MAQUET
GETINGE GROUP

# SERVO Education
# NAVA STUDY GUIDE

CRITICAL CARE

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# 1 INTRODUCTION

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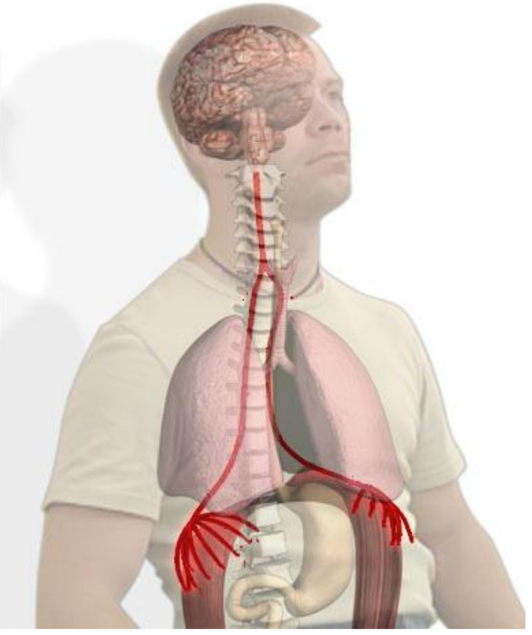
# 1 INTRODUCTION

NAVA – Neurally Adjusted Ventilatory Assist is an optional mode of ventilation for the SERVO-i ventilator. NAVA delivers assist in proportion to and in synchrony with the patient's Edi signal (the electrical activity of the diaphragm).

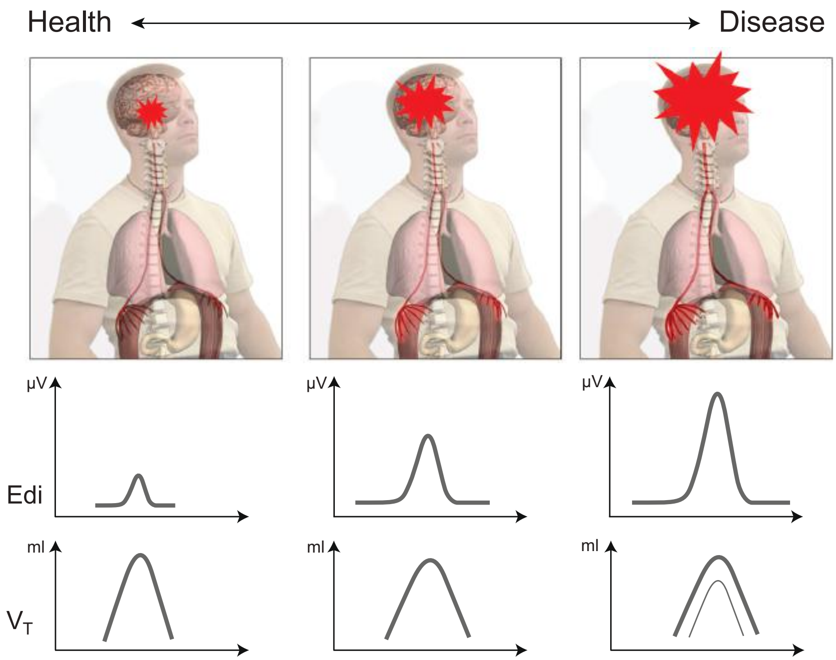
A spontaneous breath starts with an impulse generated by the respiratory center. The impulse is transmitted via the phrenic nerves, which excites the diaphragm. Before the mechanical effect is achieved, the signal is modulated and the muscle response is achieved by chemical coupling.

Contraction of the diaphragm pushes its dome downwards, creating a negative alveolar pressure, and gas flows into the lung.



All muscles, including the diaphragm and other respiratory muscles, generate electrical activity to excite muscle contraction: this electrical excitation is controlled by nerve stimuli.

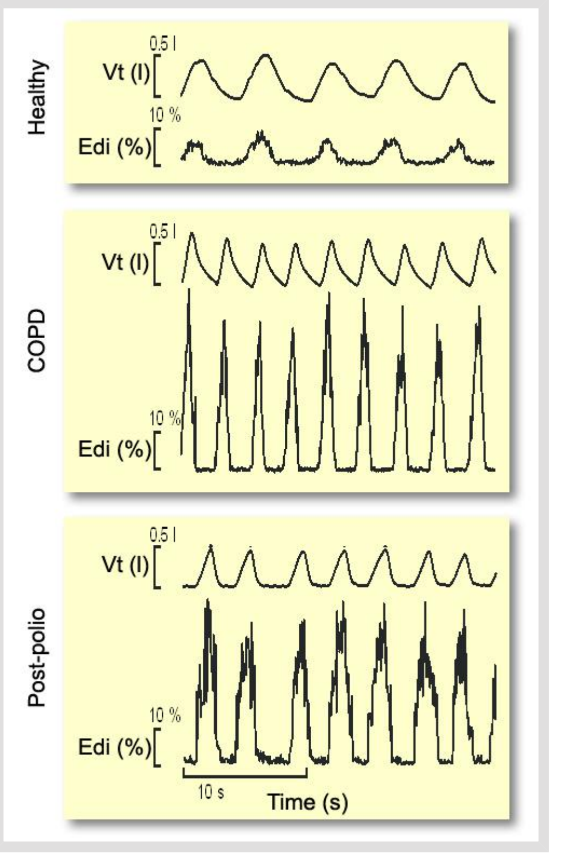
## 1.1 NEUROVENTILATORY COUPLING




The efficacy of the respiratory muscles and the degree of respiratory demand will determine the degree of respiratory center output. In a healthy subject, the low amplitude of diaphragm excitation reflects the fact that neuroventilatory coupling is highly efficient and that only about 5% of maximum capacity is used.

In disease, muscle performance may not be up to expectation, leading to an increased output from the respiratory center with the aim of recruiting additional motor units in the diaphragm.

In this example, the increased signal seen in COPD and post-polio patients thus reflects the fact that a larger part of the muscular reserve is used. Only 5-8% of maximum capacity is used in healthy subjects, while up to 40% is used in COPD patients.




*If the diaphragm becomes weaker and/or the inspiratory load increases, the diaphragm´s electrical activation must increase to maintain a given volume. (Adapted from Sinderby et al JAP 1998)*

The electrical activity of the diaphragm (Edi) is measured in µV (micro volt). 1 µV = $10^{-6}$V, thus 1,000,000 µV = 1V.

## 1.2 RESPIRATORY CONTROL

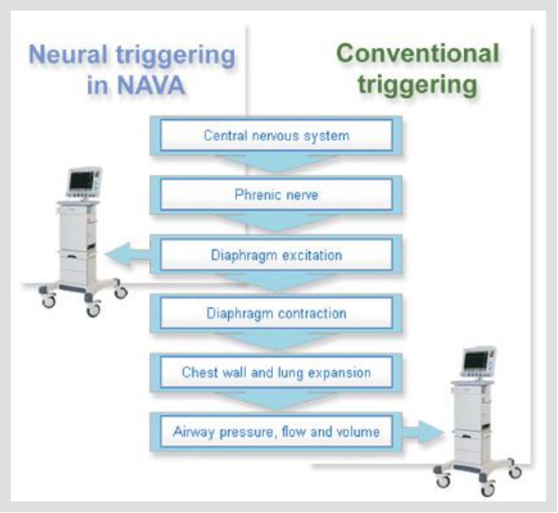
There are three important components in mechanical ventilation:

1. The timing with which breaths are delivered i.e. the frequency and inspiratory time for assist delivery.
2. The magnitude of the delivered breaths, i.e. the pressure or volume needed to ventilate the lungs.
3. The magnitude of pressure on expiration, which prevents the lungs from derecruiting between inspirations, i.e. the required PEEP level.

Conventional ventilator technology uses a pressure drop or flow reversal to initiate the assist delivered to the patient (as shown on the right-hand side of the picture). This is the last step of the signal chain leading to inhalation and is subject to disturbances such as intrinsic PEEP, hyperinflation and leakage.

The earliest signal that can be registered with a low degree of invasivity is the excitation of the diaphragm (as shown on the left-hand side of the picture).

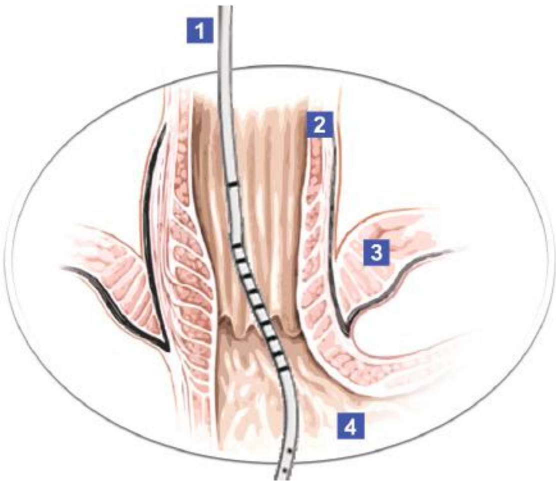
The signal that excites the diaphragm is proportional to the integrated output of the respiratory center and thus controls the depth and cycling of the breath. The excitation of the diaphragm is independent of pneumatic influence and insensitive to the above problems associated with pneumatic triggering technologies.

