CLINICAL PROTOCOL. CATEGORY: GENERAL ICU
NEURALLY ADJUSTED VENTILATORY ASSIST, NAVA WEANING PROTOCOL

Focus

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

Rationale

NAVA allows bedside monitoring of neural respiratory drive to the diaphragm by measuring and presenting electrical activation of the diaphragm (Edi) as a waveform for each breath cycle.

With NAVA, support is initiated with the detection of the diaphragmatic neural drive while the pressure support assistance is automatically delivered in proportion to the Edi intensity. Support is cycled-off with the termination of the respiratory output by the respiratory centers.

The Edi peak represents maximal electrical activity of the diaphragm for a particular breath (measured in µV).

The Edi min represents the electrical activity of the diaphragm between inspiratory efforts (measured in µV).

The NAVA level (set on the ventilator) dictates the amplification of the Edi signal (measured in µV) when delivering assist to the patient (in cmH_2O).

The maximum pressure assist provided during a specific breath is:
Peak pressure (cmH_2O)=NAVA level x (Edi peak–Edi min)+PEEP

For example, if NAVA level is set to 1 $cmH_2O/\mu V$ with a peak Edi for a specific breath of 10 µV, the maximum level of support delivered for that breath is 10 cmH_2O.

Patient selection

Recent studies have demonstrated that NAVA has beneficial effects compared to standard pressure-support ventilation (PSV): it improves patient-ventilator synchrony during invasive and non-invasive ventilation in intensive-care patients, and improves oxygenation of postoperative patients.

Edi monitoring is also an interesting tool at the bedside to monitor each patient's respiratory demand and their responses to mechanical ventilation.

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.
- Interferences with electrical devices may cause disturbances in the Edi signal.
- Relative contraindication, severe hiatal hernia.
- 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 for adults (usually 16 Fr, 125 cm), calculate the insertion length according to the formula provided on the sheet in the catheter package.
- Dip the catheter in water. This activates the lubricant on the catheter. Do not use silicone spray or other lubricants. This may result in the catheter malfunctioning.
- Insert Edi catheter according to protocol "insertion nasogastric feeding tube" to calculated insertion length.
- Test the 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 the Edi cable to the Edi catheter.
- Open the "Neural access" menu on the ventilator and select "Edi catheter positioning"

Protocol contributed by Dr Hadrien Rozé MD, CHU de Bordeaux, France.

- Check the 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, slowly withdraw the catheter, 1 to 2 cm. If the lower leads are highlighted, insert the catheter further 1 to 2 cm. Close the catheter positioning window. Secure the catheter to nose according to nasogastric feeding tube protocol and record the insertion length in cm of the correct position.

2. Testing spontaneous breathing and initiating NAVA

Patients are initially switched from volume or pressure controlled ventilation (VC or PC) to pressure support (PS) in order to assess if spontaneous breathing is possible (screening). The fixed level of pressure support is adapted to tidal volume VT in order to obtain 7–8 ml/kg of ideal body weight.

Once the patient is able to breathe spontaneously, but has failed a spontaneous breathing trial (SBT), a weaning protocol is required and NAVA can be initiated (Figure 1).

The selection of an optimal NAVA level is the subject of discussion in the literature.

Weaning procedure

Our approach during weaning is to measure the maximal respiratory drive (Edi_{maxSBT}) recorded during a daily reproducible respiratory effort. The effort chosen is the SBT. After a failed SBT, the Edi_{maxSBT} recorded is used as a basis for titrating the NAVA level. The objective is to obtain an acceptable pressure assist and work of breathing, by reducing the Edi_{max} by means of the NAVA level titration. We have chosen the Edi_{max} level to 60 % of the Edi_{maxSBT}. Figure 2 represents the daily titration of NAVA level according to Edi_{maxSBT}. Area A to D define the different steps in the weaning procedure.

Option 1: SBT (area B) is initiated and well tolerated for at least 2 hours then discuss extubation Figure 1.

