Neurally Adjusted Ventilatory Assist (NAVA) In Neonates Advanced

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<table>
<thead>
<tr>
<th>Conventional Ventilation</th>
<th>NAVA Ventilation</th>
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<th>NAVA Ventilation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Patient Controls using Flow Trigger:</strong></td>
<td><strong>Patient Controls using Neural Trigger:</strong></td>
<td><strong>Flow Trigger:</strong></td>
<td><strong>Neural Trigger:</strong></td>
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<tr>
<td>Initiation of Breath</td>
<td>Initiation of Breath</td>
<td>Based on patient's effort</td>
<td>Based on patient's drive</td>
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<tr>
<td>Rate (in some modes)</td>
<td>Rate</td>
<td>Leak dependent</td>
<td>Leak independent</td>
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<tr>
<td>Termination (some modes/ventilators)</td>
<td>Termination of Breath</td>
<td>When breathing:</td>
<td>When breathing:</td>
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<td></td>
<td>Peak Pressure (tidal volume)</td>
<td>Ventilator synchronous for:</td>
<td>Ventilator synchronous for:</td>
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<td></td>
<td>Inspiratory Time</td>
<td>Breath initiation, termination (some vents)</td>
<td>Breath initiation, size, and termination</td>
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<td></td>
<td><strong>Ventilator Controls:</strong></td>
<td><strong>When apneic:</strong></td>
<td><strong>When apneic:</strong></td>
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<tr>
<td>FIO2</td>
<td>FIO2</td>
<td>Ventilates in pressure (or volume) control</td>
<td>Ventilates in pressure control</td>
</tr>
<tr>
<td>PEEP</td>
<td>PEEP</td>
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<tr>
<td>Peak Pressure or Tidal Volume</td>
<td>NAVA Level</td>
<td></td>
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<tr>
<td>Inspiratory Time</td>
<td>Apnea time (minimum rate)</td>
<td></td>
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<tr>
<td>Termination of Breath</td>
<td>Peak Inspiratory pressure</td>
<td></td>
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<tr>
<td>Minimum Rate</td>
<td><strong>Synchrony:</strong></td>
<td></td>
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<tr>
<td></td>
<td>Initiation of Breath</td>
<td></td>
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<tr>
<td></td>
<td>(some modes/vents)</td>
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**Disclaimers**

Dr Stein:
- Was on the speaker’s bureau for Maquet
- Is discussing products made by Maquet
- Has received no financial support or incentives from Maquet to use NAVA or collect this data
- Is on the speakers bureau for Chiesi
How to set the NAVA level

- NAVA level is the proportionality factor that converts the Edi signal into a pressure.
- The higher the NAVA level the more work of breathing the ventilator does.
- The lower the NAVA level the more work of breathing the patient does.
- Goal – to unload the work of breathing from the patient to the ventilator without over assisting the patient.
- The ventilator continues to respond to the patient’s respiratory drive but supports the patient’s respiratory effort.

Edi Titration Study – to determine the optimal NAVA level

Edi Titration Study – to determine the optimal NAVA level

## Pressure and Volume Distribution in Premature Neonates

<table>
<thead>
<tr>
<th>Variable (+ SD)</th>
<th>NAVA</th>
<th>NIV NAVA</th>
</tr>
</thead>
<tbody>
<tr>
<td># Neonates</td>
<td>24</td>
<td>12</td>
</tr>
<tr>
<td>Birth weight – grams</td>
<td>857 (362)</td>
<td>835 (179)</td>
</tr>
<tr>
<td>Study weight – grams</td>
<td>862 (361)</td>
<td>844 (165)</td>
</tr>
<tr>
<td>Gestational age – weeks</td>
<td>26.5 (2.3)</td>
<td>26.8 (1.5)</td>
</tr>
<tr>
<td>Study age - days</td>
<td>8 (9)</td>
<td>13 (12)</td>
</tr>
<tr>
<td>Ave # Breaths / neonate</td>
<td>29,646</td>
<td>45,030</td>
</tr>
<tr>
<td>Total breaths</td>
<td>711,498</td>
<td>540,361</td>
</tr>
</tbody>
</table>

Stein, Firestone 2015 - in progress

### Clinical Case - Significant apnea

- 29 weeks 1180 grams
- CPAP at birth and weaned from 35% down to RA over 2 days
- Ready to come off CPAP – pCO2 <50
- However - Significant Apnea despite Caffeine
APNEA