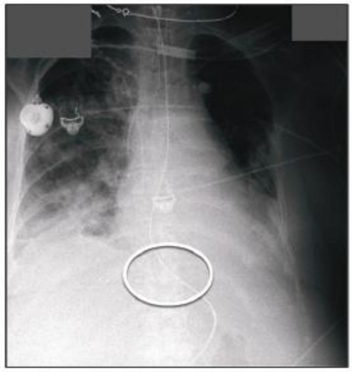



*Adapted from C. Sinderby, Nature Medicine, 1999*

By following diaphragm excitation and adjusting the support level in synchrony with the rise and fall of the electrical discharge, the ventilator and the diaphragm will work with the same signal input. In effect, this allows the ventilator to function as an extra muscle, unloading extra respiratory work induced by the disease process.

The electrical discharge of the diaphragm is captured by an Edi Catheter fitted with an electrode array. The Edi Catheter is positioned in the esophagus.



1. Edi Catheter
2. Esophageal wall
3. Diaphragm
4. Stomach

Since NAVA uses the Edi to control the ventilator, it is important to understand what the signal represents. All muscles (including the diaphragm and other respiratory muscles) generate electrical activity to excite muscle contraction.

The electrical excitation is controlled by nerve stimulus and controlled in magnitude by adjusting the stimulation frequency (rate coding) or the number of nerves sending the stimulus (nerve fiber recruitment). Both rate coding and nerve fiber recruitment will be transmitted into muscle fiber motor unit action potentials which will be summed up both in time and space to produce the intensity of electrical activity measured in the muscle, in this case the Edi. By means of the Edi signal, NAVA delivers pressure in response to the patient's respiratory drive.

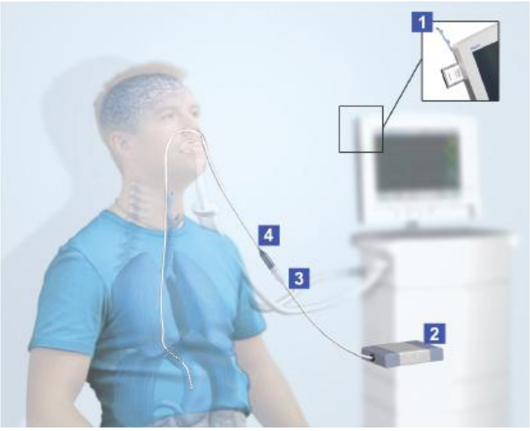
To reduce the influence of external noise, the measurement of muscle electrical activity is performed by bipolar differential recordings, where the signal difference between two single electrodes is measured.

Patients with chronic respiratory insufficiency may demonstrate signals 5-7 times stronger to compensate for this insufficiency. Due to the differential recording and low signal amplitude, measurement of Edi is sensitive to electrode filtering, external noise, and cross-talk from other muscles, e.g. the heart which produces electrical amplitudes about 10-100 times that of the diaphragm. Since the Edi must always be present to initiate a contraction of the diaphragm, it should however always be possible to record the signal in healthy subjects.

## 1.3 NAVA ACCESSORIES

Parts needed for NAVA are:

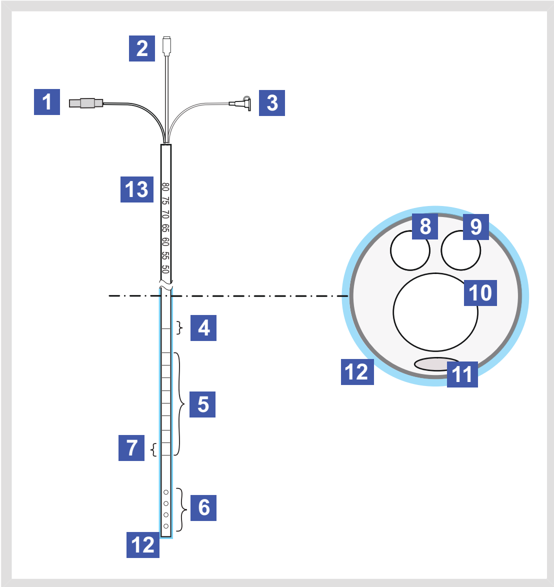
1. NAVA software option - if not pre-installed, the software is installed with a PC Card.
2. Edi Module
3. Edi Cable
4. Edi Catheter



## 1.4 EDI CATHETER

The Edi Catheter is a single-use gastric feeding tube with an electrode array of ten electrodes. One electrode is a reference electrode and nine are measuring electrodes. The electrodes are made of stainless steel.

1. Connection to Edi cable
2. Nutrition feed
3. Evacuation (only 12 and 16 Fr)
4. Reference electrode
5. Electrodes (9)
6. Holes for nutrition/evacuation
7. Inter Electrode Distance (IED)
8. Lumen for electrodes
9. Sump lumen (only 12 and 16 Fr)
10. Feeding lumen
11. Barium strip for X-ray identification
12. Coating for easier insertion and better electrical conductivity (indicated in the picture with light blue)
13. Scale in centimeters from the tip




On the right-hand side of the picture, a cross-section of the Edi Catheter is displayed. Only Edi Catheter that are 12 Fr and 16 Fr have a sump lumen for evacuation.

The different Edi Catheter sizes have different distances between the electrodes – Inter Electrode Distance, IED. It is vital to select the correct Edi Catheter size for the patient so as to detect an optimal Edi signal.

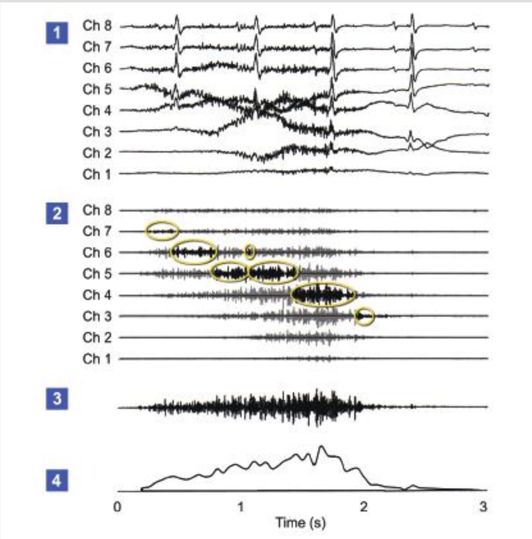
The table below provides guidelines for choosing the right Edi Catheter for different patients.

| Edi Catheter size | Inter Electrode Distance, IED | Patient weight | Patient height |
|---|---|---|---|
| 16 Fr 125 cm | 16 mm | | > 140 cm |
| 12 Fr 125 cm | 12 mm | | 75 - 160 cm |
| 8 Fr 125 cm | 16 mm | | > 140 cm |
| 8 Fr 100 cm | 8 mm | | 45 - 85 cm |
| 6 Fr 50 cm | 6 mm | 1.0 - 2.0 kg | < 55 cm |
| 6 Fr 49 cm | 6 mm | 0.5 - 1.5 kg | < 55 cm |

## 1.5 EDI MODULE

The Edi Module is a one-slot plug-in module that is interchangeable between different SERVO-i´s

The SERVO-i receives several signals from the Edi Catheter and the signals are filtered and further processed to retrieve four ECG waveforms and the Edi waveform.

