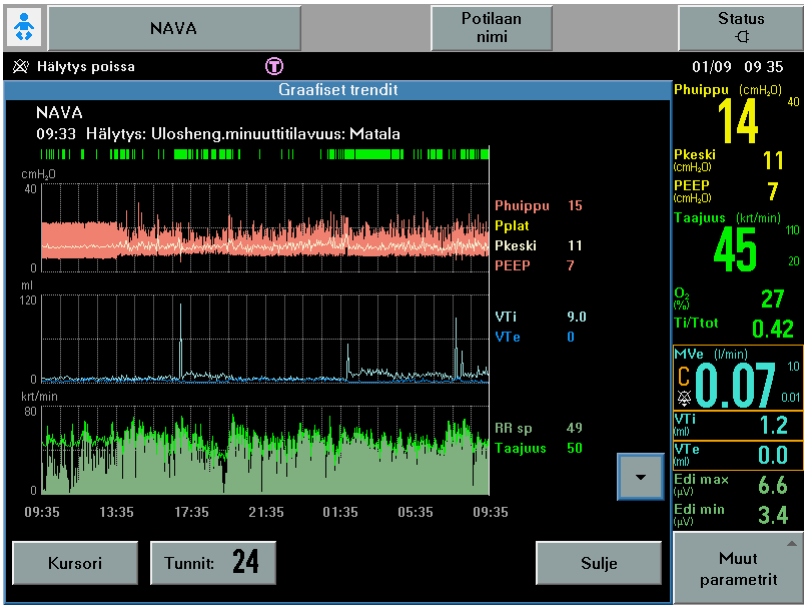


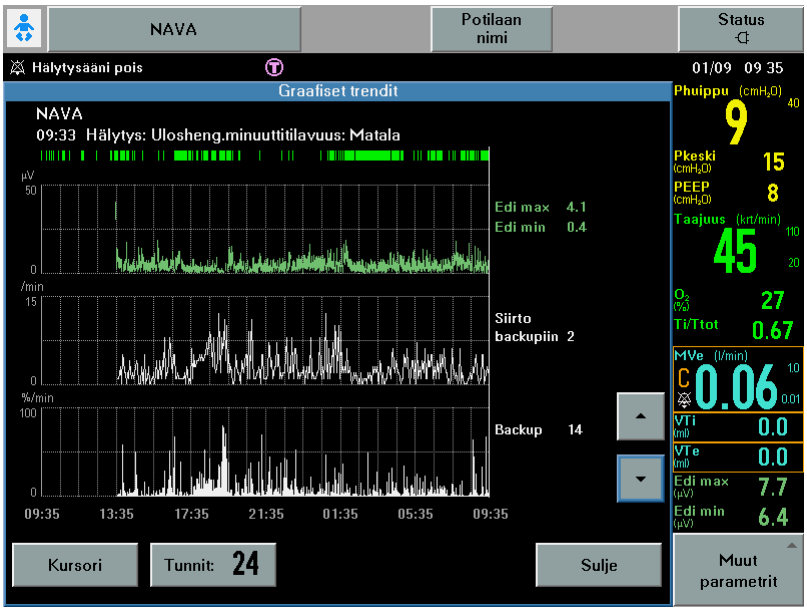
@dol 27: SIMV + PS
fr 45/ 22/6 /FiO2 0.60
Chest x-ray

