Home Non-Invasive Ventilation for Chronic Hypercapnic Respiratory Failure

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Learning objective – Chronic Obstructive Pulmonary Disease and Obesity Hypoventilation Syndrome

Review the use of Non-Invasive Ventilation (NIV)/ Positive Airway Pressure (PAP) Therapy in Chronic Hypercapnic Respiratory Failure Chronic Obstructive Pulmonary Disease and Obesity Hypoventilation Syndrome:

1. Why is Hypercapnia BAD?
2. Who will benefit?
3. When to initiate?
4. How to get an NIV/PAP machine?
5. What modes/settings to use?
Challenges

- Relatively New Therapy option
- Patient Factors
- DATA
- Relatively New Therapy option
Why?
Effects of Hypercapnia in COPD

Risk of Readmission and Mortality Following Hospitalization with Hypercapnic Respiratory Failure

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30-day readmission risk increased
Increased mortality
(36% in a period of 19-31 months)
Hypercapnia

Impaired clearance of alveolar edema

Mitochondrial dysfunction and mitigated proliferation of alveolar epithelial cells

Impaired phagocytic and antiviral activity of alveolar macrophages

Muscle atrophy and reduced anabolic capacity

Attenuated antimicrobial response to bronchial epithelial cells

May induce bronchodilation and/or bronchoconstriction

Muscle atrophy and reduced anabolic capacity
Who?
COPD with persistent hypercapnia will benefit

<table>
<thead>
<tr>
<th>Table 2. Summary of clinical trials investigating role of noninvasive ventilation in chronic obstructive pulmonary disease with chronic respiratory failure</th>
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<tbody>
<tr>
<td><strong>Low-Intensity Noninvasive Ventilation</strong></td>
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<tr>
<td><strong>High-Intensity Noninvasive Ventilation</strong></td>
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<tr>
<td><strong>Casanova et al. (10)</strong></td>
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<td><strong>Clini et al. (11)</strong></td>
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<td><strong>McEvoy et al. (12)</strong></td>
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<td><strong>Struijk et al. (21)</strong></td>
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<td><strong>Köhlein et al. (20)</strong></td>
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<td><strong>Murphy et al. (22)</strong></td>
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<td><strong>N</strong></td>
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<tr>
<td><strong>Age, yr</strong></td>
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<td></td>
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<tr>
<td><strong>BMI, kg/m²</strong></td>
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<tr>
<td><strong>FEV₁, % predicted</strong></td>
</tr>
<tr>
<td><strong>Paco₂, mm Hg</strong></td>
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<tr>
<td><strong>Paco₃, mm Hg</strong></td>
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<tr>
<td><strong>Mode</strong></td>
</tr>
<tr>
<td><strong>IPAP/EAPAP, cm H₂O</strong></td>
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**Definition of abbreviations:** Bilevel-S = no backup rate; Bilevel-S/T = backup rate; BMI = body mass index; COPD = chronic obstructive pulmonary disease; EPAP = expiratory positive airway pressure; FEV₁ = forced expiratory volume in 1 second; IPAP = inspiratory positive airway pressure; Paco₂ = carbon dioxide tension; Paco₃ = arterial oxygen tension; QoL = quality of life; RCT = randomized controlled trial; SaO₂ = arterial oxygen saturation.
Patient Selection – high intensity NIV

<table>
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<tr>
<td>• Post exacerbation –NIV inpatient</td>
<td>• GOLD 3 and 4</td>
<td>Stage 4</td>
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<tr>
<td>• Screened at least 2 weeks after pH&gt;7.3-within 4 weeks</td>
<td>• &gt;48 h after free from ventilator support</td>
<td>Baseline paco2 &gt;=52, pH&gt;7.35-1 hr rest</td>
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<tr>
<td>• Persistent hypercapnia (paco2&gt;53) and hypoxemia(po2&lt;=55 or &lt;60 with polycythemia, PHTN, cor pulm, &lt;90% hypoxemia in &gt;30% sleep time)</td>
<td>• Hypercapnia – paco2 &gt; 45</td>
<td>No exacerbations in 4 weeks</td>
</tr>
<tr>
<td>• FEv1&lt;50%, ratio&lt;60%, smoker</td>
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<td>NO obesity (BMI &gt;=35)</td>
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<tr>
<td>• NO obesity – BMI&gt;=35, OSA, NM d/s</td>
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<td>No active cardiac problems(arrhythmias)</td>
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<td>• NO intubation during exacerb,</td>
<td></td>
<td></td>
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<td>• NO HD/RRT</td>
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<td>• FU – 12 m</td>
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Outcomes improved by NIV

- Decreased hospitalization
- Decreased mortality
- Decreased intubation
- Decreased ER visits
- Improvement in dyspnea
- Improvement in hypercapnia
- Increased awake Pao2
- Increased 6 MWD – may be improved after 6 months of use

Outcomes not affected

- Number of admissions for respiratory causes
- Number of admissions for COPD exacerbations
- No difference in FEV1
- Sleep efficiency
- ADL
- QOL
Definition of OHS

• BMI $\geq 30$ kg/m$^2$
• Sleep Disordered Breathing
• Awake resting PaCO$2$ $\geq 45$ mm Hg
• Other causes of hypoventilation excluded
When?
Should OHS patients be discharged with NIV/PAP after an admission for acute respiratory failure?