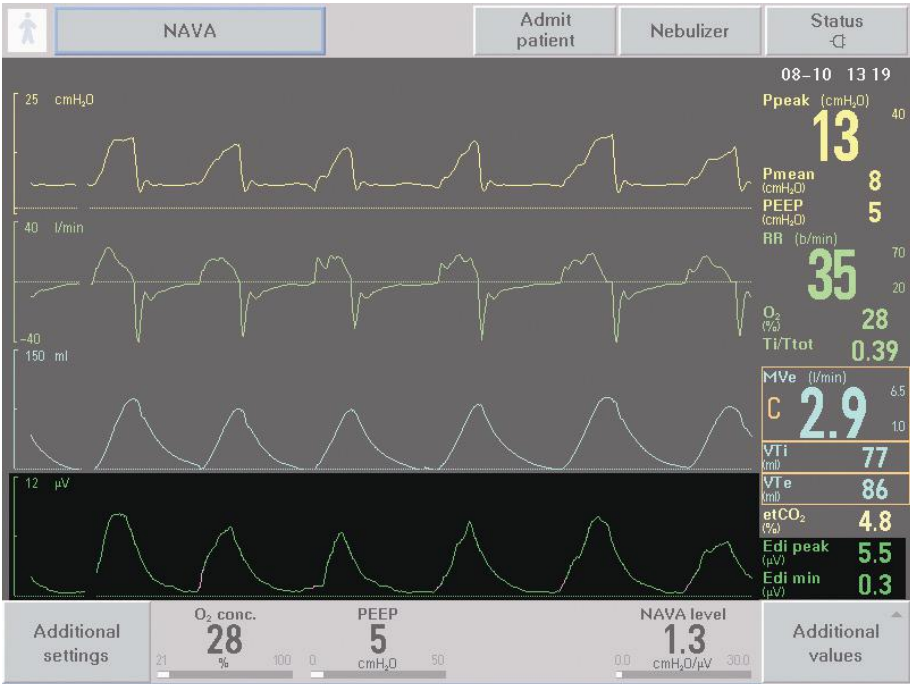



*Adapted from C. Sinderby, Nature Medicine, 1999*

The picture illustrates how the recorded raw signal becomes the Edi signal used by the ventilator to assist the patient.

1. The first set of waveforms shows the raw signals detected by the electrodes during one single inspiration. Nine measuring electrodes and one reference electrode are used.
2. The second set of waveforms shows filtered signals (e.g. filtered from the ECG signal). The marked parts indicate where the Edi signal is strongest. The location of the strongest Edi signal moves downwards as the patient makes a maximal inspiration. (Diaphragm descends during inspiration).
3. In this waveform, the signals have been double-subtracted at the position of the strongest Edi.
4. This waveform is the final Edi signal used by the ventilator to assist the patient. The waveform is derived as the Root Mean Square (RMS) of the signal in waveform 3.

When NAVA is installed, the Edi signal is shown as a waveform on the SERVO-i User Interface in all modes of ventilation as well as in stand-by mode, i.e. in the positioning window.




The Edi peak and Edi min are available as numerical values.

- Edi peak – the highest Edi value during one breath cycle
- Edi min – the lowest Edi value during one breath cycle.

# 2 NAVA WORKFLOW

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# 2 NAVA WORKFLOW

**Note:** Refer to the User's Manual for all safety related details.

The list describes the work flow, which will be further described in the sections below.

- Select Edi Catheter for the patient.
- Insert Edi Module into SERVO-i.
- Connect Edi Cable to Edi Module.
- Perform Edi Module function check.
- Measure NEX and calculate the insertion distance Y for the Edi Catheter.
- Dip the Edi Catheter in water and insert it into patient.
- Connect the Edi Catheter to the Edi Cable.
- Position the Edi Catheter by using the positioning window.
- Set initial NAVA level.
- Select NAVA mode – set parameters and backup.
- Ventilate patient with NAVA.

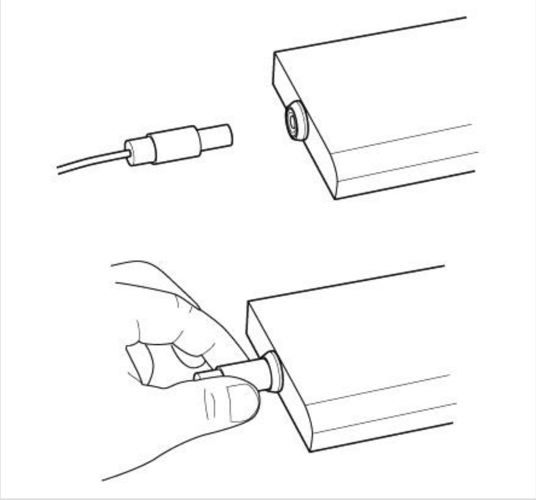
The Edi signal can be displayed in all ventilatory modes.

## 2.1 SELECT EDI CATHETER FOR THE PATIENT

| Edi Catheter size | Inter Electrode Distance, IED | Patient weight | Patient height |
|---|---|---|---|
| 16 Fr 125 cm | 16 mm | | > 140 cm |
| 12 Fr 125 cm | 12 mm | | 75 - 160 cm |
| 8 Fr 125 cm | 16 mm | | > 140 cm |
| 8 Fr 100 cm | 8 mm | | 45 - 85 cm |
| 6 Fr 50 cm | 6 mm | 1.0 - 2.0 kg | < 55 cm |
| 6 Fr 49 cm | 6 mm | 0.5 - 1.5 kg | < 55 cm |

## 2.2 EDI MODULE FUNCTION CHECK

- Insert the Edi Module into a free slot in the module compartment on the Patient Unit.
- Make sure it clicks into place.
- Connect the Edi Cable to the Edi Module.
- Remove the cap from the test plug and connect the test plug to the other end of the Edi Cable. The Edi Module test will then start automatically.
  - Wait until the dialog "Edi Module test passed" appears on the display.
    - If the test fails, replace the Edi Cable and/or Edi Module and re-run the test.
  - To remove the Edi Cable, hold the ribbed part of the connector and pull gently to release.
- Press OK, remove the test plug and replace the cap.



## 2.3 POSITIONING OF THE EDI CATHETER – CALCULATE THE INSERTION DISTANCE

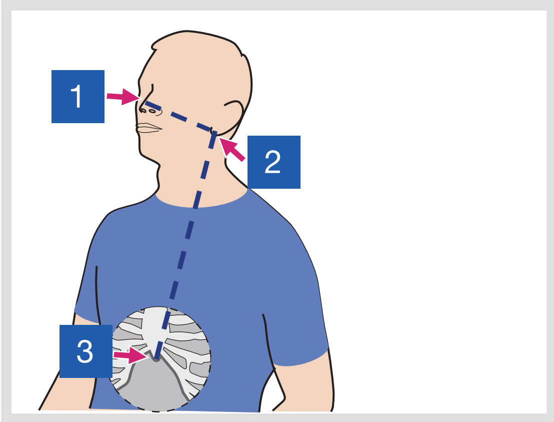
The Edi Catheter is a single-use device and is packed sterile. Follow hospital routines for handling the Edi Catheter.

- Verify by visual inspection that the package and the Edi Catheter are undamaged.

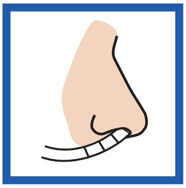
> **Note:** If a guide wire is used, only use a guide wire from MAQUET.

## 2.4 MEASURE "NEX"

- Measure the distance from the bridge of the **N**ose (1) to the **E**arlobe (2) and to the **X**iphoid process (3). The acronym NEX is useful as a memory aid.
- Note the NEX measurement

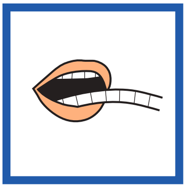



- **Nasal insertion:** multiply the NEX distance by a factor of 0.9 and add the extra centimeters according to the table to the right. This gives the insertion distance (Y).



| Insertion distance Y for nasal insertion | |
|---|---|
| **Fr/cm** | **Calculation of Y** |
| 16 Fr | NEX cm x 0.9 + 18 = Y cm |
| 12 Fr | NEX cm x 0.9 + 15 = Y cm |
| 8 Fr 125 cm | NEX cm x 0.9 + 18 = Y cm |
| 8 Fr 100 cm | NEX cm x 0.9 + 8 = Y cm |
| 6 Fr 50 cm | NEX cm x 0.9 + 3.5 = Y cm |
| 6 Fr 49 cm | NEX cm x 0.9 + 2.5 = Y cm |

- **Oral insertion**: multiply the NEX distance by a factor of 0.8 and add the extra centimeters according to the table to the right. This gives the insertion distance (Y).

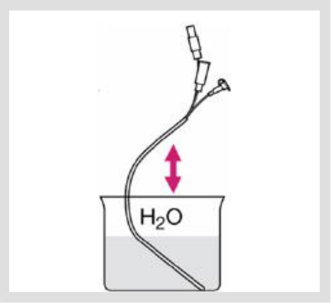


| Insertion distance Y for oral insertion | |
|---|---|
| **Fr/cm** | **Calculation of Y** |
| 16 Fr | NEX cm x 0.8 + 18 = Y cm |
| 12 Fr | NEX cm x 0.8 + 15 = Y cm |
| 8 Fr 125 cm | NEX cm x 0.8 + 18 = Y cm |
| 8 Fr 100 cm | NEX cm x 0.8 + 8 = Y cm |
| 6 Fr 50 cm | NEX cm x 0.8 + 3.5 = Y cm |
| 6 Fr 49 cm | NEX cm x 0.8 + 2.5 = Y cm |

## 2.5 INSERT EDI CATHETER INTO PATIENT

- Dip the Edi Catheter in water for a few seconds to activate the coating for easier insertion and better electrical conductivity.

