Tips and Tricks for the Treatment of COPD with Non-Invasive Ventilation

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Agenda

- Overview of Non-Invasive Ventilation (NIV)
- How NIV helps you meet your COPD goals
- Brief History of NIV
- NIV Modes
- AVAPS & COPD
- AVAPS-AE & COPD
- MPV & COPD
- Summary
Future of NIV

- NIV now being touted as a way to help COPD patients in the home to prevent hospital re-admissions
  - AVAPS
  - AVAPS-AE
  - Mouth Piece Ventilation (MPV)
Overview of NIV

- NIV has gained increasingly great popularity as the technology has advanced.
Overview of NIV

- Hundreds of articles demonstrating the benefits to the patients and the organization
How can NIV help you meet your goals?

Decrease complications of intubation/mechanical ventilation

- Impaired cardiac function
- Increased intracranial pressure
- Gastric distension
- Renal and hepatic dysfunction
- Dynamic Hyperinflation and Auto-PEEP
- Clinical Barotrauma
- Pulmonary interstitial emphysema
- Pneumomediastinum
- Pneumothorax
- Difficult intubation; loss of airway
- Tissue injury; hemorrhage
- Increased airway secretions
- Loss of endogenous humidification system
- Impaired mucociliary clearance
- Increased work of breathing
- Loss of ability to speak
- Laryngeal edema, vocal cord dysfunction
- Aspiration
- Tracheal stenosis
- Ventilator-Associated Pneumonia
How can NIV help you meet your goals?

- Improve patient comfort

- This:

- Versus this:
How can NIV help you meet your goals?

- Minimize length-of-stay
How can NIV help you meet your goals?

- Minimize costs
How can NIV help you meet your goals?

- Outcomes for patients have steadily improved
Brief History of NIV
(Started with NIV)

Poliomyelitis epidemic patients at Ranchos Los Amigos Hospital, California, 1953.

Robert M Kacmarek Respir Care 2011;56:1170-1180
Brief History of NIV
(“Portable” NIV)

Left: Chest cuirass ("turtle shell"), Right: “Raincoat” wrap with wire grid and Emerson 33-CRE negative-pressure ventilator.

Robert M Kacmarek Respir Care 2011;56:1170-1180
Brief History of NIV
(Early Invasive Vents)

Clockwise from upper left: Puritan Bennett MA-1, Ohio 560, Siemens Servo 900.

Robert M Kacmarek Respir Care 2011;56:1170-1180
Current-generation intensive care unit ventilators.
Brief History of NIV
(Even with invasive vents, still wanted NIVs)

Non-invasive ventilation with a ventilator providing only volume control without patient triggering.

Robert M Kacmarek Respir Care 2011;56:1170-1180
Brief History of NIV

- First commercially marketed about 30 years ago
  - After I graduated from school
- Evidenced-Based Medicine
  - Has not always been around!
  - Therefore, NIV entered without a lot of research
- What happened
  - Unfounded fears
  - Low Pressures
- What’s still happening
Ventilation Basics

- Normal ventilation
NIV Modes

- **Primary NIV Modes**
  - CPAP (Continuous Positive Airway Pressure)
  - S/T (Spontaneous/Timed)
    - BiPAP

- **Other Modes**
  - AVAPS (Average Volume-Assured Pressure Support)
    - BiPAP with a Target Tidal Volume
NIV Modes

- **Primary Modes**
- **CPAP mode**
  - In the CPAP (continuous positive airway pressure) mode, the ventilator functions as a demand flow system, with the patient triggering all breaths and determining their timing, pressure, and size.
Ventilation Basics

- CPAP
Settings

- CPAP
NIV Modes

• **Primary Modes**
  
  • **S/T (Spontaneous/Timed) mode (BiPAP)**
    
    • The S/T (spontaneous/timed) mode guarantees breath delivery at the user-set rate.
    
    • It delivers pressure-controlled, time-cycled mandatory and pressure supported spontaneous breaths, all at the IPAP pressure level.
    