CPAP vs. NIV vs. NIV NAVA

NIV PS with Apnea

NIV PC

CPAP with Apnea
NIV PC with Autocycling

NIV NAVA with Apnea

NIV NAVA as CPAP

NAVA and BPD

Limited experience at TCH:
- All patients inborn or transferred at birth (no late BPD admissions)
- Early use of NAVA
- Majority of BPD < 25 weeks or hypoplastic lungs due to prolonged ROM
- No patients ventilated at 36 weeks or home on ventilator in > 2 years (typically 3-4/yr)
- Withdrew from OPQC complex discharge group due to no patients
Clinical Case - CLD and NAVA

- 32 weeks, 1730 grams admitted to a level 3 NICU after hx of leaking for many months. Received Surfactant but uneventful course and discharged home after 5 weeks.
- After 1 day at home she was readmitted to PICU with RSV pneumonia.
  - Required high vent settings and unable to ventilate
  - Transferred to specialized PICU for airway evaluation and management
    - Received trach and GT but continued on high vent support, opiate dependent for sedation and MRSA infection
    - Mom kicked out of RM House due to prostitution and requested transfer to our PICU to ‘be closer to family’
- On arrival in our PICU was on SIMV PC 28/6, 90% with pCO2 in 60s and compensated pH (+17)
  - Opiate dependent with signs of withdrawal
  - Diagnosed with pneumonia and septicemia (positive bld cx with klebsiella) and started on antibiotics
  - Over the next 3 days had severe BPD spells with sats as low as 0% up to 5 times per day
- Transitioned to NAVA

9 hours prior to NAVA

- Note high Edi

3 hours on NAVA

- Decreasing RR
- Periods of recruitment
- Immediate decrease in Edi
- NAVA and BPD

Anecdotal reports from other NICUs:
- Patients on CV with BPD switched to NAVA:
  - Decreased FiO2, PIP and TV overall with better gases
  - Intermittent large PIP and TV
  - Less sedation, increased comfort and more sleep
  - Less ‘BPD spells’
  - Many, previously committed to home ventilation, extubated to NIV NAVA and then to NC
  - Become ‘addicted’ to NAVA and challenging to transition to home vent
  - ‘Sprints’ on home vent until tolerated
Issues with Invasive NAVA

- Patient is in backup ‘all the time’ so why are we in NAVA?

In NAVA backup when apneic

In SIMV PC when apneic

Clinical Case - Disappearing Edi Signal

- 2 day old 33 week neonate on NIV PC
- NAVA catheter placed
- Good Edi signal noted

Edi signal on NIV PC
Placed on NIV NAVA — no

Head’s Paradoxical Reflex

Back on NIV PC — Edi present

Relook at Original tracing
Relook at Edi on NIV NAVA

Using the catheter positioning screen to diagnose arrhythmias

- Intubated patients noted to have arrhythmias on the bedside monitor
- Nava catheter electrodes are situated behind the heart and close to the atria – retrocardiac EKG
- Catheter positioning screen may be a useful adjunct to diagnosing arrhythmias

Normal Sinus Rhythm

Premature Atrial Contraction

Premature atrial beat

P wave
Atrial Flutter 2:1 Block

Atrial Fibrillation

AV Block

AV Nodal Re-entrant Tachycardia

QRS complexes
P wave
Atrial Fibrillation
AV Block
p-waves
AV Nodal Re-entrant Tachycardia
Retrograde p-wave
NAVA WORKS IN NEONATES!
But does it make a difference?

TCH VON data - neonates < 1500 grams
Comparison group – Level 2b

Time line events:
- Feb 2008 – moved into the new NICU
- May 2008 – NAVA
- 2009 – OPQC collaborative – line infection
- July 2010 – NIV NAVA
% Late infection in neonates < 1500 grams - VON Data

% CLD in neonates < 1500 grams
VON Data

% Death or Morbidity in neonates < 1500 grams

% Survival without Morbidities in neonates < 1500 grams
Median LOS (days) in neonates < 1500 grams - VON Data

NAVA WORKS IN NEONATES!

But does it make a difference?

- Large multi-center trials are needed to answer questions if:
  - NAVA prevents intubation or decreases time on ventilators?
  - NAVA decreases the incidence of chronic lung disease?
  - NAVA improves outcomes?