  **Important:** Do not apply any other substance than water to the Edi Catheter. Other substances (lubricants, gels or any other solvents) might destroy the coating and disturb the contact with the electrodes.

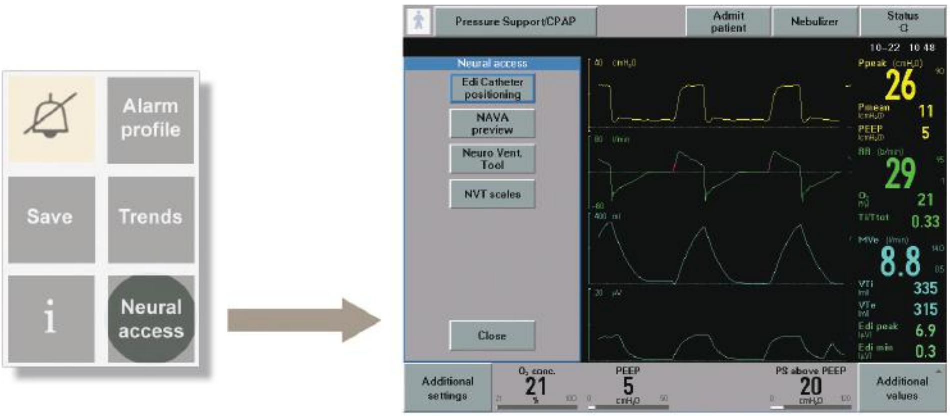



- Insert the Edi Catheter through the nostril or through the mouth until the calculated insertion distance (Y) is reached.

## 2.6 VERIFY EDI CATHETER POSITION

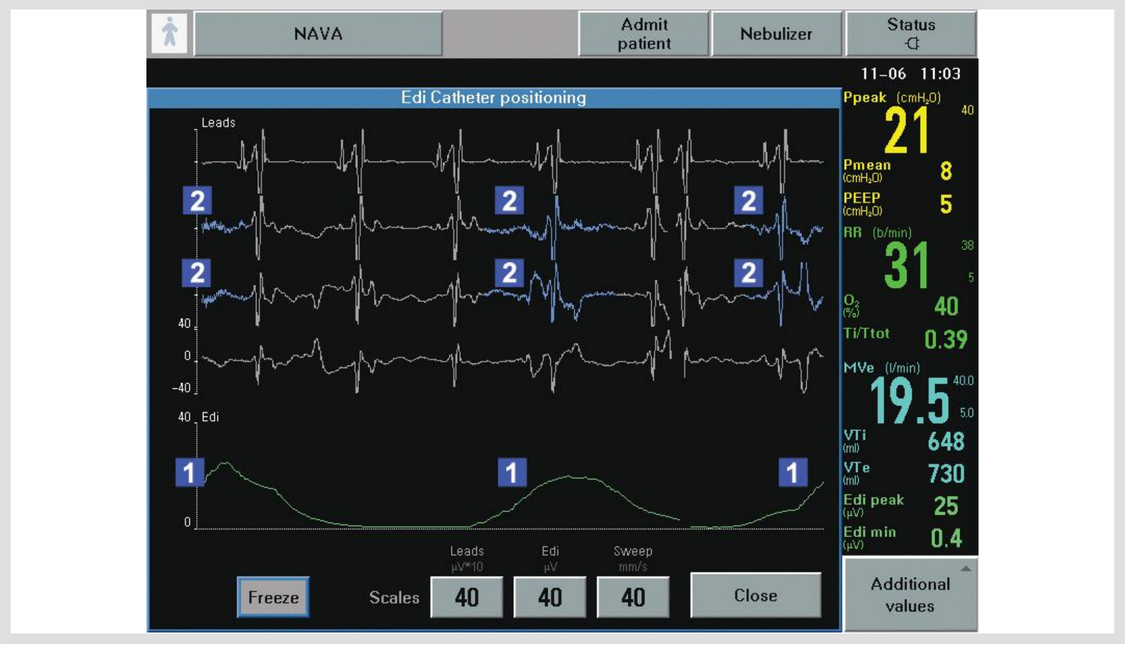
- Connect the Edi Catheter to the Edi Cable.

- Open the "*Neural access*" menu



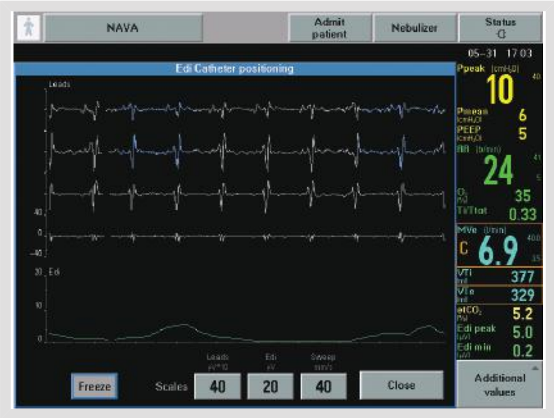

- Select "*Edi Catheter positioning*".

- Verify the position by means of the ECG waveforms
  - Verify that P and QRS waves are present in the top leads, and that the P waves disappear in the lower leads while QRS amplitude also decreases in the lower leads. Verify that the Edi scale is fixed and set appropriately (greater than or equal to 5μV). Avoid clipping the Edi Signal, i.e. avoid too low an upper limit on the scale.
- If Edi deflections are present, observe which leads are highlighted in blue.
  - If the leads highlighted in blue are in the center (i.e. second and third leads), secure the Edi Catheter in this position (see below). Mark the Edi Catheter (at its final position) and make a note of the final distance in cm.

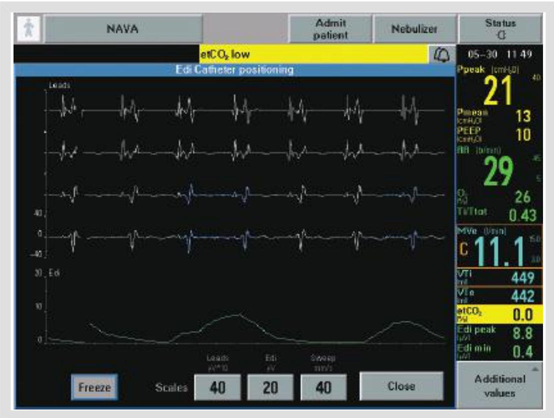



1. Edi deflections
2. Blue highlights

**Note:** If Edi deflection does not produce blue highlighted leads, refer to the Troubleshooting chapter.

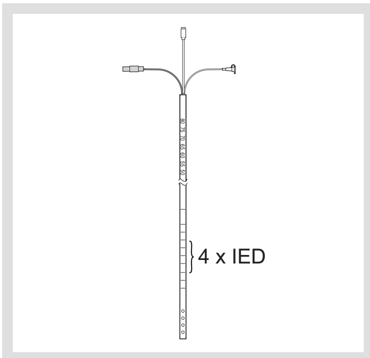



- If the top leads are highlighted in blue, pull out the Edi Catheter in steps corresponding to the IED (IED = the distance between 2 electrodes) until the blue highlight appears in the centre. Do not pull out more than 4 times the IED.




- If the bottom leads are highlighted in blue, insert the Edi Catheter further in steps corresponding to the IED until the blue highlight appears in the center. Do not insert more than 4 times the IED.

| Edi Catheter size | Inter Electrode Distance, IED |
|---|---|
| 16 Fr 125 cm | 16 mm |
| 12 Fr 125 cm | 12 mm |
| 8 Fr 125 cm | 16 mm |
| 8 Fr 100 cm | 8 mm |
| 6 Fr 50 cm | 6 mm |
| 6 Fr 49 cm | 6 mm |



## 2.7 SECURE THE EDI CATHETER

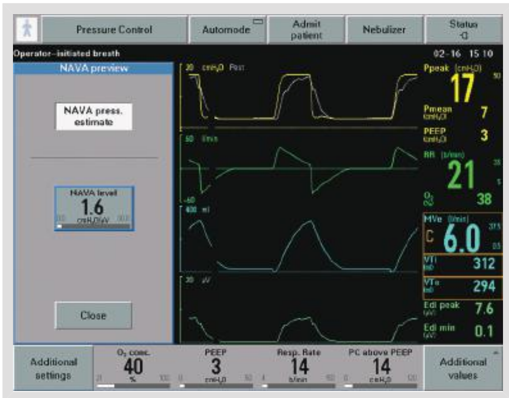
- As a final verification, check:
  - correct position of the marking on the Edi Catheter;
  - appearance of the ECG waveforms;
  - appearance of the blue highlights on the waveforms.

  If this does not produce a satisfactory result, refer to the Troubleshooting chapter.
- Secure the Edi Catheter. Ensure that the Edi Catheter is not secured to the endotracheal tube.

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

## 2.8 SET INITIAL NAVA LEVEL

- Press "*Neural access*".

