Η χρήση μη επεμβατικού αερισμού -πότε αρχίζει-πότε σταματάει

Ευμορφία Κονδύλη
Αναπ/τρια Καθηγήτρια Εντατικής Ιατρικής, Ιατρική Σχολή - ΠΚ, ΜΕΘ -ΠΑΓΝΗ
NIV - Benefits

- Decrease the rate of
  - Intubation
  - Sedation
- ICU
- ICU-related Infections

Association of Noninvasive Ventilation With Nosocomial Infections and Survival in Critically Ill Patients
Contraindications of NIV

<table>
<thead>
<tr>
<th>Absolute</th>
<th>Cardiac or respiratory arrest</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Anatomical abnormality (unable to fit the interface)</td>
</tr>
<tr>
<td></td>
<td>Inability to keep patent airway (uncontrolled agitation, coma or obtunded mental status)</td>
</tr>
<tr>
<td>Relative</td>
<td>Refractory hypotension</td>
</tr>
<tr>
<td></td>
<td>Mild agitation or poor cooperation</td>
</tr>
<tr>
<td></td>
<td>Mild hypotension</td>
</tr>
<tr>
<td></td>
<td>Upper gastrointestinal haemorrhage or vomiting</td>
</tr>
<tr>
<td></td>
<td>Inability to expectorate copious secretions</td>
</tr>
<tr>
<td></td>
<td>Recent frail upper gastrointestinal or airway surgery</td>
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<tr>
<td></td>
<td>Multiorgan failure</td>
</tr>
<tr>
<td></td>
<td>Isolated right ventricular failure</td>
</tr>
</tbody>
</table>
When to start NIV

**Indications**

**Bedside observations**
- Increased dyspnoea—moderate to severe
- Tachypnoea (>24 breaths per min in obstructive, >30 per min in restrictive)
- Signs of increased work of breathing, accessory muscle use, and abdominal paradox

**Gas exchange**
- Acute or acute on chronic ventilatory failure (best indication), PaCO₂ >45 mm Hg, pH <7.35
- Hypoxaemia (use with caution), PaO₂/FIO₂ ratio < 300
Criteria For termination of NIV

- Hemodynamic instability
- Decrease level of consciousness
- Worsening PH and PaCO\textsubscript{2}
- Worsening PaO\textsubscript{2}
- Tachypnea $>30$ b/min

Dyspnea intensity $\geq 4$ after the first NIV was independently associated with NIV failure (OR, 2.41, $p=0.001$) and mortality (OR, 2.11; $p=0.009$), Dangers et al., *ERJ 2018*

- Signs of increase WOB
- Inability to clear secretions
- Agitation or intolerance to NIV with progressive respiratory failure
Monitoring NIV

<table>
<thead>
<tr>
<th>Patient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory rate</td>
</tr>
<tr>
<td>Other vital signs</td>
</tr>
<tr>
<td>Dyspnoea/accessory muscle use/abdominal paradoxical breathing</td>
</tr>
<tr>
<td>Level of consciousness</td>
</tr>
<tr>
<td>Comfort with the interface</td>
</tr>
<tr>
<td>Collaboration</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ventilator parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tidal volume (&gt;4 mL/Kg: 6–7 mL/Kg) and minute ventilation</td>
</tr>
<tr>
<td>Air leakage volume (&lt;0, 4 L/s or &lt; 25 L/min)</td>
</tr>
<tr>
<td>Pressure support and PEEP settings</td>
</tr>
<tr>
<td>Asynchrony (ineffective efforts, auto-triggering, double-triggering, short/long cycle)</td>
</tr>
<tr>
<td>Trigger/slope (ramp)/Inspiration time/expiration settings</td>
</tr>
<tr>
<td>Auto-PEEP</td>
</tr>
<tr>
<td>Alarms (apnoea or high respiratory rate, low/high minute ventilation, others)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gas exchange</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous pulse-oximetry (SpO₂)</td>
</tr>
<tr>
<td>Arterial or venous blood gas samples (^{b})</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Risk factors of failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before initiation</td>
</tr>
<tr>
<td>Lung infection</td>
</tr>
<tr>
<td>Altered mental status</td>
</tr>
<tr>
<td>Hypotension</td>
</tr>
<tr>
<td>High severity scores</td>
</tr>
<tr>
<td>Copious secretions</td>
</tr>
<tr>
<td>Extremely high respiratory rate</td>
</tr>
<tr>
<td>Severe hypoxaemia in spite of high F&lt;sub&gt;1&lt;/sub&gt;O&lt;sub&gt;2&lt;/sub&gt;</td>
</tr>
</tbody>
</table>