Option 2: SBT is not tolerated, maximal peak Edi (Edi_{maxSBT}) is seen on the trend of the SERVO-i during the SBT (Edi_{maxSBT} area B in Figure 2).

- This Edi_{maxSBT} represents the drive for a given patient when the effort is too high.
- Press “NAVA” in “Select ventilation mode”. Start with previous NAVA level setting or adjust NAVA level in the NAVA preview screen.
- Choose Edi trigger to trigger 0.5 µV, adapt PEEP and FiO_2 to the patient’s need.

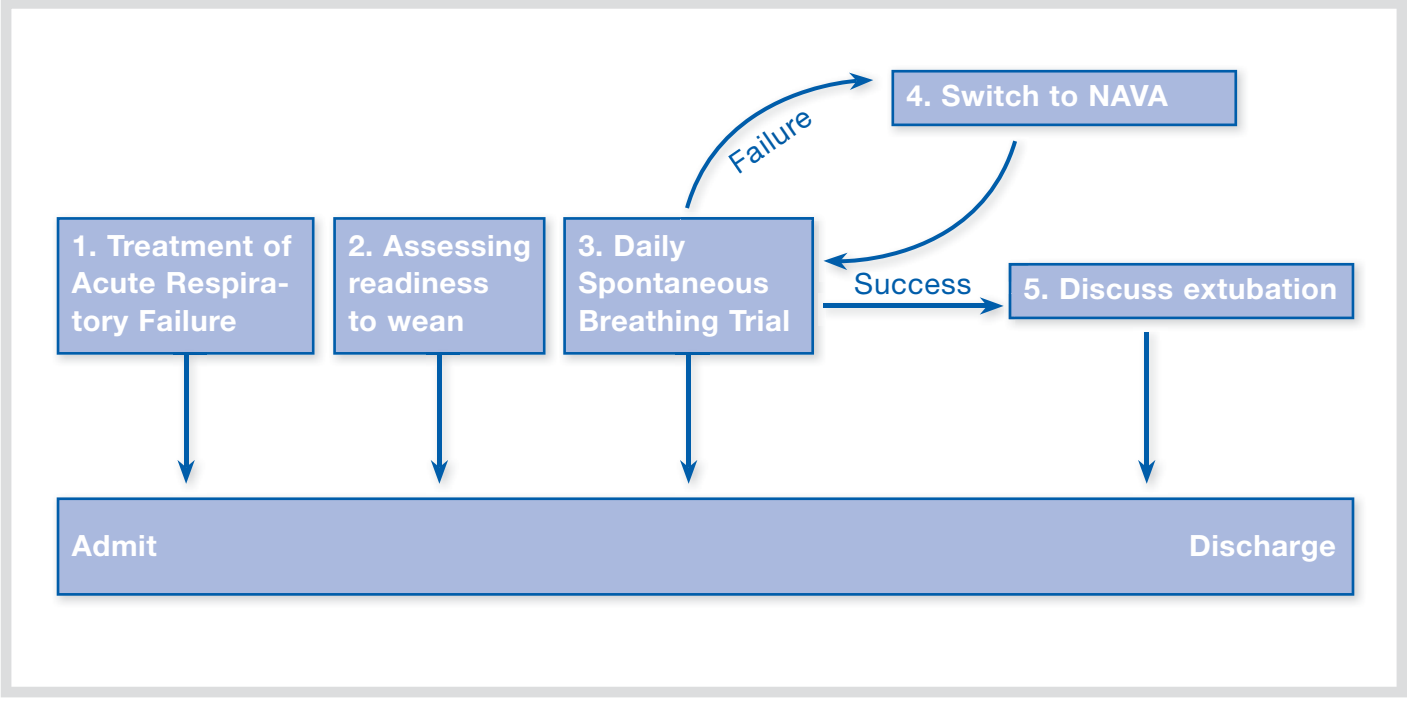

Figure 1. NAVA weaning protocol.