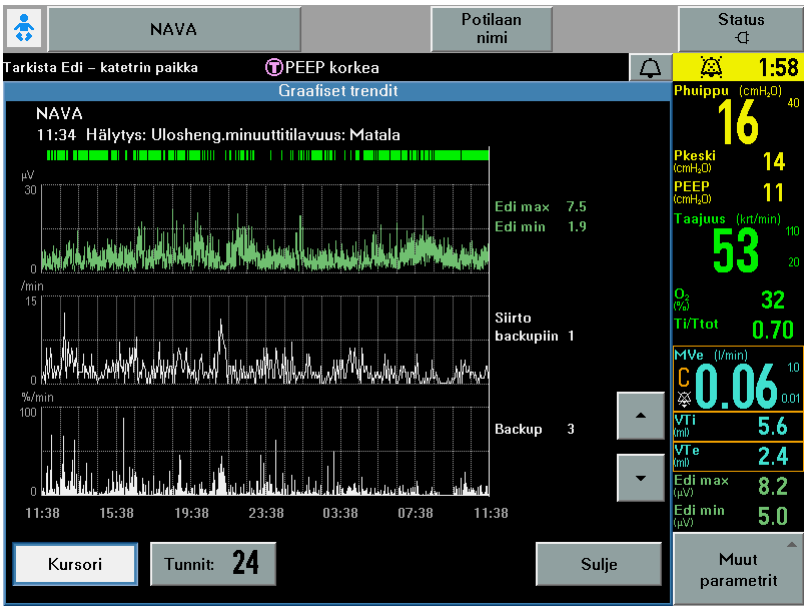


@dol 33: NAVA 2.0, PEEP +7, FiO2 0.30-0.45


NAVA
Potilaan nimi
Status
Hälytysääni pois
31/08 13:53
50 cmH2O
Phuippu (cmH2O)
24
Pkeski (cmH2O) 8
PEEP (cmH2O) 7
Taajuus (krt/min)
42
20 l/min BTPS
-20
40 ml BTPS
O2 (%) 39
MVe (l/min)
0.16
VTi (ml) 9.7
VTe (ml) 2.3
20 µV
Edi max (µV) 13
Edi min (µV) 12
Muut säädöt
O2-kons.
39
%
PEEP
7
cmH2O
NAVA-taso
2.0
cmH2O/µV
Muut parametrit


NAVA
Potilaan nimi
Status
Hälytys poissa
01/09 09 35
Graafiset trendit
NAVA
09:33 Hälytys: Ulosheng.minuuttitilavuus: Matala
cmH2O
Phuippu 15
Pplat
Pkeski 11
PEEP 7
ml
VTi 9.0
VTe 0
krt/min
RR sp 49
Taajuus 50
09:35 13:35 17:35 21:35 01:35 05:35 09:35
Phuippu (cmH2O)
14
Pkeski (cmH2O) 11
PEEP (cmH2O) 7
Taajuus (krt/min)
45
O2 (%) 27
Ti/Ttot 0.42
MVe (l/min)
0.07
VTi (ml) 1.2
VTe (ml) 0.0
Edi max (µV) 6.6
Edi min (µV) 3.4
Kursori
Tunnit: 24
Sulje
Muut parametrit


NAVA
Potilaan nimi
Status
Hälytysääni pois
01/09 09 35
Graafiset trendit
NAVA
09:33 Hälytys: Ulosheng.minuuttitilavuus: Matala
Edi max 4.1
Edi min 0.4
Siirto backupiin 2
Backup 14
09:35 13:35 17:35 21:35 01:35 05:35 09:35
Phuippu (cmH2O) 9
Pkeski 15
PEEP 8
Taajuus (krt/min) 45
O2 27
Ti/Ttot 0.67
MVe (l/min) 0.06
VTi 0.0
VTe 0.0
Edi max 7.7
Edi min 6.4
Kursori
Tunnit: 24
Sulje
Muut parametrit


NAVA
Potilaan nimi
Status
Tarkista Edi – katetrin paikka
PEEP korkea
1:58
Graafiset trendit
NAVA
11:34 Hälytys: Ulosheng.minuuttitilavuus: Matala
Edi max 7.5
Edi min 1.9
Siirto backupiin 1
Backup 3
11:38 15:38 19:38 23:38 03:38 07:38 11:38
Phuippu (cmH2O) 16
Pkeski 14
PEEP 11
Taajuus (krt/min) 53
O2 32
Ti/Ttot 0.70
MVe (l/min) 0.06
VTi 5.6
VTe 2.4
Edi max 8.2
Edi min 5.0
Kursori
Tunnit: 24
Sulje
Muut parametrit

Potential for brain protection

1. No iatrogenic hyperventilation
   the infant is normoventilated by own regulation (Stein et al)

2. Less exposure to brain toxic medications
   less pain medication/sedatives are needed (Kallio et al, 2013)
   less dexamethasone

3. Less stress
   baby is more comfortable and sleeps better

Lehtonen L, 2014

Clinical experiences

The feedback comes from the both patients and parents:

Baby is more comfortable. Baby sleeps better.