After initiation

| Inappropriate ventilator settings |
| Unfitting interface |
| Excessive air leakage |
| Asynchrony with the ventilator |
| Poor tolerance to NIV |

After 60–90 min

| No reduction in respiratory rate or carbon dioxide |
| No improvement in pH or oxygenation (|\text{SpO₂}| or |\text{PaO₂}/\text{FiO₂}|) |
| Signs of fatigue |
| Neurological or underlying disease impairment |

Criteria for endotracheal intubation
• Acute exacerbation of COPD
• Acute asthma

• Cardiogenic pulmonary edema
• de novo ARF-ARDS/Pneumonia

• Immunocompromised patients
• Post-operative acute respiratory failure
Acute exacerbation of COPD
Early use of non-invasive ventilation for acute exacerbations of chronic obstructive pulmonary disease on general respiratory wards: a multicentre randomised controlled trial


P K Plant, J L Owen, M W Elliott

- Need for IMV
  15%/ 27%, p=0·02

- In-hospital mortality
  10%/20%, p=0·05

- More rapid improvement in pH in the first hour, p=0·02
- Greater fall in respiratory rate at 4 h, p=0·035.

RR >23/min
pH 7·25–7·35 with a PaCO2 > 45 mmHg
• 17 RCT involving 1264 participants
• BiPAP versus standard care alone
• AECOPD pH < 7.35 and PaCO$_2$ > 45 mmHg

• Decrease mortality by 46%
• Decrease intubation by 65%
• Similar results in subgroups
  ▫ pH 7.30-7.35 vs. pH < 7.30
  ▫ ICU vs. ward setting
Official ERS/ATS clinical practice guidelines: noninvasive ventilation for acute respiratory failure

Should NIV be used in ARF due to a COPD exacerbation to prevent the development of respiratory acidosis?

- We suggest NIV not be used - Conditional recommendation, low certainty

Should NIV be used in established acute hypercapnic respiratory failure due to a COPD exacerbation?

- We recommend bilevel NIV - Strong recommendation, high certainty

Eur Respir J 2017; 50: 1602426
Acute asthma

- A few uncontrolled studies and RCTs have compared NIV versus routine care in patients with acute asthma.

Official ERS/ATS clinical practice guidelines: noninvasive ventilation for acute respiratory failure

- ? Should NIV be used in ARF due to acute asthma?

- Given the uncertainty of evidence we are unable to offer a recommendation on the use of NIV for ARF due to asthma.
Acute cardiogenic pulmonary edema

Cardiovascular
- ↓ Venous return → ↓ RV preload → ↓ LV preload
- ↑ Pulmonary vascular resistance → ↑ RV afterload → RV enlargement → ↓ LV Compliance
- ↓ LV afterload (↓ systolic wall stress)
- ↓ Systemic blood pressure → ↓ Cardiac output

Respiratory
- Recruitment of collapsed alveoli → ↑ Functional residual capacity
- Maintenance continuously opened alveoli → Gas exchange during the whole respiratory cycle
- Intra-alveolar pressure against oedema
- ↓ Work of breathing
- ↑ Oxygenation
Acute cardiogenic pulmonary edema

- *Cochrane Database Syst Rev. May 2013*
- 32 RCTs involving 2916 participants
- CPAP/BiPAP+ usual care vs. usual care alone
- Decrease mortality by 33%
- Decrease intubation by 48%
- similar incidence of AMI
  - 15%
  - RR=1.24 CI=0.79-1.95

In summary, there is no relationship between use of NIV and risk of AMI, and NIV may be considered in patients with ACPE complicating a Type II AMI or a non-STEMI. Further data are necessary to assess the role of NIV in patients with STEMI.
Official ERS/ATS clinical practice guidelines: noninvasive ventilation for acute respiratory failure

Should NIV be used in ARF due to cardiogenic pulmonary oedema?