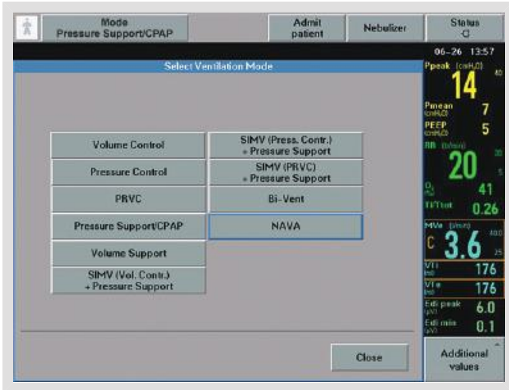



- Select "*NAVA preview*".
- In the uppermost waveform, two curves are presented simultaneously. The gray curve shows the estimated pressure based on Edi and the set NAVA level, the yellow curve is the current patient airway pressure in the selected conventional mode.
- If possible, perform an expiratory hold and verify that the positive Edi deflection coincides with a negative pressure deflection. If this is not the case, refer to the Troubleshooting chapter.

- Press "*NAVA level*" and use the Main rotary dial to set the NAVA level. As a guide, the first NAVA level to be tried should be the same or a little below the pressure used in the current mode of ventilation.
- Press "*Close*" to save the NAVA level. The NAVA level will be transferred to the NAVA ventilation mode window. Note that the patient is still being ventilated in the conventional mode and that this is an estimate of the pressure to be delivered with NAVA.

## 2.9 SELECT NAVA MODE – SET PARAMETERS

- Open "*Select Ventilation Mode*" window and choose "*NAVA*".




- The "*Set Ventilation mode*" parameters window opens.

### Basic and Trigg. Edi

- NAVA level ($cmH_2O$/µV)
- PEEP ($cmH_2O$)
- Oxygen concentration (%)
- Trigger Edi (µV). Default setting is 0.5 µV (0 - 2 µV).

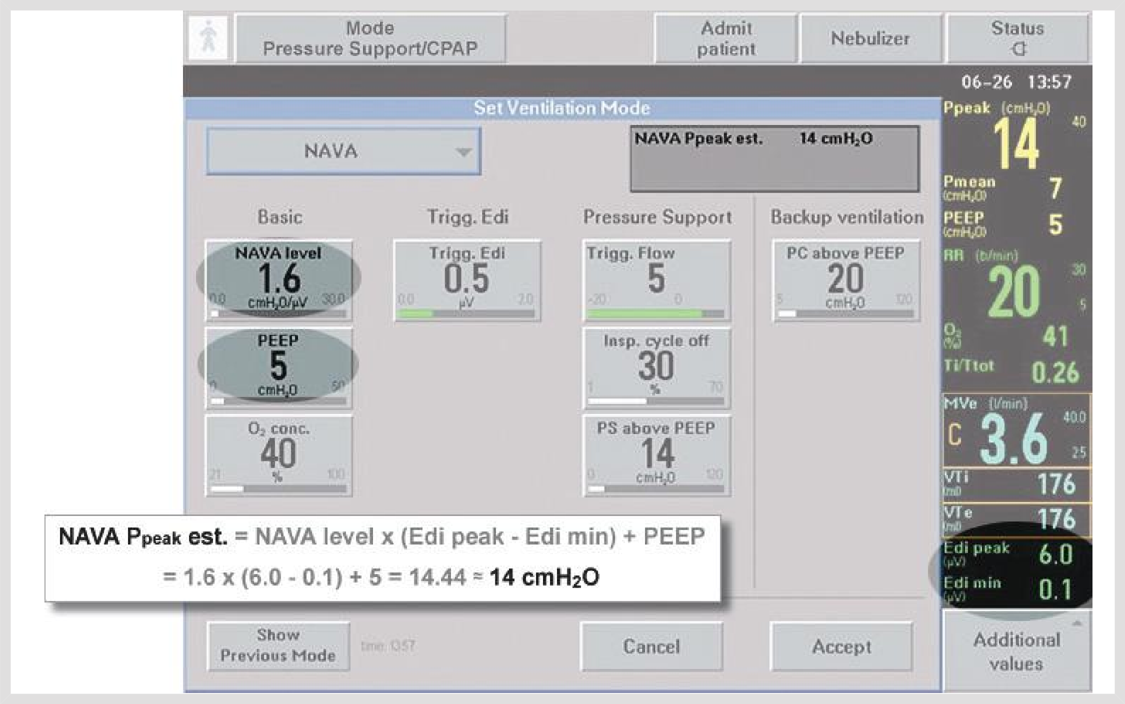
### Pressure Support

- Trigger Sensitivity
- Inspiratory Cycle off (%)
- PS above PEEP ($cmH_2O$)

### Backup ventilation

- PC above PEEP ($cmH_2O$)

## 2.10 EXAMPLE OF SETTING THE NAVA LEVEL




The NAVA Ppeak pressure is calculated according to the formula:

NAVA Ppeak = NAVA level x (Edi peak – Edi min) + PEEP

In the above example, NAVA Ppeak est. in the "Set Ventilation Mode" window is calculated by means of this equation.

See the next chapter for more information on NAVA level.

# 3 MODE DESCRIPTION

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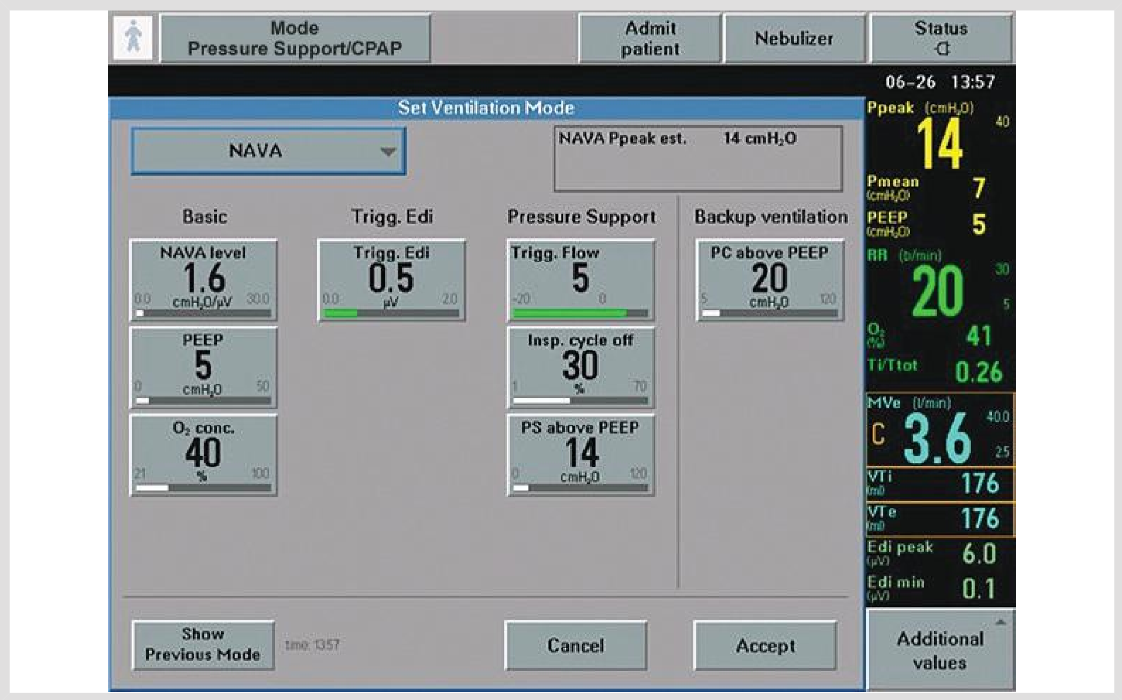
# 3 MODE DESCRIPTION

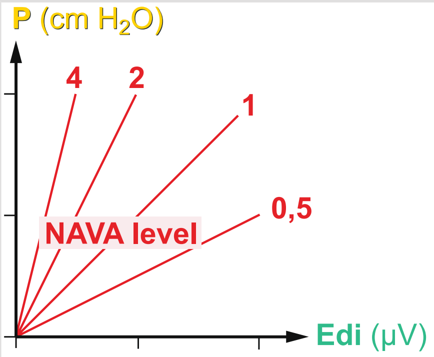



NAVA ventilation mode is only available in Invasive ventilation.

- There are four basic settings: NAVA level, PEEP, $O_2$ conc. and Edi trigg.
  - NAVA Level setting – value transferred from NAVA preview (0-30 cm$H_2$0/μV). Default setting is 1.0 cm$H_2O$/μV.
  - The Edi trigger level can be set between 0.0 and 2.0 μV.
- Pressure support: select values for Pneumatic trigger level, Inspiratory cycle off and Pressure Support level.
- Back-up ventilation: select the Pressure back-up level to achieve adequate ventilation in case of apnea.
- Press “*Accept*” to accept the settings and proceed with NAVA ventilation.