    • If the patient fails to trigger a breath within the interval determined by the Rate setting, the ventilator triggers a mandatory breath with the set I-Time.
Ventilation Basics

- S/T (BiPAP)
Settings

- Primary Modes
- S/T mode

### Active Mode: S/T

- **IPAP**: 12 cmH₂O
- **Rate**: 12 BPM
- **I-Time**: 1.00 secs
- **Rise**: 2
- **EPAP**: 4 cmH₂O
- **O₂**: 22 %

### Diagram:
- **Pressure**
  - **IPAP**
  - **EPAP**
  - **Rise**
  - **Mandatory (Timed) breath**

**Patient-triggered (Spont) spontaneous breath with pressure support**

**1/Rate**

**I-Time**
Settings

• **Primary Modes**
  • **S/T Mode**
    • Target VT Challenges between Volume and Pressure Vents

  • **Volume** Ventilator
    o Establish Target VT
      • VT delivered
      • PIP may change with changing patient position & lung status
Settings

- Primary Modes
  - S/T Mode
    - Target VT Challenges between Volume and Pressure Vents

- **Pressure** Ventilator
  - Establish Target VT
  - Adjust pressure to deliver VT
    - However, must continually adjust with changing patient position and lung status
NIV Modes

• **Other Modes**
  • AVAPS (Average Volume Assured Pressure Support)
  • AVAPS mode delivers a target tidal volume.
  • It achieves the target volume by regulating the pressure applied.
  • The AVAPS mode delivers time-cycled mandatory breaths and pressure-supported spontaneous breaths.
  • If the patient fails to trigger a breath within the interval determined by the rate control, the ventilator triggers a mandatory breath with the set I-Time.
  • Mandatory and spontaneous breaths are delivered at a pressure that is continually adjusted over a period of time to achieve the volume target, VT.
  • Min P and Max P define the pressures that can be applied.
AVAPS

- What is AVAPS?
  - Vent automatically modifies pressure to maintain an average target user-defined VT
    - 1 cmH\textsubscript{2}O to possibly 2.5 cmH\textsubscript{2}O per minute change in pressure
  - During AVAPS setup, there may be a period of time before the target tidal volume is achieved
  - AVAPS \textbf{should not} be used when rapid IPAP adjustments are needed to achieve the desired VT
AVAPS

Set-Up

- When changing from ST to AVAPS, set Min P the same as the IPAP setting
  - Delivered VT should be the same as prior
- Confirm target VT is achieved.
- Allow AVAPS algorithm to adjust pressure needed to achieve the target VT
  - If displayed VT is significantly below target
    - Increase Min P to reach VT target quickly
    - Set Max P to limit delivered pressure
  - Once desired VT is achieved reduce Min P slightly (2 to 3 cmH₂O) to allow AVAPS algorithm to adjust
AVAPS

• Which Patients?
  • Obese hypoventilation patients: To compensate for changes in body position; averaged tidal volume ensured
  • COPD-type patients: To achieve a combination of ventilation comfort and efficiency with no compromise. Get both benefits by applying “the right pressure at the right time.”
  • Restricted patients: To provide the comfort and leak compensation of a pressure mode, and the safety of a guaranteed volume.
  • Neuromuscular disorders: With standard bi-level therapy, a patient’s tidal volume declines as disease process worsens
  • Other patients who would benefit from a more stable VT
AVAPS

• **Benefits**
  • Make titration process easier, no IPAP adjustment needed
  • Follow disease progression as patient’s ventilator needs change
  • Improve patient’s ventilation efficiency and comfort
  • Increase safety by guaranteeing an averaged tidal volume
AVAPS

• **Cautions**
  - This mode is not a PRVC type mode
    - It will **not** respond quickly (max 2 ½ cm H20 / min)
  - Not intended for patients with high resistance and low compliance (ARDS)
  - Helpful if patients are through their acute phase
    - It is ideal for stabilized chronic patients
Positive outcome of average volume-assured pressure support mode of a Respironics V60 Ventilator in acute exacerbation of chronic obstructive pulmonary disease: a case report

Miyuki Okuda1, Makoto Kashio1, Nobuya Tanaka1, Takashi Fujii1 and Yoshinari Okuda2

Abstract

Introduction: We were able to treat a patient with acute exacerbation of chronic obstructive pulmonary disease who also suffered from sleep-disordered breathing by using the average volume-assured pressure support mode of a Respironics V60 Ventilator (Philips Respironics: United States). This allows a target tidal volume to be set based on automatic changes in inspiratory positive airway pressure. This removed the need to change the noninvasive positive pressure ventilation settings during the day and during sleep. The Respironics V60 Ventilator, in the average volume-assured pressure support mode, was attached to our patient and improved and stabilized his sleep-related hypoventilation by automatically adjusting force to within an acceptable range.

