NAVA and NIV NAVA in neonatal settings
# Table of contents

1. **Introduction and background facts** | 4  
2. **Invasive ventilation with NAVA** | 9  
3. **Non invasive ventilation with NAVA** | 13  
4. **NAVA and NIV NAVA features and management tips** | 14
NAVA delivers assist in proportion to and in synchrony with the patient’s respiratory efforts. These efforts are reflected by the Edi signal, which represents the electrical activity of the diaphragm.

As long as the patient has an Edi Catheter in position, the Edi signal can in addition be monitored in all modes of ventilation, invasive and non invasive, as well as in Standby, including values for both Edi peak and Edi min.

The values are also trended in all modes, as well as in Standby.

**The NAVA level**

The NAVA level is the factor by which the Edi signal is multiplied to adjust the amount of assist delivered to the patient. This assist is thus proportional to the patient’s Edi and as such, it follows a physiological pattern.
Insertion and positioning of the Edi Catheter

Select the appropriate Edi Catheter according to the patient height and weight. The table below provides more details.

<table>
<thead>
<tr>
<th>Patient height</th>
<th>Patient weight</th>
<th>Edi Catheter size</th>
</tr>
</thead>
<tbody>
<tr>
<td>45 - 85 cm</td>
<td>1.0 - 2.0 kg</td>
<td>8 Fr 100 cm</td>
</tr>
<tr>
<td>&lt; 55 cm</td>
<td>0.5 - 1.5 kg</td>
<td>6 Fr 49 cm</td>
</tr>
</tbody>
</table>

Insert the Edi Module into the SERVO-i ventilator and connect the Edi Cable.

Perform the Edi Module function check.

Measure the distance from the bridge of the Nose (1) to the Earlobe (2) and then to the Xiphoid process (3). This is the NEX measurement. Make a note of it.

[Diagram showing measurement points]

Calculate the insertion distance (Y) for the Edi Catheter. This will depend on whether the Edi Catheter is inserted orally or nasally, as well as on the size of the Edi Catheter. Use the appropriate table as shown below.
Insertion distance Y for nasal insertion

<table>
<thead>
<tr>
<th>Fr/cm</th>
<th>Calculation of Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 Fr 100 cm</td>
<td>NEX cm x 0.9 + 8 = Y cm</td>
</tr>
<tr>
<td>6 Fr 50 cm</td>
<td>NEX cm x 0.9 + 3.5 = Y cm</td>
</tr>
<tr>
<td>6 Fr 49 cm</td>
<td>NEX cm x 0.9 + 2.5 = Y cm</td>
</tr>
</tbody>
</table>

Insertion distance Y for oral insertion

<table>
<thead>
<tr>
<th>Fr/cm</th>
<th>Calculation of Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 Fr 100 cm</td>
<td>NEX cm x 0.8 + 8 = Y cm</td>
</tr>
<tr>
<td>6 Fr 50 cm</td>
<td>NEX cm x 0.8 + 3.5 = Y cm</td>
</tr>
<tr>
<td>6 Fr 49 cm</td>
<td>NEX cm x 0.8 + 2.5 = Y cm</td>
</tr>
</tbody>
</table>

Examples:
- Infant – height 40 cm, weight 900 g
- Selected Edi Catheter – 6 Fr 49 cm
- Insertion – nasal
- NEX – 12 cm
- **Insertion distance Y** = 12 x 0.9 + 2.5 = 12.3 cm

Dip the Edi Catheter into water for a few seconds. Do NOT use lubricants as this may destroy the Edi Catheter coating and interfere with the measurement of the Edi signal.

Insert the Edi Catheter to the Y value calculated above.

Connect the Edi Catheter to the Edi Cable.

Open the “Neural access” menu and select “Edi Catheter positioning” to confirm the position of the Edi Catheter.