Lehtonen L, 2014

Clinical experiences

The feedback comes from the clinical data

→ potential brain protection

→ potential lung protection

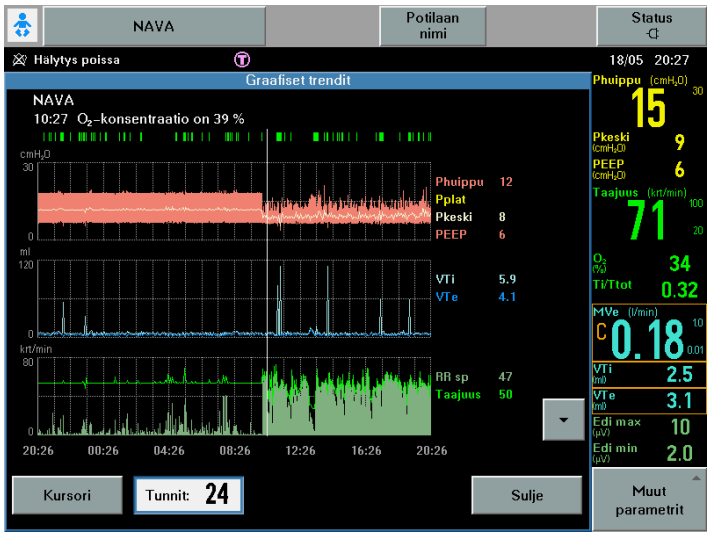
Potential for lung protection

Peak inspiratory pressure decreases

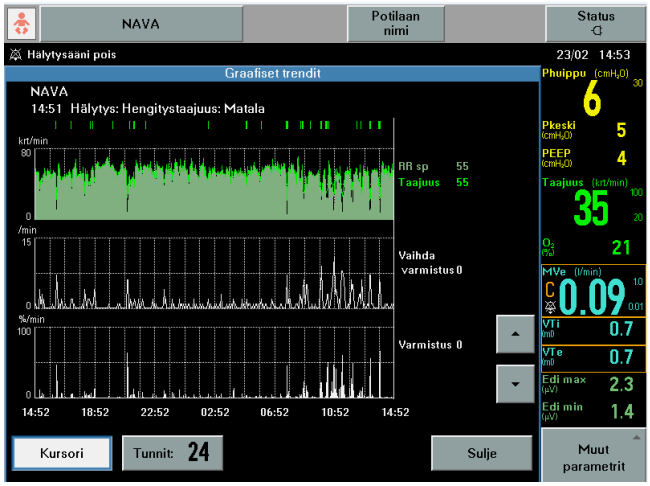
Stein H & Howards D J Pediatrics 2012;
Lee et al, J Pediatrics 2012;
Kallio et al, 2014

→ less barotrauma

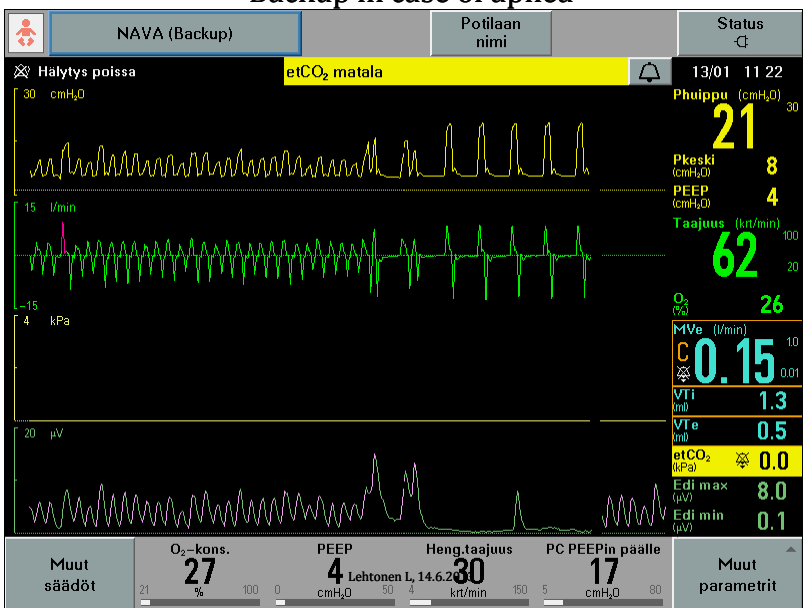
Peak inspiratory pressure is lower on NAVA
PIP 18 cmH2O → 9 to 15 cmH2O