## 3.1 NAVA LEVEL

How does one set the assist level with NAVA? When using NAVA, the amount of pressure delivered (in $cmH_2O$) is adjusted by multiplying the Edi (expressed in µV) by a proportionality factor, known as the "NAVA level" (expressed in $cmH_2O$/µV). The NAVA level expresses a type of "gain" factor i.e. how many $cmH_2O$ the patient will receive per µV Edi.

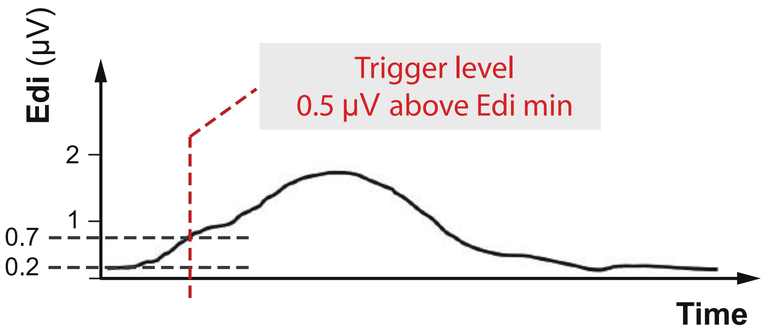



Ppeak (Pest) in NAVA =

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

## 3.2 TRIGGER LEVEL

The NAVA “trigger” detects increases in Edi and should be set to a level where random variability in the background noise does not exceed the trigger level. The variable background noise is typically less than 0.5 µV, which is the default value for Trigg. Edi.




It is important to emphasize that NAVA is triggered by an increase in Edi from the Edi min rather than a specific level of Edi.

As a secondary source NAVA also employs the pneumatic trigger, based on flow or pressure, which operates in combination with the neural trigger on a first-come-first-served basis.

## 3.3 NAVA RESPIRATION CYCLE

### Inspiration starts:

- When the patient triggers a breath, gas flow into the lungs at a varying pressure proportional to the patient's Edi.
- The maximum available pressure level is 5 $cmH_2O$ below the preset upper pressure limit.


### Expiratory phase starts:

- When the Edi decreases below 70% for normal and high Edi signals (40% for low Edi signals) of the peak value;
- If the pressure increases 3 $cmH_2O$ above the inspiratory target pressure;
- If the upper pressure limit is exceeded.

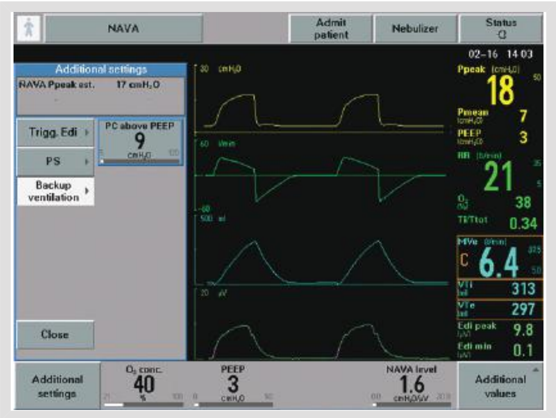
### The maximum time for inspiration is:

- Infant – 1.5 seconds
- Adult – 2.5 seconds

## 3.4 ADDITIONAL SETTINGS

In the "*Additional settings*" window, it is possible to adjust values and still see the curves.

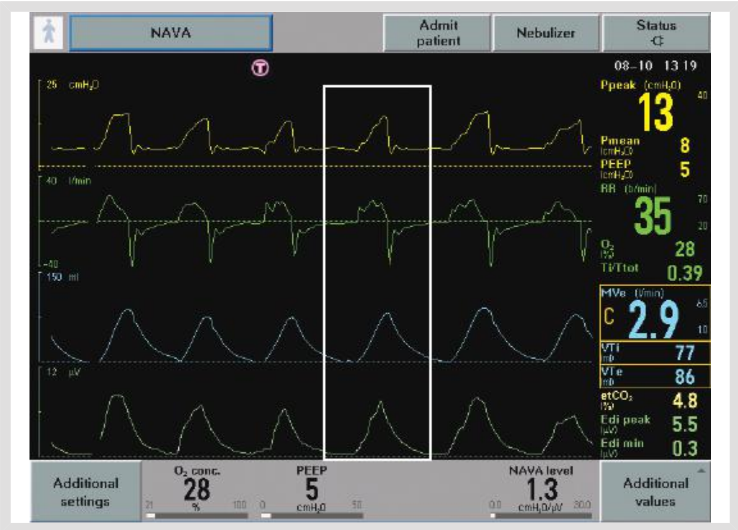


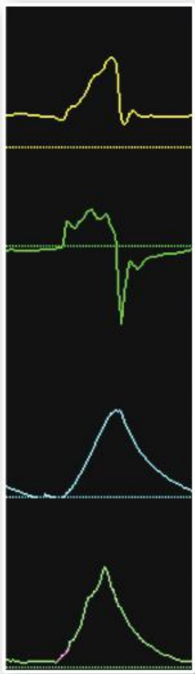


## 3.5 RUNNING IN NAVA MODE

Inspiratory support is delivered in proportion to the Edi signal (inspiratory trigger, size and cycle off).

The patient triggers the assisted inspiration in NAVA according to the first-come-first-served principle (Edi, flow or pressure trigger).



In the User Interface, there are different trigger colors depending on how the inspiration is triggered (for NAVA - light pink, see picture; flow pressure - purple). In the User Interface, there are direct access knobs for adjustment of NAVA level, PEEP and $O_2$.

### 3.5.1 SUCTIONING/DISCONNECTION IN NAVA

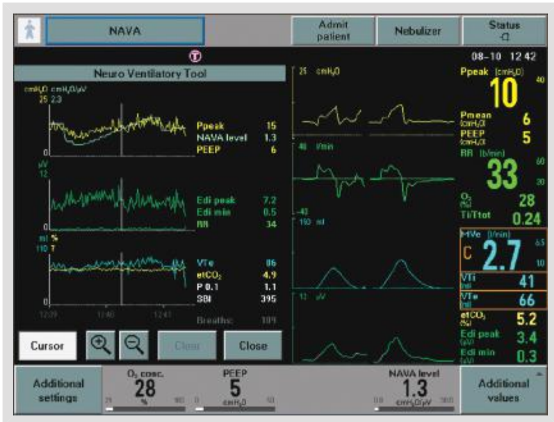

During suctioning or disconnection of the patient, it is important to use the Suction Support function, otherwise the asynchrony alarm may be activated.

## 3.6 NEURO VENTILATORY TOOL (NVT)

Neuro Ventilatory Tool is a breath-by-breath presentation of:

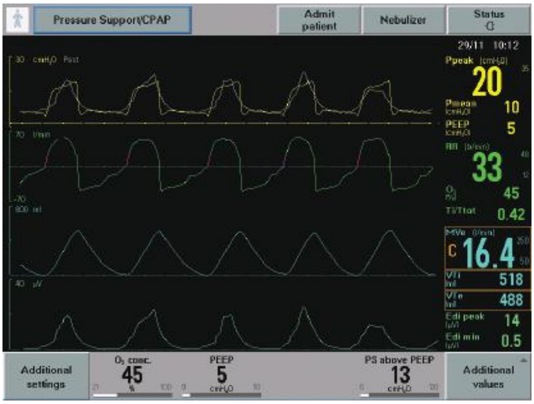
- Ppeak (graph), NAVA level (graph), PEEP (numerical value)
- Edi peak (graph), Edi min (graph), RR (numerical value)
- Vte (graph), $etCO_2$ (graph), P01 (numerical value), SBI (numerical value)

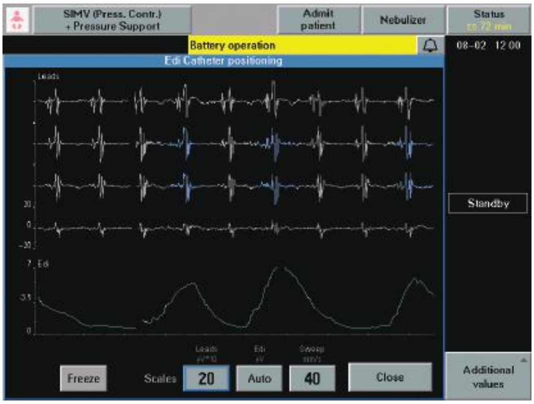
When using the Neuro Ventilatory Tool window, data is presented and stored breath-by-breath and can be exported to a Ventilatory Record Card.