Verify the position of the Edi Catheter by analyzing the ECG waveforms. Ideally, P and QRS waves are present in the top ECG curves, while the P waves gradually decrease and disappear in the lower ECG curves, where QRS amplitude also decreases. Check that the Edi scale is fixed and that it is set appropriately (greater than or equal to 5 µV).
If Edi deflections are present, observe which leads are highlighted in blue.

- If the second and third leads are highlighted in blue, secure the Edi Catheter in this position after marking it at its final position and making a note of the distance in centimeters.
- If the top leads are highlighted, pull out the Edi Catheter in steps corresponding to the Inter Electrode Distance (IED, measured in millimeters) until the blue highlight appears in the center. Do not exceed four times the IED. Mark the Edi Catheter at its final position.
- If the bottom leads are highlighted, insert the Edi Catheter further in steps corresponding to the IED until the blue highlight appears in the center. Again, do not exceed four times the IED. Mark the Edi Catheter at its final position.
- If the Edi signal is very low, there will be no blue highlights. If this happens, evaluate the Edi signal as described below.
INTRODUCTION AND BACKGROUND FACTS

Secure the Edi Catheter in position once the position has been verified. Check first that the marking on the Edi Catheter is in the right place and observe the ECG waveforms and their blue highlights. Make sure that the Edi Catheter is not secured to the endotracheal tube.

Record the insertion length.

**Important:** Always follow hospital routines to check the position of the Edi Catheter when it is used as a gastric feeding tube.

Evaluate the Edi signal. A low or absent Edi may be due to any of the following:

- hyperventilation
- sedation
- muscle relaxants
- neural disorders

Edi Catheter positioning may be reconfirmed after 1-2 hours if minor adjustments are necessary.
Setting the initial NAVA level

Option 1: Set the NAVA level initially to 1 cmH₂O/µV 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.
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 in steps of 0.1-0.2 cmH₂O/µV. The changes in NAVA level are mediated in a few breaths to Edi max. The usual NAVA level is 0.5 - 2.0 cmH₂O/µV, with Edi signals between 5 - 15 µV.

Setting and optimizing PEEP

Initially, set the same PEEP as in the previous ventilator settings. If Edi min is constantly > 1 µV (as a sign of tonic diaphragmatic activity to maintain FRC), increase PEEP.
INVASIVE VENTILATION WITH NAVA

Setting apnea time

Set the initial apnea time at 5 seconds. If breathing is irregular and the patient unstable, you may decrease apnea time down to 2 seconds. This will result in back-up breaths after each 2-second apnea until next spontaneous breath indicated by Edi signal occurs.

However, make sure that the back-up ventilation does not hyperventilate the patient preventing spontaneous breathing efforts (which would keep the patient unnecessarily on back-up ventilation).

The trends will show the number of back-up periods and percent time the patient has been on back-up per each minute. If the patient is stable and switching a lot between back-up and NAVA support, you may increase apnea time to decrease back-up ventilation. Avoid high pressure settings in PS and PC, this will reduce locking in PS and PC.

Back-up settings

Shorter apnea time (<5 seconds) increases the significance of back-up ventilation settings as there is a risk for hyperventilation usually not occurring with NAVA ventilation. Adjust the back-up settings appropriately taking into account the pre-NAVA settings and the recovery process of the patient.

Other Settings

Set Edi trigger to 0.5 µV and trigger sensitivity to 1 - 2 (to prefer Edi triggering).

Weaning patients from NAVA

Decrease the NAVA level as the patient's pulmonary status improves.
The trend curves give information about respiratory variables for the preceding 24 hours and they should be routinely checked together with the child's clinical condition.

The following trend curves are described:
- Number of switches to Backup/min
- Percent (%) of time in backup ventilation/min
- Respiratory rate trend

**Respiratory rate trend**

The respiratory rate trend can also be used to determine the amount of time the neonate is in NAVA versus backup ventilation. When in NAVA, the measured and spontaneous respiratory rate will be equal. When in backup ventilation, the measured respiratory rate will be higher than the spontaneous respiratory rate.
NIV NAVA in practice

The NAVA levels in NIV NAVA are usually lower than in invasive NAVA (0.5 - 1.0 µV/cmH₂O).

