Clearing the Air
Ventilator Strategies in the NICU

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Objectives

• Discuss alternatives to conventional strategies
• Discuss the indications for advanced alternative strategies
• Discuss whether we should be using newer modalities in the NICU
• Discussion
Respiratory Therapy Toy box
Why are Modes so Difficult?

9 different modes to choose from and 3 of those have added features
What advanced strategies are we going to discuss?

- NIV ventilation
- Auto modes
- Bi-Level or Bi-Vent
- HFO
- NAVA
- NAVA NIV
NIV Ventilation

• Devices
  – With SiPAP
  – With NIV mode on the Conventional Ventilator
  – CPAP device with generator or conventional ventilator

• Interfaces
  – Nasal mask
  – Nasal prongs
  – RAM cannula
Challenges with NIV

• Interfaces
  – Masks, prongs, and RAM cannulas have leaks
  – Masks and prongs carry the risk of pressure ulceration

• Triggering
  – Leaks make triggering efforts by the baby ineffective
  – Leaks may lead to auto-cycling

• Weaning
  – Inability to effectively trigger makes PSV ineffective
  – Inability to detect spontaneous breathing effort makes weaning the rate ineffective
How do we Overcome the Challenges of NIV

• Interface
  – Products on the market to protect the face (deuderm based)
  – Alternate between prongs and mask
  – Use of chin strap

• Triggering
  – Set NIV vent up with a physiological rate
  – Consider NAVA NIV if available

• Weaning
  – Wean PC setting until the PIP matches PEEP setting – now you have CPAP
Invasive Auto Modes – Auto modes / Adaptive Support Ventilation / Volume Guarantee / Mandatory Minute Ventilation

• What is Auto-mode
  – Auto modes are hybrid modes of ventilation that allow the patient to go back and forth from mandatory breath delivery to spontaneous breath delivery based on effort.
  – Spontaneous breaths are supported
  – Mandatory breaths are determined by the end user
  – Continuous monitoring of the patient’s respiratory efforts
  – Can track performance through trend screens
Auto mode set up on the Servo I Ventilator

PS level can be changed
Why choose Automode?

• Spontaneous ventilation modes are better tolerated assuming enough support is provided.
  – Patient is in control of breath – breath initiation, Ti, flow, and breath termination
  – Important to evaluate the settings and the patient to insure adequate support
  – Alarm settings must reflect alerts that you need to be aware of

• May reduce the need for sedation
  – No studies to support this – most data are retrospective observations
If the ventilator senses 2 consecutive spontaneous breathing efforts it will change to the spontaneous mode. If the “trigger timeout” is violated the ventilator switches back to the mandatory mode.
Weaning Auto-modes

• Gradually decrease the amount of spontaneous support towards a CPAP target

• Assure that the patient spends majority of time in the spontaneous mode – check trend screens

• Evaluate for extubation readiness
Bi-Vent / Bi-Level Modes

• This is a mode of ventilation that alters PEEP levels and allows the patient to breath spontaneously.

• It was originally used for adult patients with ARDS and low lung compliance, although the set up for this purpose is very different than for neonates.

• This may be a good mode to use for neonates with low lung compliance, leaky ETT’s in patients who have evidence of lung volume loss on CXR.

• It is a lung recruitment tool.
Bi-Vent / Bi-Level Use in Neonates

• Set a High PEEP and a Low PEEP (the gradient between the 2 pressures results in air movement in and out of the lungs – set pressures are titrated to target specific exhaled $V_T$ measurements)

• Set time spent at High PEEP and time spent at Low PEEP – be sure to allow enough expiratory time to facilitate exhalation

• Set a rate (rate may be set based on the amount of time a patient spends at each PEEP level)

• Rate = 60/(Time High + Time Low)

• Time High is usually 0.4-0.6 for neonatal patients
Bi-Vent / Bi-Level Use in Neonates

- Might consider this mode for patients with severe RDS, resulting in low lung compliance, low lung volumes, and OI calculations > 12-13 cmH$_2$O
- Works in the presence of leaky ETT’s because as the pressure drops – flow is added to maintain set pressure points for the specified period of time.
Bi-Vent /Bi-Level Concept

- Spontaneous breaths can be taken at any point in the cycle
- Spontaneous breaths can be supported or augmented
- Transitions from 1 PEEP level to the next are tracked so that the transition occurs when the patient completes their current breath phase
Must be set up correctly to insure patient comfort – this represents a Time High that is too long leading to erratic ventilation.
Less Time High – More synchrony