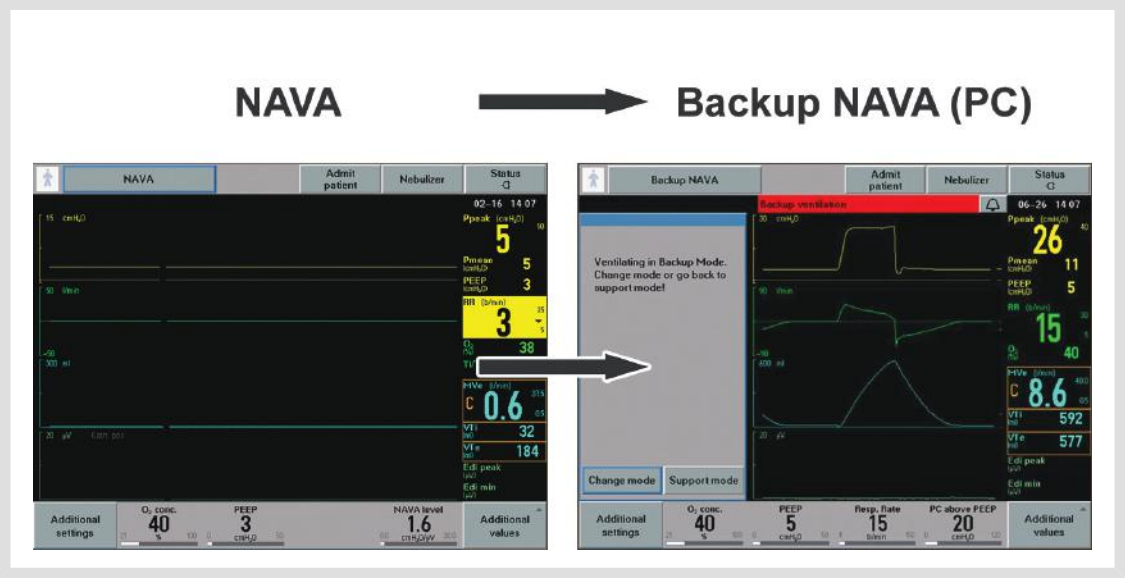
## 3.7 MONITORING OF THE EDI SIGNAL

Edi monitoring is available in all modes of ventilation, invasive and non invasive. In Stand-by, it is possible to monitor the Edi signal in the positioning window.



## 3.8 NAVA BACKUP FUNCTION




In case of an apnea (resulting in a permanently low Edi signal and no pneumatic trigger), the ventilator will switch to NAVA backup (Pressure Control) after the set apnea time.

## 3.9 NAVA (PS)

### 3.9.1 SWITCHING TO NAVA (PS)

The ventilator switches from NAVA to NAVA (PS) if one or more of the following conditions are fulfilled during NAVA ventilation:

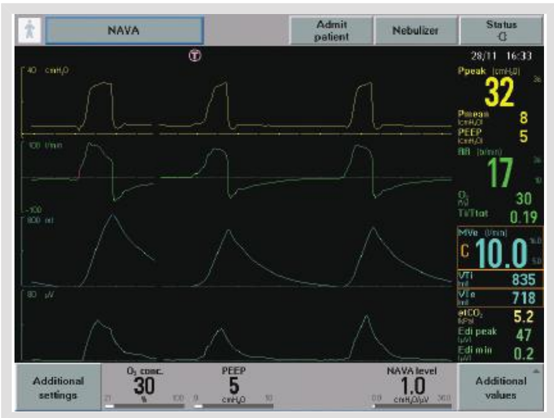
- The Edi respiratory rate differs from the pneumatic respiratory rate by more than 25% for at least 5 s. The calculated respiratory rates are based on the last 20 s.
- The Edi Ti/Ttot is more than 0.5, calculated over the last 20 s if the catheter position is classified as invalid.
- The Edi Ti/Ttot is more than 0.6, calculated over the last 20 s if the catheter position is classified as valid.
- The Edi Catheter is disconnected.
- There is ECG leakage into the Edi signal.

**Note:** Pneumatic respiratory rate and Ti/Ttot are shown in the User Interface. Edi respiratory rate and Edi Ti/Ttot are not shown on the User Interface.

### 3.9.2 SWITCHING BACK FROM NAVA (PS) TO NAVA

The ventilator switches back automatically from NAVA (PS) to NAVA if all of the following conditions are fulfilled:

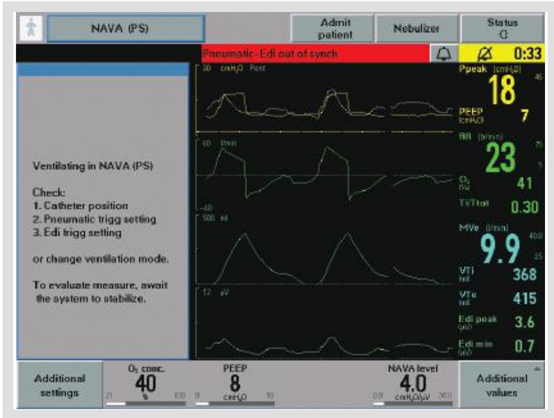
- The Edi respiratory rate differs from the pneumatic respiratory rate by less than 20%.
- At least 7 of the last 10 breaths are classified as synchronous with the Edi signal.



## 3.10 ALARM FOR ASYNCHRONY

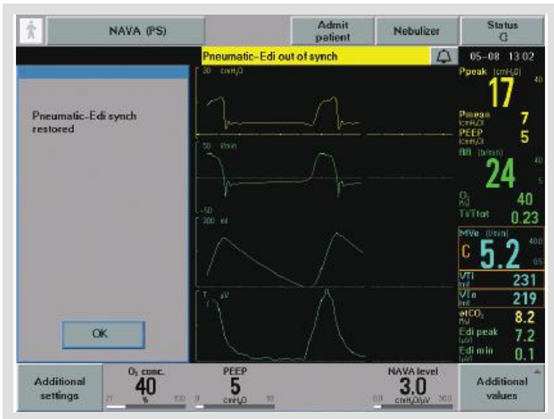
The ventilator will switch back and forth without sounding an alarm until one of the following conditions is fulfilled:

- The ventilator has been in NAVA (PS) for more than 80 s.
- There have been six switches from NAVA to NAVA (PS) in the last 5 minutes.




### 3.10.1 BACK TO NAVA

If the asynchrony alarm is activated, the ventilator will search for synchrony indices. As soon as synchrony is re-established, the message “Pneumatic Edi synch restored” is displayed. Press the ”OK” button, or wait 10 s, then the ventilator will switch back to NAVA.



# 4 TROUBLESHOOTING

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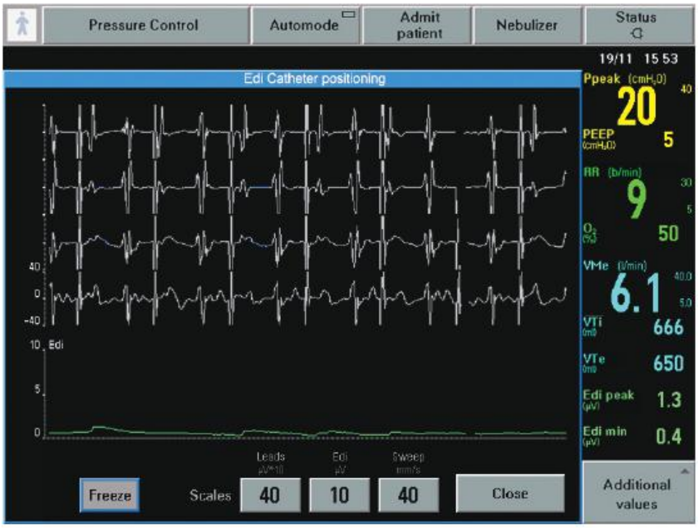
# 4 TROUBLESHOOTING

## 4.1 LOW OR NO EDI SIGNAL

If a low or no Edi signal is detected:

- Verify the Edi Catheter positioning.
- Verify that the effects of muscle relaxants have worn off.
- Verify the patient's sedation level. The apneic threshold might be higher due to CNS depressant drugs.
- Verify, by means of blood gas or end tidal $CO_2$, that the patient is not hyperventilated, as this may affect the Edi.
- Too high a PEEP level and/or too high support pressures may diminish diaphragm electrical activity to a level where it is difficult to detect. In this case, reduction of these levels may restore Edi and diaphragm activity.