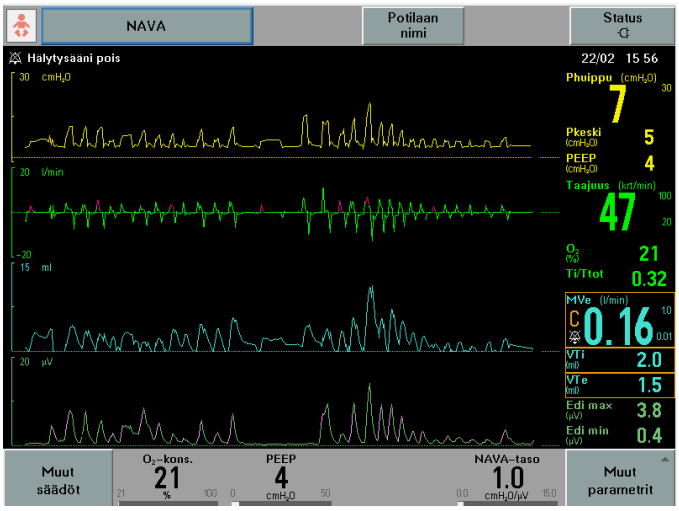
A new tool to monitor the patient



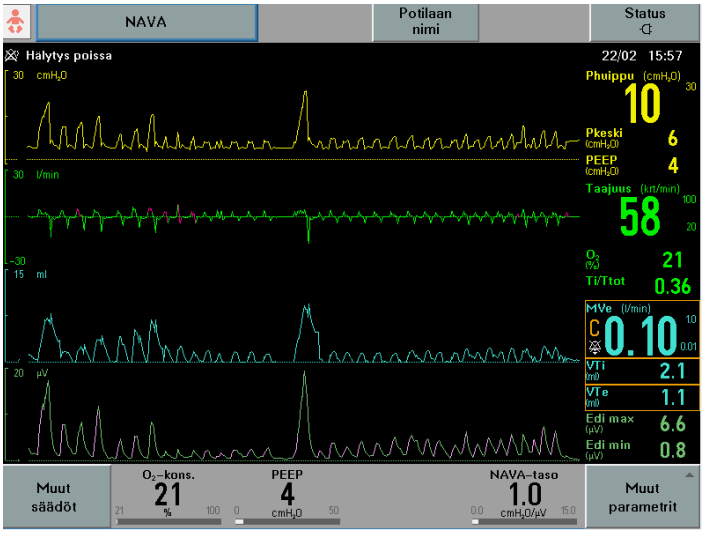
Backup in case of apnea



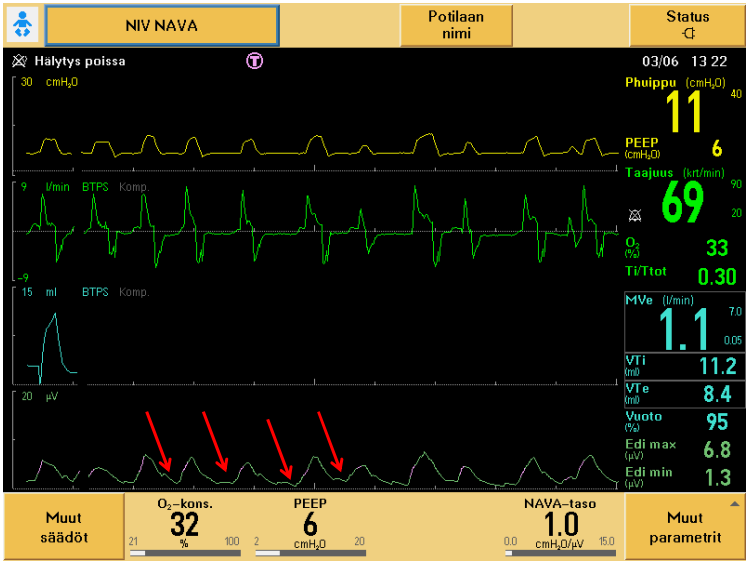
Periodic breathing pattern

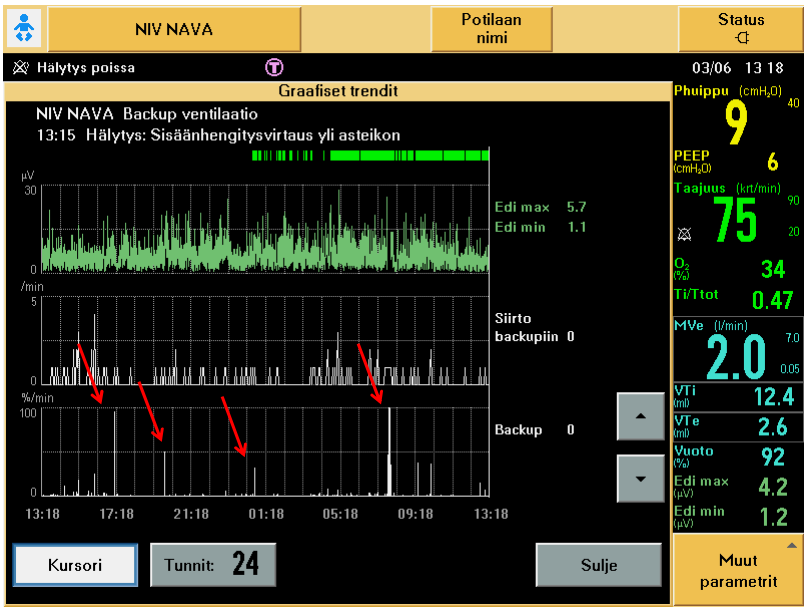


Sigh



A tool to adjust PEEP/CPAP





Lehtonen L, 2014

Why should be consider NAVA ventilation?