**Recommendation 4:** We suggest that hospitalized patients with respiratory failure suspected of having OHS be started on NIV therapy before being discharged from the hospital, until they undergo outpatient workup and titration of PAP therapy in the sleep laboratory, ideally within the first 3 mo after hospital discharge *(conditional recommendation, very low level of certainty in the evidence).*
NIV prolonged time to readmission or death within 12 months

- Used higher Paco2 threshold (>53)
- Used NIV for longer time
- High Intensity NIV – targeting normocapnia
- Started 2-4 weeks after discharge

What?
<table>
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<tr>
<th>Murphy-2017</th>
<th>Struik - 2014</th>
<th>Kohnlein -</th>
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</table>
| • Nasal, oronasal, face masks  
• **INPATIENT TITRATION**  
• Daytime NIV acclimatization  
• Nocturnal NIV with current day time o2 settings  
• PS mode – IPAP-18, EPAP-4, back up rate 14-16)  
• Titration -Spo2>88%, tcco2 < by >=4 mm hg  
• Repat studies if necessary  
• Only clinical screening for OSA  
• Goal to increase IPAP to >=25 | • Initiated in the hospital  
• Bi-level-S/T  
• Back up rate 12/min  
• IPAP-14, gradually increased to max tolerated levels  
• EPAP-4  
• Visual inspection of breathing used to titrate  
• TcCO2 monitored – no specific goal  
• The mean nocturnal PtcCO2 measured during the night before discharge out of hospital better in patients on NIV | • Advised to use NPPV for  
• at least 6 h per day, preferably during sleep, **but usage**  
• during daytime was also accepted.  
• PS mode-with high back up rate  
• Target to reduce paco2 by 20%  
• 24-hour helpline  
• Unclear if it was inpatient |
COPD

VENTILATOR SET UP
HMV IN COPD TRIAL

START HERE

START PRESSURES (cmH₂O)
IPAP 15cmH₂O
EPAP 4cmH₂O

Is TcCO₂ falling?
Aim to decrease by
0.6KPa - 1KPa overnight

no

Check for leak and
mask fit before
changing settings:

Increase IPAP by 2
Review after 1 hour

Increase EPAP by 2
This may require an increase in
IPAP to maintain differential
Review after 1 hour
Max EPAP 6cmH₂O

FINISH HERE

S₉O₂ > 88%?

yes

IPAP AIM ≥25cmH₂O

no

No oxygen or EPAP
changes required

Patient demonstrating upper
airways obstruction or snoring?

yes

Entrain O₂ @ 1-4L/min
Aim SaO₂ > 88%

S₉O₂ > 88%?

no

FINISH HERE

Entrain O₂ @ 1-4L/min
Aim SaO₂ > 88%

FINISH HERE

Entrain O₂ @ 1-4L/min
Aim SaO₂ > 88%
COPD

ATS – suggest against in lab titration

Acclimatization is important benefit of inpatient titration

Education

Titration to normocapnia

2 studies - NM disease; COPD/OHS – compared in lab titration vs other (nurse led titration)
  ◦ No difference in compliance, asynchrony
  ◦ No difference in decrease in paco2 at 3 m
  ◦ No difference in QOL

In OSA studies – compliance not better with in-lab titration
COPD: JAMA meta-analysis

BPAP vs no device
  ◦ Lower risk of mortality
  ◦ Decreased need for intubation
  ◦ No impact on HRQL
  ◦ Fewer all-cause admissions, ED visits, fewer patients with ICU admissions
  ◦ Less dyspnea (6 studies)
  ◦ Fewer COPD exacerbations

HMV vs no device (2 studies - observational)
  ◦ Fewer all-cause admission
  ◦ No diff in mortality
OHS: Should we initiate NIV/PAP?

**Recommendation 2:** For stable ambulatory patients diagnosed with OHS, we suggest treatment with PAP during sleep (*conditional recommendation, very low level of certainty in the evidence*).
**Recommendation 3:** For stable ambulatory patients diagnosed with OHS and concomitant severe OSA (apnea–hypopnea index $\geq 30$ events/h), we suggest initiating first-line treatment with CPAP therapy rather than NIV (*conditional recommendation, very low level of certainty in the evidence*).
COPD Patients with Acute Hypercapnic Respiratory Failure (PCO₂ > 52)

**Key/Legend**
- Start/end of process
- Activity or task
- Decision point (yes/no)

BMI: body mass index
OSA: obstructive sleep apnea
ABG: arterial blood gas
PAP: positive airway pressure
PSAT: portable sleep apnea testing
FEV₁: forced expiratory volume in 1 second
PSG: polysomnogram
NIV: non-invasive ventilation

1. **Patient Evaluation**
   - History + OSA
   - Spirometry
   - ABG
   - HCO₃ greater than 20
2. Discuss PAP Therapy
3. Consent Patient
4. Obtain PSAT

**BMI 35 or greater?**
- **NO** Refer to NIV Clinic
- **YES**

**PSAT Result?**
- **NEGATIVE** Refer to NIV Clinic
- **POSITIVE**

**FEV₁ greater than 50%?**
- **NO**
  - PSAT OSA greater than desaturations?
    - **YES** Expedited PSG
    - **NO** Refer to NIV Clinic
- **YES** Desaturations significantly < 80% can consider oxygen titration prior to d/c

NIV clinic referral
Summary

- Hypercapnic Respiratory Failure associated with increased morbidity and mortality
- COPD patients with persistent hypercapnia and Stable OHS patients need NIV/PAP
- In COPD – No evidence to start NIV on discharge, initiate 2-4 weeks after discharge if there is persistent hypercapnia
- In OHS – discharge with NIV/PAP with sleep lab evaluation titration within 3 months
- In COPD can start with BiPAP – with a goal to decrease paco2
- In OHS can start with CPAP or BIPAP
Thank you

Questions?