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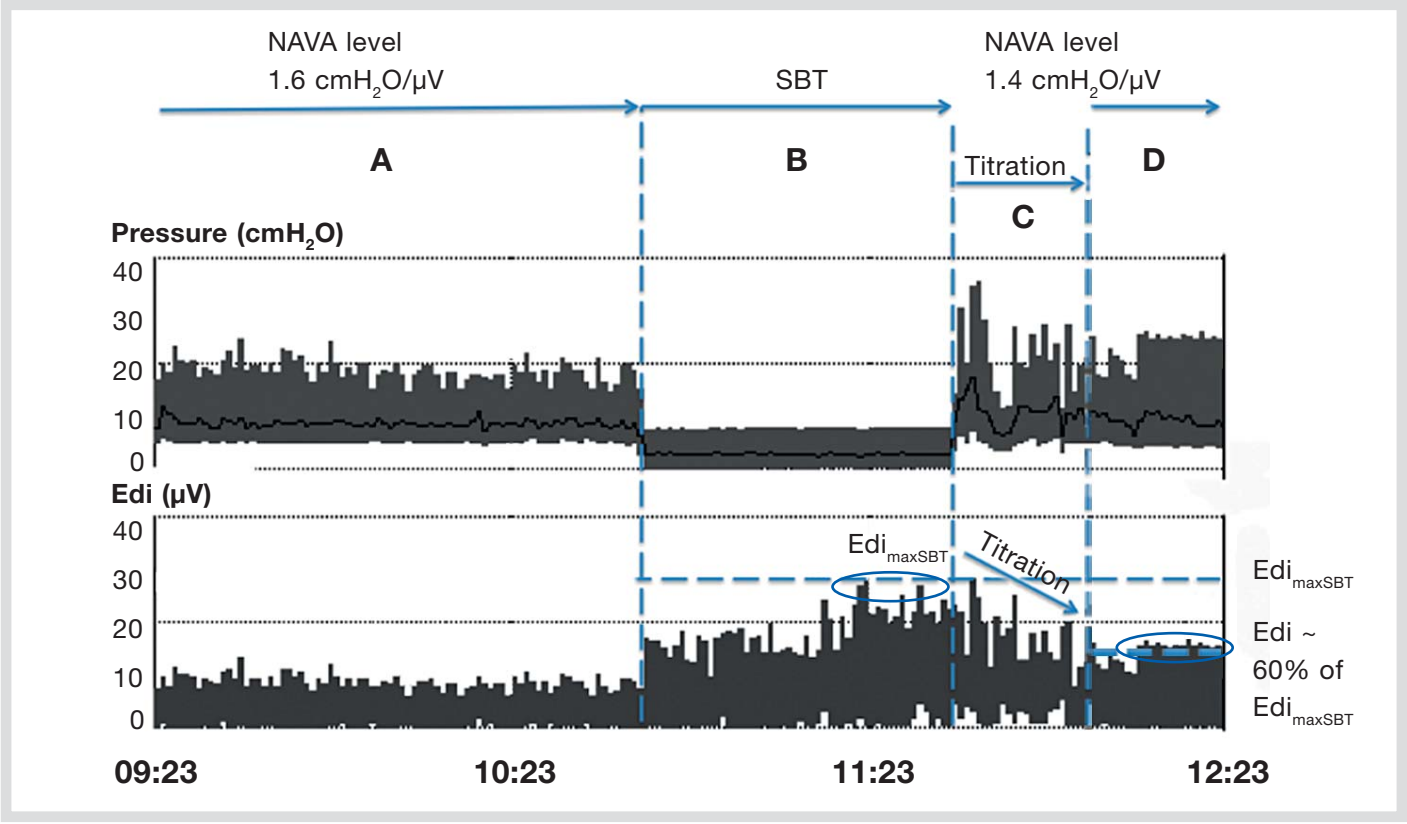

Figure 2. Daily titration of NAVA level to obtain an acceptable pressure assist and work of breathing at an Edi_{max} ~ 60% of Edi_{maxSBT}.