It is simple.

Lehtonen L, 2014

Why should be consider NAVA ventilation?

It is simple. It is safe.

Why should be consider NAVA ventilation?

It is simple. It is safe. The child does better job with regulating than we do.

Evidence

- Research evidence
  - Physiological studies: less asynchrony, lower PIP
  - Research of clinical outcomes scarce
  - One RCT including neonates, no meta-analyses
- Clinical experience
  - Positive user experiences - increasingly
  - Consensus is still lacking
- Patient perspective
  - Patient-friendly care
  - Positive feedback from the parents

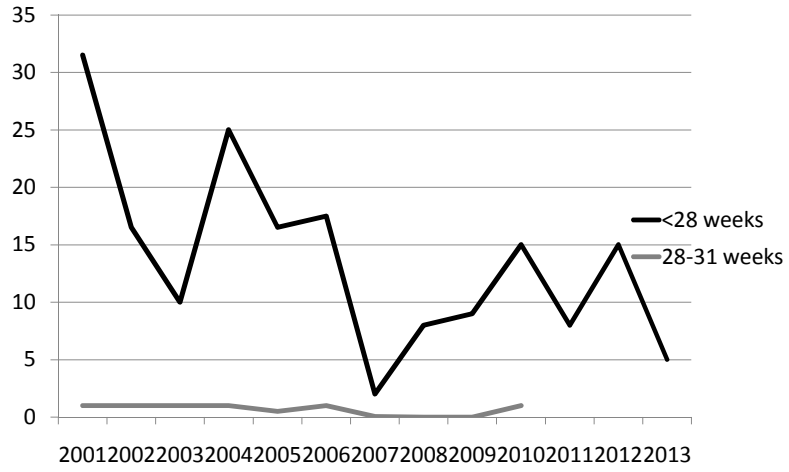
Turku University Hospital, Finland

NAVA ventilation beginning from 9/2009

NIV-NAVA beginning from 1/2010

	9/2009	2010	2011	2012	2013	2014
NAVA	9	20	28	37	36	44
NIV-NAVA		15	33	28	24	12

Ventilator days (median) in gestational age groups in Turku University Hospital



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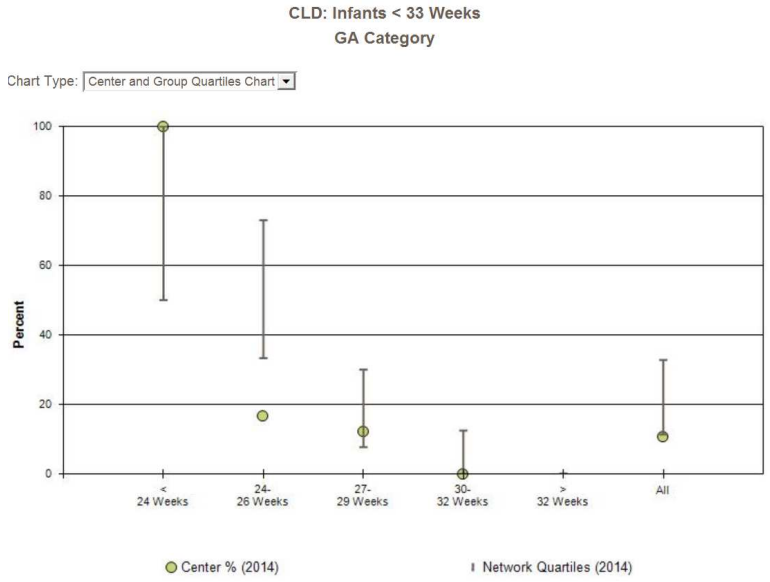
Low rate of BPD compared to Vermont Oxford Network



A practical guideline: how to begin and NAVA level

- **To insert Edi-catheter, slide the catheter in until you see the Edi signal**
- **Start from NAVA level 1.0 $cmH_2O/\mu V$ and adjust according to patient's breathing effort (reflected by Edi max level when the patient is sleeping)**
  - **If Edi peak high (>15), increase support (NAVA level)**
  - **If Edi peak low (<5), decrease support (NAVA level)**
- **Adjust PEEP to keep Edi min close to baseline**
  - **If Edi min is high, increase PEEP**

A practical guideline: apnea time

- Start with apnea time of 5 seconds
- Adjust according to patient's respiratory drive:
  - Frequent apnea in unstable infant, decrease apnea time
  - More stable infant, increase apnea time to prioritize NAVA