

## CLINICAL PROTOCOL. CATEGORY: GENERAL ICU

# NEURALLY ADJUSTED VENTILATORY ASSIST, NAVA

### Focus

This clinical protocol describes the rationale, patient selection, practical issues and some of the troubleshooting involved in using invasive Neurally Adjusted Ventilatory Assist (NAVA®) with adult patients.

### Rationale

NAVA is a ventilatory mode characterized by ventilator triggering by diaphragm muscle electrical activity (Edi). In addition, the level of support depends on the intensity of the Edi signal (proportional support).

The maximum pressure provided during a specific breath is:

$$\text{Peak pressure (cmH}_2\text{O)} = \text{NAVA level} \times (\text{Edi peak} - \text{Edi min}) + \text{PEEP}$$

The NAVA level (set on the ventilator) dictates the amplification of the Edi signal when delivering assist to the patient. For example, if the NAVA level is set to 0.5  $\mu\text{V}/\text{cmH}_2\text{O}$  and the Edi for a specific breath is 20  $\mu\text{V}$ , the maximum level of support for that breath is 10  $\text{cmH}_2\text{O}$ .

The Edi peak represents maximal electrical activity of the diaphragm for a particular breath (in  $\mu\text{V}$ ).

The Edi min represents the electrical activity of the diaphragm between inspiratory efforts (in  $\mu\text{V}$ ).

### Patient selection

Today no literature exists that provides evidence that NAVA improves survival, length of ICU stay or time spent on the ventilator. However, compared to other ventilatory modes, ventilator support in NAVA more closely resembles normal respiratory physiology. Several studies have demonstrated improved patient-ventilator synchrony in NAVA compared to Pressure Support ventilation. Accordingly, patients at risk for asynchrony with the ventilator (i.e. intrinsic PEEP, respiratory muscle weakness) are most likely to benefit from NAVA. Improved patient-ventilator synchrony may improve quality of sleep.

Contraindications for NAVA ventilation:

- Known contraindications for naso-/orogastric feeding tube (including recent upper airway surgery, esophageal surgery, recent esophageal bleeding, skull base fracture)
- Known phrenic nerve lesions
- Congenital myopathy (relative contraindication)
- MRI scanning: the Edi Catheter is not approved for use in MRI environments. Remove from patient before entering the MRI area.

### NAVA in practice

#### 1. Nasal insertion of Edi Catheter

- Choose appropriate catheter size (usually 16 Fr, 125 cm), calculate insertion length according to formula provided on sheet in catheter package.
- Rinse catheter with water. This activates the lubricant on the catheter. Do not use silicon spray or other lubricants. This may result in catheter malfunctioning. Insert Edi catheter according to protocol “insertion nasogastric feeding tube” to calculated insertion length.
- Test Edi Module by connecting one end of the Edi Cable to the Edi Module and the other end to the test plug. Wait until the message “Test passed” appears on the ventilator screen.
- Connect Edi Cable to Edi Catheter.
- Open the “Neural access” menu on the ventilator.
- Select “Edi Catheter positioning”
- Check catheter position: usually there are P waves and QRS complexes in the upper leads. In the lower leads, the P waves disappear and the amplitude of the QRS complexes decreases.

- Confirm that the middle two ECG leads are highlighted in blue during an inspiratory effort. If the upper leads are highlighted in blue during inspiration, withdraw catheter a short distance 1 to 2 cm. If the lower leads are highlighted, move the catheter downwards instead. Close catheter positioning window.
- Secure catheter to nose according to nasogastric feeding tube protocol.

## 2. Setting initial NAVA level

The initial NAVA level is best selected based on the level of support provided using conventional ventilator modes (Pressure Support or Pressure Control):

- Open “Neural access”.
- Select “NAVA preview” (accessible in all ventilatory modes except in NAVA)
- 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 were switched to NAVA at this time.
- Adapt the NAVA level so that the area under the estimated pressure curve (gray) resembles the area under 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.
- Set adequate values for PEEP, FiO<sub>2</sub>, levels for Pressure Support and backup ventilation in this window.

## 3. Optimizing NAVA level

The selection of an optimal NAVA level is the subject of much discussion in the literature. NAVA titration curves have been used, as well as the concept of “neuroventilatory efficiency” (tidal volume divided by Edi peak). Although these methods do have a strong physiological rationale, their applicability in daily practice is not clear. It is reasonable (and safe) to titrate the NAVA level based on patient comfort (as is done with PSV).

- Reduce actual NAVA level by 0.2  $\mu\text{V}/\text{cmH}_2\text{O}$  and evaluate after approx. 20 seconds whether or not the patient is still comfortable. If so, a further reduction in NAVA level can be made. If the patient becomes uncomfortable, return to the previous NAVA level. This should be repeated twice daily.
- The usual NAVA level is between 0.5 and 3.0  $\mu\text{V}/\text{cmH}_2\text{O}$ .
- In ARDS patients, the tidal volume should be taken into account (generally below 6 ml/kg predicted body weight).

## 4. Weaning patients from NAVA

Studies are currently being performed to investigate whether the Edi signal provides information that is useful to guide weaning from mechanical ventilation. For now, patients on NAVA may be weaned using a similar strategy to that used for weaning patients on Pressure Support ventilation:

- Gradual reduction in NAVA level (as described above)
- Consider spontaneous breathing trial daily, in particular when  $P_{\text{peak}} - \text{PEEP} < 10 \text{ cmH}_2\text{O}$  (protocol weaning).

## Troubleshooting

- No Edi signal during catheter positioning: if the catheter appears adequately positioned but ECG leads are not highlighted in blue during inspiratory effort (in the catheter positioning window), this may indicate absence of diaphragm activity, for instance due to high levels of support. Reduce the level of support and repeat catheter positioning a few minutes later. Other reasons for a low/absent Edi signal include high level of sedation, neuromuscular blocking agents, phrenic nerve lesions and myopathy.
- Small catheters (12 Fr) may easily become obstructed. Flush catheter 4 times a day with 10 ml of water to prevent obstruction.
- High respiratory rate: in NAVA, the respiratory rate is usually higher compared to Pressure Support. One of the reasons is the absence of wasted efforts in NAVA. It should be noted that a high respiratory rate, and in particular a chaotic breathing pattern, are characteristic of NAVA. This should not be regarded as agitation, but merely as a physiological breathing pattern for this particular patient.

- Flow triggering in NAVA mode: in NAVA, the ventilator provides support on a “first- come-first-served” basis. Thus if inspiratory flow is sensed before a rise in the Edi signal, the breath will be flow-triggered. However, this does not mean that a Pressure Support inspiration is provided, since the breath delivered will remain proportional to the Edi signal. Thus even if all breaths are flow-triggered while in NAVA mode (which is extremely unlikely), the ventilatory pattern will still be different from that in Pressure Support ventilation. Reasons for flow triggering of breaths while in NAVA include early activation of accessory respiratory muscles and limitations in Edi signal analysis by software.

### **NAVA versus NAVA (PS)**

For safety reasons, the machine switches automatically to Pressure Support under certain circumstances, including:

- Catheter disconnection
- Too much ECG interference with the Edi signal
- Major discrepancies between flow/pressure and Edi signals
- Refer to manual for more detailed description.

If the ventilator subsequently detects an adequate Edi signal, it will switch back to NAVA automatically.

If no patient efforts are detected for a certain time period (the apnea time, default 20 seconds), the ventilator automatically switches to Pressure Control ventilation as the backup mode.

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