Neurally Adjusted Ventilatory Assist (NAVA)

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**No Disclosures**
Objectives

- Describe how NAVA works
- Explain initiation procedure
- Discuss management strategies
What is NAVA?

- Mode of ventilation
- Requires a Servo I ventilator & a special feeding tube
- Can be used with multiple interfaces (invasive or NIV)
  - Ram Cannula
  - CPAP/BiPAP mask
  - Nasal prongs
  - ETT/trach
NAVA History

- 1960’s- Diaphragm Electromyography (EMG)
  - Publications noted increased activity on inhalation with sustained, lower levels on exhalation
- 1999- Dr. Christer Sinderby invented NAVA
  - Developed the catheter with electrodes embedded
- 2000- Collaboration with Maquet
  - Developed software that eliminates artifact and produces Edi waveform
- 2007- FDA approval
How does NAVA work?

- The Electrical activity of the Diaphragm (Edi) is measured via insertion of a NAVA feeding tube (either NG or OG) and connected to Servo I ventilator.
- Clinician sets NAVA level and PEEP
- Patient controls their respiratory rate and tidal volume
- The ventilator delivers the breath in proportion to, and in synchrony with the Edi signal
- Edi signal provides continuous monitoring of the respiratory drive
- The signal is measured in microvolts 62.5 times per second
NAVA allows the patient to trigger the ventilator many steps up the neuro-ventilatory cascade providing greater synchrony and patient comfort.
Indications:

- Spontaneously breathing
- Intact phrenic nerve
- Anticipation of requiring ventilatory support >48hrs
- Difficult to wean patients
- Patients that have ventilator asynchrony problems unless sedated and/or paralyzed
- Past failed extubations
- Requiring Bipap support

Contraindications:

- Insufficient/absent respiratory effort
- Bilateral diaphragm paralysis secondary to phrenic nerve damage
- Central apnea
- Any contraindications for having an OG/NG placed or need for MRI
- Congenital myopathy
- Esophageal atresia or diaphragmatic hernia
Edi: The New Respiratory Vital Sign

**Edi Peak:**
- Represents the signal to the diaphragm during inspiration
- Reflective patient’s respiratory status/disease process
- Ideally should range from about 10-20 $\mu$V
- Represents phasic diaphragm activity

**Edi Min:**
- Represents the signal to the diaphragm at end exhalation
- Indicative of PEEP optimization
- Ideally should range from 0.1-1.0 $\mu$V
- Represents tonic diaphragm activity
Neuro-muscular Coupling

Health

Disease

Edi

V_T

μV

ml
EDI Catheters

- Sizes range from 6Fr/49cm to 16Fr/125cm
- Lumen for gastric feeding (Sump lumen on 12Fr and 16Fr)
- Electrode array (10 electrodes) to measure Edi and esophageal ECG
- Coating on Edi Catheter for easier insertion - activated by dipping in sterile water (ONLY use sterile water!)
- Barium strip for X-ray identification
- Disposable (proper NAVA functionality ensured at least 5 days at normal use although we have been using them for 3-4 weeks without issues)
- Normal use for feeding
- Are NOT MRI compatible! EDI catheter should be removed, kept as clean as possible and can be reinserted after scan
Edi Catheter Insertion

- Connect the Edi module and cable
- Perform the Edi module function check
- Select appropriately sized catheter
- Measure NEX (the distance in cm 1-2-3)
- Access Edi catheter positioning screen on ventilator
- Slowly insert catheter to estimated depth

Edi Catheter Selection Guidelines

The following table can be used as a guideline for which Edi catheter can be used with different size of patients (neonate, pediatric, and adult).

<table>
<thead>
<tr>
<th>Fr/cm</th>
<th>6 / 49</th>
<th>6 / 50</th>
<th>8 / 50</th>
<th>8 / 100</th>
<th>12 / 125</th>
<th>16 / 125 or 8 / 125</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (kg)</td>
<td>&lt; 55</td>
<td>0.5 - 1.5</td>
<td>&lt; 55</td>
<td>1.0 - 2.0</td>
<td>&lt; 55</td>
<td>1.0 - 2.0</td>
</tr>
</tbody>
</table>
Edi Catheter Positioning

Optimal positioning:

- Middle two leads will be highlighted in **BLUE**
- QRS complex decreasing in size from top to bottom
- P-waves decreasing in size from top to becoming absent in bottom lead
- Document proper position depth
- Verify placement per hospital protocol prior to NG use
Edi Catheters
Edi Catheter Positioning

Edi catheter is not inserted deep enough:

- Bottom two leads are highlighted in **BLUE**
- Slowly advance catheter until middle two leads are **BLUE**
Edi Catheter Positioning

Edi catheter is inserted too deep:

- Top leads are highlighted in **BLUE**
- Slowly pull catheter back until leads 2 & 3 are **BLUE**

![Diagram of Edi Catheter Positioning](image)
Monitoring

- **Pressure Control**
- **Automode**
- **Admit patient**
- **Nebulizer**
- **Status**

### Additional settings

- **Additional settings**
- **O₂ conc.** 40%
- **PEEP** 5 cmH₂O
- **Resp. Rate** 34 b/min
- **PC above PEEP** 12 cmH₂O

### Additional values

- **O₂ conc.** 40%
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- **Resp. Rate** 34 b/min
- **PC above PEEP** 12 cmH₂O
NAVA Preview

Adjust the NAVA level so that the estimated pressure curve (gray) resembles the actual pressure curve (yellow). The NAVA level is typically set between 1.0 and 4.0 cmH20/μV. The range of settings is 0-15.0 cmH20/μV.