- Start titration of NAVA level in order to obtain Edi values of ~60% of Edi_{maxSBT} (area C).
- After failed SBT, patient respiratory drive is high, the first NAVA level chosen will deliver high pressure assist until the respiratory drive decrease significantly (initial part of area C, Figure 2). The level of pressure will be limited to the preset alarm pressure (35 cmH_2O in our practice). Pressure and Edi will rapidly decrease, second part of area C, Figure 2.
- Continue titration of NAVA level in order to obtain Edi_{max} around 60% of Edi_{maxSBT} (area D in Figure 2).
- If the Edi is lower than 60% of the Edi_{maxSBT}, decrease NAVA level by 0.2 uV every 20 second.
- If the Edi is higher than 60% of the Edi_{maxSBT}, increase NAVA level by 0.2 µV every 20 second.
- 30 minutes after the titration step, check at the end of area D, Figure 2, that the SERVO-i trend of Edi_{max} is 60% of the Edi_{maxSBT}. Observe if the patient is comfortable and if necessary check the arterial blood gases.

3. Setting NAVA level every day

NAVA level modification is done at least once a day after daily SBT. Elimination of sedation or improvement of diaphragmatic dysfunction after prolonged controlled mechanical ventilation can be associated with daily increase of Edi_{maxSBT} at the beginning of weaning. This will allow daily reduction of the NAVA level.

This protocol adapts the level of assistance to the patient's respiratory demand and avoids excessive pressure assist with low Edi.

4. Weaning patients from NAVA

Patients on NAVA can be weaned using a similar strategy as that being used for weaning patients on Pressure Support (PS) ventilation with a daily SBT (using PS CPAP or T piece trial), described in section 2.

If SBT is well tolerated for at least 2 hours, extubation can be proposed.

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Troubleshooting

No Edi signal during catheter positioning under controlled ventilation or PS: If the catheter appears adequately positioned but the ECG curves are not highligthed in blue during inspiratory effort (in the catheter positioning window), this may indicate absence or very low diaphragm activity, for instance due to high levels of pressure support. In this situation, the patient's efforts only trigger the ventilator.

Reduce significantly the level of support (NAVA Level) 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.

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, with high variability and sometimes a transient 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.

Lower tidal volume with high variability is also a physiological breathing pattern in NAVA compared to PSV and does not require higher NAVA level.

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. Reasons for flow triggering of breaths while in NAVA also include early activation of accessory respiratory muscles and limitations in Edi signal analysis by the software.

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, the ventilator pattern will still be different from that in Pressure Support ventilation. Sometimes, as in Pressure Support ventilation, pneumatic trigger can be increased in order to limit autotriggering and preferentially use the electrical trigger of the Edi signal.

Maximal inspiratory pressure in NAVA mode: You can control the maximal inspiratory pressure allowed by the ventilator in the alarm setting for Upper Pressure Limit; the SERVO-i will not deliver more than 5 cmH_2O of pressure below this preset alarm pressure. For example, if you choose 40 cmH_2O in the alarm menu, the maximal inspiratory pressure will not exceed 35 cmH_2O. Flow becomes pressure regulated at the level of maximal inspiratory pressure like in Pressure Support, but with persistent neural trigger.

Abnormal/pathologic breathing drive: Sometimes increasing NAVA level does not reduce Edi because of significant respiratory demand – the drive remains high and the patient is unwell. This situation is often the limit of spontaneous breathing.

NAVA versus NAVA (PS)

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

- Catheter disconnection.
- Too much ECG or other electrical device interference with the Edi signal.
- Major discrepancies between flow/pressure and Edi signals.
- 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.

Refer to manual for more detailed description.

The views, opinions and assertions expressed in the clinical protocol are strictly those of the contributing clinicians and do not necessarily reflect or represent the views of Maquet Critical Care AB.

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