Decreased RR but higher VE
HFOV

• Best outcomes are noted when initiated early in the lung disease process vs. using it as a rescue measure when conventional ventilation is maxed out and fails

• Usually indicated for OI calculation > 12-15 cmH₂O but can be initiated at any time
NAVA - Neurally Adjusted Ventilatory Assist

- Spontaneous Mode of Ventilation
- Ventilatory support is controlled by contraction and relaxation of the diaphragm
- Diaphragm activity is controlled by receptors in the brain which send signals to the phrenic nerve
- Response of the ventilator is based on signals received by the NAVA catheter which is connected to the ventilator
- NAVA signals will trigger the ventilator to initiate flow, when the lungs are full the diaphragm relaxes, flow ceases, and the patient exhales
Patient Trigger and Cycling Variables

- **NAVA**
  - Central nervous system
  - Phrenic nerve
  - Diaphragm excitation
  - Diaphragm contraction
  - Chest wall and lung expansion
  - Airway pressure, flow and volume

- **Conventional**

- **NAVA**

- **Muscle weakness**

- **Chest/lung impedance**

- **Airway leaks**
NAVA Catheter

- Saturate with water to activate the electrodes prior to insertion
- Double lumen catheter so you can use as a feeding tube
Catheter Placement

1. $E_{di}$ signal
2. Blue highlights
NAVA Level

• Edi is measured in $\mu$V and is proportional to the intensity of the diaphragm contraction

• The $\text{Edi}_{\text{peak}}$ represents inspiratory work of breathing (contraction of the diaphragm)
  – There is an inverse relationship between the $\text{Edi}_{\text{peak}}$ and the NAVA level set
  – Goal is to have an $\text{Edi}_{\text{peak}}$ between 5-15 $\mu$V

• The $\text{Edi Min}$ represents the expiratory work of breathing (relative relaxation of the diaphragm)
  – There is an inverse relationship between the $\text{Edi}_{\text{min}}$ and the PEEP setting
  – Goal is to have and $\text{Edi}_{\text{min}} \leq 2 \mu$V
NAVA settings

NAVA Preview helps to set the appropriate NAVA level.
Of Note:
- The Trigg. Edi determines response from the diaphragm signal
- The Trigg. Flow determines the response for PS when the Edi signal is not detected
- The Insp cycle off determines when the PS terminates

The Edi trigger, the flow trigger as well as the Insp cycle off are important in the overall functionality related to reading signals and providing the appropriate support. Patients can get stuck in PS if the flow trigger is set too sensitive, especially in the presence of a leaky ETT.
Using incremental NAVA level to determine support
Increasing NAVA Level

Additional settings
- Additional values
  - O₂ conc.: 47%
  - PEEP: 6 cmH₂O
  - NAVA level: 1.2
  - MVe: 1.1 l/min
  - VTi: 15.8 cm³
  - VTe: 16.4 cm³
  - Leakage: 5%
  - Edd peak (µV): 6.9
  - Edd min (µV): 1.2

Alarm(s) off: Check tubing

NIV NAVA

Admit patient

Nebulizer

Status

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NAVA Trigger

- **PS** trigger
- Diaphragm signal
- Additional settings: O₂ conc. 44%, PEEP 6 cmH₂O, NAVA level 1.6 cmH₂O/µV
- Additional values: Edi peak 5.9 µV, Edi min 2.4 µV
NAVA in a patient with a significant ETT leak
NIV NAVA with RAM cannula

Image of medical equipment and data with various parameters such as tidal volume, oxygen concentration, PEEP, and NAVA level.
NIV NAVA with a significant leak, inadequate NAVA level and inadequate PEEP
NAVA Summary

• You can provide too much NAVA support but it shouldn’t result in too much volume delivery

• You can provide too little NAVA support and it will result in an increased work of breathing

• PEEP adjustments can be much more analytically evaluated using the Edi_{min} signal

• It is important to evaluate the PIP, the delivered VT and the Edi_{peak} when assessing extubation readiness
Summary

• For a vast majority of patients, the standard modes that are commonly used are sufficient

• When patients need advanced support it is important to evaluate the goals of what you are trying to achieve so that you can select the appropriate mode

• Sometimes you need to try more than 1 mode or tweak more than 1 setting within a mode

• Have some healthy skepticism: Most of the advanced modes have little evidence in the neonatal population

• Let your patient be your guide
QUESTIONS ?????