Case presentation: Our patient was a 74-year-old Japanese man who was hospitalized for treatment due to worsening of dyspnea and hypoxemia. He was diagnosed with acute exacerbation of chronic obstructive pulmonary disease and full-time biphasic positive airway pressure support ventilation was initiated. Our patient was temporarily provided with portable noninvasive positive pressure ventilation at night-time following an improvement in his condition, but his chronic obstructive pulmonary disease again worsened due to the recurrence of a respiratory infection. During the initial exacerbation, his tidal volume was significantly lower during sleep (378.9 ± 72.9mL) than while awake (446.5 ± 63.3mL). A ventilator that allows ventilation to be maintained by automatically adjusting the inspiratory force to within an acceptable range was attached in average volume-assured pressure support mode, improving his sleep-related hypoventilation, which is often associated with the use of the Respironics V60 Ventilator. Polysomnography performed while our patient was on noninvasive positive pressure ventilation revealed obstructive sleep apnea syndrome (apnea-hypopnea index = 14), suggesting that his chronic obstructive pulmonary disease was complicated by obstructive sleep apnea syndrome.

Conclusion: In cases such as this, in which patients with severe acute respiratory failure requiring full-time noninvasive positive pressure ventilation therapy also show sleep-disordered breathing, different ventilator settings must be used for waking and sleeping. On such occasions, the Respironics V60 Ventilator, which is equipped with an average volume-assured pressure support mode, may be useful in improving gas exchange and may achieve good patient compliance, because that mode allows ventilation to be maintained by automatically adjusting the inspiratory force to within an acceptable range whenever ventilation falls below target levels.
AVAPS = so far promising results in obesity-hypoventilation in STABLE patients

Impact of volume targeting on efficacy of bi-level non-invasive ventilation and sleep in obesity-hypoventilation

Jean-Paul Janssens a,*, Marie Metzger a, Emilia Sforza b

Conclusion: In stable patients treated by BPPV for obesity-hypoventilation, volume targeting improved control of nocturnal hypoventilation at the expense of a slight decrease in objective and subjective sleep quality, and comfort of ventilation.
AVAPS

- Adults

Home Mechanical Ventilation for COPD: High-Intensity Versus Target Volume Noninvasive Ventilation

Jan H Storre MD, Elena Matrosovich MD, Emelie Ekkemkamp MD, David J Walker MD, Claudia Schmoor PhD, Michael Dreher MD, and Wolfram Windisch MD

BACKGROUND: High-intensity noninvasive ventilation (HI-NIV) is the most effective means of improving several physiological and clinical parameters in subjects with chronic hypercapnic COPD. Whether the newer hybrid mode using target tidal volume noninvasive ventilation (target $V_T$ NIV) provides additional benefits remains unclear. METHODS: Subjects with COPD successfully established on long-term HI-NIV were switched to target $V_T$ NIV. Optimal target $V_T$ settings according to nocturnal transcutaneous $P_{CO_2}$ measurements were achieved following a randomized crossover trial using 8 mL/kg ideal body weight and 110% of individual $V_T$ during HI-NIV, respectively. The following parameters were compared at the beginning of the trial while subjects were on HI-NIV, and after 3 months on optimal target $V_T$ NIV: sleep quality by polysomnography, overnight gas exchange, subjects' tolerance, overnight pneumotachygraphic measurements during NIV, health-related quality of life (severe respiratory insufficiency questionnaire), exercise capacity (6-min walk test), and lung function. RESULTS: Ten of 14 subjects completed the study. There were no differences between HI-NIV and target $V_T$ NIV in any of the above-mentioned parameters. Specifically, the mean overnight transcutaneous $P_{CO_2}$ was equivalent under each form of ventilation (both 45 ± 5 mm Hg, $P = .75$). CONCLUSIONS: Switching subjects from well-established HI-NIV to target $V_T$ NIV shows no clinical benefits in chronic hypercapnic COPD. In particular, sleep quality, the control of nocturnal hypventilation, daytime hypercapnia, overnight ventilation patterns, subjects' tolerance, health-related quality of life, lung function, and exercise capability were all similar in subjects who underwent HI-NIV and target $V_T$ NIV. Nevertheless, target $V_T$ NIV might offer some physiological advantages in breathing pattern and might be beneficial in some individual patients. (German Clinical Trials Register [www.drks.de] Registration DRKS00000450.)

Key words: Chronic obstructive pulmonary disease; mechanical ventilation; sleep quality; target volume; ventilation mode. [Respir Care 2014;59(9):1389–1397. © 2014 Daedalus Enterprises]
Trilogy

- Newest Model
  - IP
  - OP
  - Transport
- NIV and IV modes
- New modes
  - AVAPS-AE
  - MPV
Trilogy Modes

• **New Mode**
  • **AVAPS-AE**
    • *(Average Volume Assured Pressure Support with Auto EPAP)*
    • Currently only on the Philips Trilogy
    • AVAPS as previously described
    • Adds auto-titrating EPAP technology
Trilogy Modes