NAVA level x (Edi peak - Edi min) + PEEP = PIP
Invasive Settings

- Edi Trigg 0.5
- Keep PEEP same for now
- NAVA level as determined from preview screen
- Set appropriate PS settings
- Set appropriate backup ventilation settings
NAVA Modes

RT will actually set 3 modes for NAVA and the patient will automatically switch between these based upon the criteria below:

**NAVA** – **NAVA (PS)** – **NAVA (Backup)**

- Specific cases of asynchrony
- Edi Catheter disconnection
- ECG signal leakage into Edi signal.

- No pneumatic trigger

- Apnea with low Edi signal and no pneumatic trigger

- Edi resp. rate differs from pneumatic resp. rate by less than 20%
- 7 of the last 10 breaths are in synchrony with the Edi signal.

- Edi signal is back

*Notify RT if the patient seems to be switching between modes frequently or is staying in NAVA (Backup).*
Invasive NAVA Management

- Optimize the NAVA level according to Edi peak, which should be targeted between 10-20 μV.
- If Edi peak is < 5 μV, decrease the NAVA level.
- If Edi peak is > 25 μV, increase the NAVA level.
- Initially, set the same PEEP as in the previous ventilator mode. If Edi min is consistently > 2 μV (as a sign of tonic diaphragmatic activity to maintain FRC), increase PEEP. Optimal Edi min is 0.1-1.0 μV.
- When weaning NAVA level, watch for decrease in PIP without loss of Vt.
- PIP’s will automatically decrease as the patient's pulmonary status improves.
Troubleshooting

A **LOW** or absent Edi signal can signify:

- Hyperventilation
- Sedation
- Muscle relaxants
- Neural disorder
- Catheter malposition
- High PEEP levels

A **HIGH** Edi signal can signify:

- Insufficient respiratory support
- Pain/Discomfort
- Agitation
Non-invasive Settings

- Edi Trigg 0.5
- Keep PEEP same for now
- NAVA level as determined from preview screen
- Set appropriate backup ventilation settings
- Verify alarm limits (especially PIP and apnea)
Alarms

- Upper pressure alarm limit defaults to 20 cmH2O in NIV
- Set apnea time for backup ventilation
Non-invasive NAVA Management

- The NAVA levels in NIV NAVA are usually lower than in invasive NAVA (0.5 - 1.0 μV/cmH2O).
- Higher NAVA levels may increase the amount of gas entering the stomach/intestine and cause abdominal distention.
- If Edi peak is < 5 μV, decrease the NAVA level.
- If Edi peak is > 25 μV, increase the NAVA level.
- The changes in NAVA level should be in steps of 0.1-0.2 μV/cmH2O, with a few breaths between each step.
- Usually patients can be switched to nCPAP, when the NAVA level is < 0.5 μV/cmH2O.
- The maximum peak pressure is 32 cmH2O, or 5 cmH2O less than set upper pressure limit, whichever is lowest.
WWRTD?

Hint: Optimal Edi peak is 10-20 μV

Wean NAVA level due to Edi peak <5 μV
Increase PEEP due to Edi min >2 μV

Hint: Optimal Edi min is 0.1-1 μV
WWRTD?

Hint: The vent is alarming “regulation pressure limited”

Increase upper pressure alarm limit to ensure you’re not pressure limiting breaths.
NICU (Invasive NAVA)

Arterial Blood Gases Pre/Post NAVA

*Graph Legend*
- pH Arterial
- pCO2 Arterial
- PO2 Arterial
- Bicarbonate Arterial
- Base Deficit Art
- FIO2

**NAVA Initiated**
NICU (Invasive NAVA)

Arterial Blood Gases Pre/Post NAVA

NAVA Initiated
“Neurally Adjusted” Ventilatory Assist

Higher brain centers (cerebral cortex—voluntary control over breathing)

Other receptors (e.g., pain) and emotional stimuli acting through the hypothalamus

Peripheral chemoreceptors
- $O_2 \downarrow$, $CO_2 \uparrow$, $H^+ \uparrow$

Central chemoreceptors
- $CO_2 \uparrow$, $H^+ \uparrow$

Receptors in muscles and joints

Respiratory centers (medulla and pons)

Stretch receptors in lungs

Irritant receptors