- If Edi max is < 5 µV, decrease the NAVA level.
- If Edi max is > 20 µV, increase the NAVA level.

The changes in NAVA level should be in steps of 0.1-0.2 µV/cmH₂O.

Apart from the NIV NAVA levels being a little lower, the following also applies:
- The 'No patient effort alarm' can be turned off
- Apnea time can be reduced
- Leakage compensation is active

Running NIV NAVA
Using the Edi Catheter as a feeding tube

The Edi Catheter is a single-use gastric feeding tube with an array of 10 electrodes (nine measuring and one reference electrode). The Edi catheter has been validated for use for 5 days, both for feeding and when using the NAVA function.

Noting Edi Catheter insertion length

Remember to mark the Edi Catheter at its final position and make a note of the final distance in centimeters in the patient chart.

If possible, perform an expiratory hold and verify that the positive Edi deflection coincides with a negative deflection in the pressure waveform.

Suctioning

During suctioning, or in case of patient disconnection, it is important to use the Suction Support function to avoid activating the asynchrony alarm (see Alarms below). The function is not used when a closed suction system is in use.

Patient interfaces for NIV NAVA

A range of different types of patient interfaces can be used when ventilating neonatal patients with NIV NAVA. They include nasal masks and prongs and they come in a variety of sizes to suit all patients.

Troubleshooting

Patient contraindications and troubleshooting are described in this section. The troubleshooting topics that are explained are as follows:

- Low or absent Edi signal during catheter positioning
- Sharp Edi signal with high Edi max
- High respiratory rate
Patient contraindications
- Insufficient/absent respiratory effort (brain anomaly, medication)
- Anomaly (esophageal atresia, severe diaphragmatic hernia)
- Phrenic nerve injury
- Congenital myopathy
- MRI scanning (remove and reserve the Edi catheter before entering the MRI area)

Low or absent Edi signal during catheter positioning
Typical reasons for absent Edi in pediatric patients are:
- Catheter malposition
- High preset frequency in ventilation mode used
- High PIP in PS (or the ventilation mode used), relatively high $V_T$
- High PEEP
- Deep sedation

Sharp Edi signal with high Edi max
Typical reasons for sharp Edi signal with high Edi max are:
- Insufficient NAVA level causes increased breathing drive.
- Other reasons for acute change in Edi shape:
  - Pain
  - Discomfort, agitation

High respiratory rate
Typical reasons for high respiratory rate are:
- In NAVA the respiratory rate is usually higher compared to pressure support, caused by absence of wasted efforts in NAVA. In addition, tidal volumes are physiological for patient and the effect of Hering-Breuer reflex on breathing frequency is lower.
- There is no way (and no need) to limit the breathing frequency in NAVA.
- It should be noted that a high respiratory rate, and in particular a chaotic breathing pattern, are characteristic of NAVA and should not routinely be regarded as agitation, but merely as a physiological breathing pattern for this particular patient.
NAVA AND NIV NAVA FEATURES AND MANAGEMENT TIPS

- Reduce preset PEEP level in case of increase in PEEP caused by high respiratory rate.
- Possible causes for acute change in respiratory rate are:
  - Acute change in pulmonary status
  - Pain
  - Discomfort
  - Nausea
  - Fever
Legal manufacturer:
Maquet Critical Care AB
Röntgenvägen 2
SE-171 54 Solna, Sweden
Phone: +46 (0) 8 730 73 00
www.maquet.com

US Sales contact:
MAQUET Medical Systems USA
45 Barbour Pond Drive
Wayne, NJ 07470
www.maquetusa.com

For local contact outside US:
Please visit our website
www.maquet.com

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