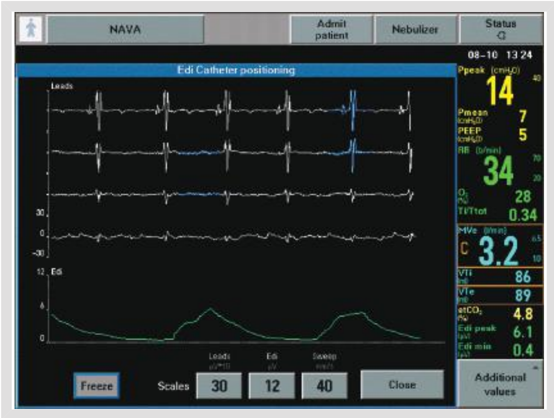
## 4.2 THE EDI SIGNAL IS PRESENT, BUT THERE ARE NO BLUE HIGHLIGHTS ON THE ECG WAVEFORMS

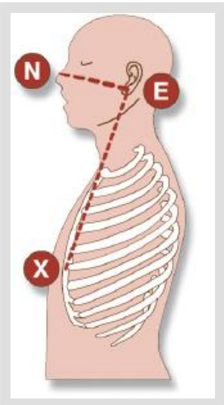
A certain amount of time (up to 30 s) is often required before the blue highlight appears.

### EXAMPLE

In the picture, the Edi Catheter is probably inserted too far and a signal from an expiratory muscle is detected. **In this case, repositioning of the Edi Catheter is needed.** Check:

- NEX measurement
- The calculation of the Y (see tables below)
- Verify that P and QRS waves are present in the top leads and that the P waves disappear in the lower leads with a decrease in QRS amplitude in the lower leads.




| **Insertion distance Y for nasal insertion** | |
|---|---|
| **Fr/cm** | **Calculation of Y** |
| 16 Fr | NEX cm x 0.9 + 18 = Y cm |
| 12 Fr | NEX cm x 0.9 + 15 = Y cm |
| 8 Fr 125 cm | NEX cm x 0.9 + 18 = Y cm |
| 8 Fr 100 cm | NEX cm x 0.9 + 8 = Y cm |
| 6 Fr 50 cm | NEX cm x 0.9 + 3.5 = Y cm |
| 6 Fr 49 cm | NEX cm x 0.9 + 2.5 = Y cm |

| **Insertion distance Y for oral insertion** | |
|---|---|
| **Fr/cm** | **Calculation of Y** |
| 16 Fr | NEX cm x 0.8 + 18 = Y cm |
| 12 Fr | NEX cm x 0.8 + 15 = Y cm |
| 8 Fr 125 cm | NEX cm x 0.8 + 18 = Y cm |
| 8 Fr 100 cm | NEX cm x 0.8 + 8 = Y cm |
| 6 Fr 50 cm | NEX cm x 0.8 + 3.5 = Y cm |
| 6 Fr 49 cm | NEX cm x 0.8 + 2.5 = Y cm |

## 4.3 WAYS TO FACILITATE SYNCHRONY AND TRANSITION FROM NAVA (PS) BACK TO NAVA

- If the amplitude of the Edi signal is low during NAVA (PS), the pressure support level may supress the Edi signal. Consider lowering the pressure support level.
- If there is leakage in the patient´s circuit, consider lowering the pneumatic trigger sensitivity in order to minimize the autotriggering.

# 5 ALARMS

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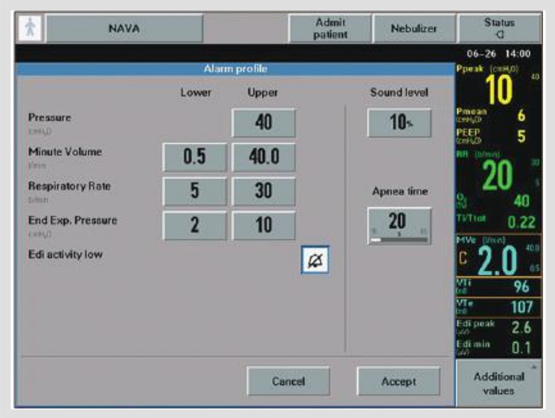
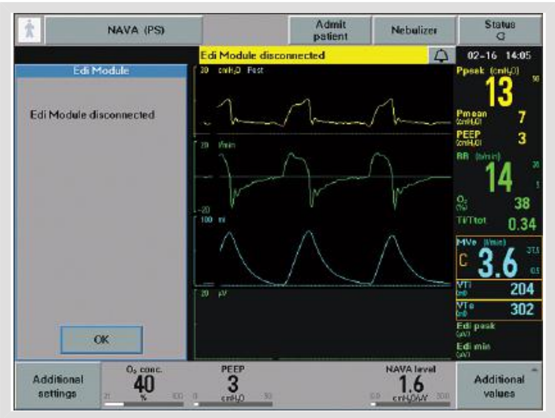
# 5 ALARMS





- "*Pressure regulation limited*" alarm – activated 5 $cmH_2O$ below Upper pressure limit.
- Patient related alarm: "*Edi activity low*" – can be silenced.





- Message and dialog when Edi Module and/or Edi Catheter are disconnected.
- High priority alarm when Edi Module and/or Edi Catheter are disconnected in NAVA.

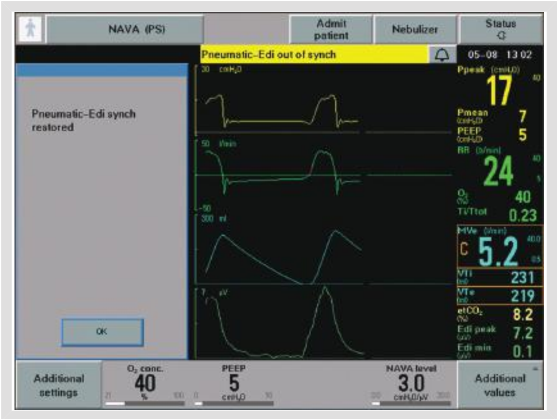
## 5.1 ALARM FOR ASYNCHRONY

The ventilator will switch back and forth without sounding an alarm until one of the following conditions is fulfilled:

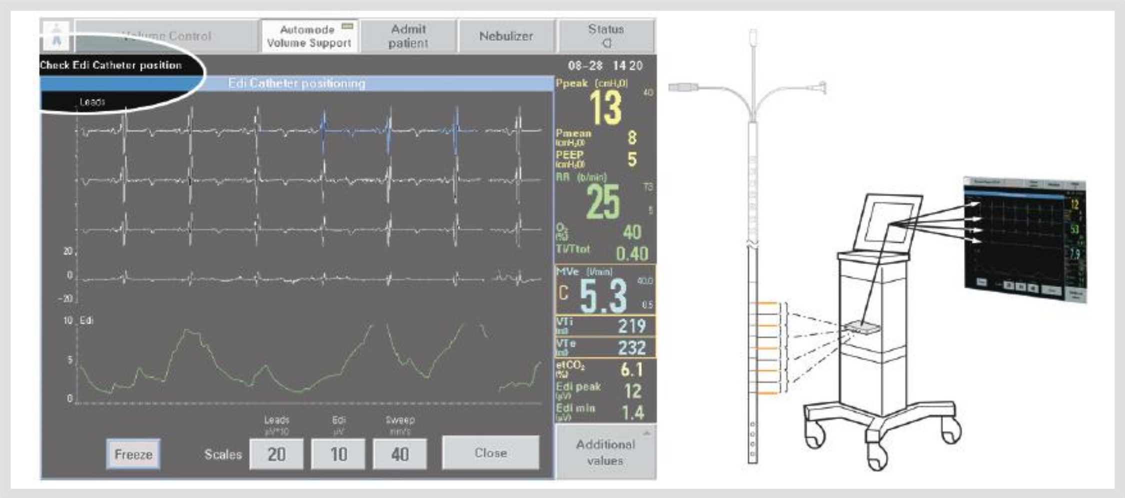
- The ventilator has been in NAVA (PS) for more than 80 s.
- There have been six switches from NAVA to NAVA (PS) in the last 5 minutes


### 5.1.1 BACK TO NAVA

If the asynchrony alarm is activated, the ventilator will search for synchrony indices. As soon as synchrony is re-established, the message “Pneumatic Edi synch restored” is displayed. Press the ”OK” button, or wait 10 s, then the ventilator will switch back to NAVA.



”*Check Edi Catheter position”* will be shown when the Edi Catheter detects the strongest signal at either end of the electrode array, i.e. the upper or lower electrode.




*The picture displays an example where only the upper ECG waveform has blue highlights. This situation indicates that the Edi Catheter is positioned a bit too far down.*

- Check that the Edi Catheter is still inserted according to the final marking.
- If the blue highlights are in the top or bottom leads, fine tune the Edi Catheter position by means of the ECG waveforms.
  - If the top leads are highlighted in blue, pull out the Edi Catheter in steps corresponding to the IED until the blue highlight appears in the centre. Do not pull out more than 4 times the IED.
  - If the bottom leads are highlighted in blue, insert the Edi Catheter further in steps corresponding to the IED until the blue highlight appears in the center. Do not insert more than 4 times the IED.

# 6 REFERENCES FOR NAVA STUDY GUIDE

## 6.1 REFERENCES

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• Order No. 66 75 357 • Printed in Sweden • 120801 • Rev: Rev 00 English •

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