- **AVAPS-AE (cont.)**
  - Has an EPAP “range” that allow the machine to auto-titrate the correct amount of pressure.
  - Every 100 breaths sends out “pulses of air” to measure if there is down-stream resistance
    - If there is resistance, it increases pressure by 1 cm H2O and then re-assesses after next 100 breaths
    - If there is not resistance, then it attempts to decrease the pressure by 1 cm H2O and assesses again
Trilogy Modes

- **AVAPS-AE (cont.)**
  - Benefit
    - If EPAP optimized, then most often, IPAP will drop as airway already open
      - IPAP pressures not needed to “pop” open airway.
    - Improved patient comfort
    - Improved patient compliance
    - Improved outcomes
Retrospective Assessment of Home Ventilation to Reduce Rehospitalization in Chronic Obstructive Pulmonary Disease

Steven Coughlin, PhD; Wei E. Liang, PhD; Sairam Parthasarathy, MD

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Table 2—Hospital readmissions following initiation of quality improvement program.

<table>
<thead>
<tr>
<th>Number of COVD-related Admissions</th>
<th>Patients with admission in the year prior to program initiation (n [%])</th>
<th>Patients with admission in the year post program initiation (n [%])</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0 (0%)</td>
<td>348 (87.7%)</td>
</tr>
<tr>
<td>1</td>
<td>0 (0%)</td>
<td>40 (10.1%)</td>
</tr>
<tr>
<td>≥ 2</td>
<td>397 (100%)</td>
<td>9 (2.2%)</td>
</tr>
</tbody>
</table>

Admissions among the 397 COPD patients enrolled in the QI program. n (%), unless otherwise stated. COPD = chronic obstructive pulmonary disease

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“Data could suggest that advanced PAP modes such as AVAPS-AE may be superior to other conventional PAP modalities such as CPAP or bilevel PAP.”

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Mouthpiece Ventilation (MPV)
Expanding ventilatory support

Mouthpiece ventilation (MPV)

MPV is a form of volume ventilation whereby the patient’s normal state is disconnected from the ventilator and the patient initiates a breath, as needed, through an oral interface.
MPV History

- MPV technique originated in 1950’s as a therapeutic adjunct for dyspnea in polio patients
- John E. Affeldt of Rancho Los Amigos Hospital
  - IPPV with a mouthpiece could relieve dyspnea in ventilator-dependent polio patients
  - Used when negative pressure was interrupted by transfers, nursing care, physical therapy
Evolution of MPV

- Traditionally performed on volume ventilators that were adapted and modified to allow for “sip breathing”.
  - Resistance added to the circuit
  - Prevented nuisance low pressure alarms
- In 1980’s the introduction of masks and pressure ventilators which allowed for compensation of leaks resulted in a shift in methods. (Ease of use etc.)
What type of patient could benefit from MPV?

Conditions with respiratory muscle dysfunction

- Muscular dystrophies
- ALS
- Other myopathies: acid maltase deficiency, polymyositis, mitochondrial disorders
- Neurological disorders: spinal muscular atrophies (SMA I,II,III)
- Neuropathies: Guillain-Barre syndrome, multiple sclerosis
- Skeletal pathologies such as kyphoscoliosis, rigid spine syndrome
Kiss trigger and MPV support system

- A new ‘kiss’ trigger with signal flow technology detects when the patient engages and disengages from the mouthpiece to deliver on-demand ventilation

- This feature combines with a mouthpiece ventilation (MPV) support system to enhance ease of use
Trilogy 100: MPV

Optional time-based patient reminder
- MPV Circuit Disconnect Alarm

Dual Prescription Function
- Facilitates independent day & nighttime settings
  - MPV during the day & mask ventilation a night
  - AC mode for MPV, PC mode with AVAPS for nocturnal mask ventilation

KISS Trigger
- Unique algorithm for a normally “disconnected” state
- Eliminates issues with a traditional flow trigger:
  - No sensitivity to adjust – mitigates auto triggering
  - *Does not* require patient effort to generate a breath
  - Important for progressively weaker respiratory muscles
MPV & COPD

• A “Third Option” for severe COPD patients who are at home
  • Typical options when have difficulty
    • Take MDI excessively and hope
    • Go to the ED
  • “Third Option”
    • MPV
Emerging Info about Benefits & Uses of MPV with COPD

- Partner with your medical director and home care/DME provider
Summary

- Each year, thousands of drills are sold.....but no one actually wants a drill!
Summary

- They want the hole!
Summary

• What do caregivers and patients want?
  • They want the outcomes!
    • Decrease complications of intubation/mechanical ventilation
    • Improved patient comfort
    • Decreased length-of-stay / re-admissions
    • Minimize costs
Summary

- NIV, and the various modes available with it, can provide a key benefit to not only your patient; but also to you department/organization
Thank You!

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