- We recommend either bilevel NIV or CPAP - Strong recommendation, moderate certainty of evidence

Studies suggest the early timing of application of NPPV in patients with ARF due to cardiogenic pulmonary oedema as its application in the pre-hospital setting has been shown to prevent clinical deterioration and to lower intubation risk
NIV in de novo acute respiratory failure ARDS - pneumonia

Brambilla, ICM 2014, mRCT in Italy, CPAP vs. O2, 80 pts with Pneumonia
Zhan, CCM 2012, mRCT in China, PS vs O2, 40 pts with Pneumonia or ARDS
Ferrer 2003, mRCT in Spain, PS vs. O2, 49 pts with Pneumonia or ARDS
23 ICUs in France and Belgium
310 patients
106 HF-O2, 111 NIMV, 94 O2
Age 60, pneumonia 75%
$\text{Po}_2/\text{FiO}_2 = 160$
Noninvasive Ventilation of Patients with ARDS - Insights from the LUNG SAFE

Am J Respir Crit Care Med. 2017 Jan

- NIMV in 15% of 2813 ARDS pts
- NIMV failure
  - 22.2% mild ARDS
  - 42.3% moderate ARDS
  - 47.1% severe ARDS.
- Hospital mortality
  - NIMV success 16%
  - NIMV failure 45%
- ICU mortality NIMV > IMV PaO2/FiO2 < 150 mm Hg.
NIV Failure in ARDS

Thille et al. CrCare 2013, observational study 113 pts

Carteaux et al. CrCare 2016, observational study 62 pts

TABLE 3. Multivariate Analysis of Risk Factors for Noninvasive Ventilation Failure in Patients With De Novo Acute Hypoxemic Respiratory Failure

<table>
<thead>
<tr>
<th>Risk Factors</th>
<th>Unadjusted Hazard Ratio (95% CI)</th>
<th>p</th>
<th>Adjusted Hazard Ratio (95% CI)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simplified Acute Physiology Score II (30)</td>
<td>1.026 (1.008–1.043)</td>
<td>0.011</td>
<td>1.024 (1.007–1.041)</td>
<td>0.013</td>
</tr>
<tr>
<td>Immunosuppression</td>
<td>2.207 (1.054–4.622)</td>
<td>0.045</td>
<td>1.351 (0.598–3.056)</td>
<td>0.476</td>
</tr>
<tr>
<td>Pao₂/Fio₂ before NIV</td>
<td>0.995 (0.990–1.001)</td>
<td>0.114</td>
<td>0.995 (0.989–1.001)</td>
<td>0.109</td>
</tr>
<tr>
<td>Mean expired tidal volume during NIV, per mL/kg predicted body weight</td>
<td>1.318 (1.109–1.567)</td>
<td>0.002</td>
<td>1.286 (1.069–1.547)</td>
<td>0.008</td>
</tr>
</tbody>
</table>
Early predictors of NIV failure in de novo ARF

- Higher severity score
- Older age
- ARDS or pneumonia as the etiology for respiratory failure,
- Failure to improve after 1 h of treatment
Official ERS/ATS clinical practice guidelines: noninvasive ventilation for acute respiratory failure

Should NIV be used in de novo ARF?

- Given the uncertainty of evidence we are unable to offer a recommendation

The main risk of NIV for the indication of de novo ARF is to delay a needed intubation
NIV in Immuno-compromised patients

NEJM 2001 – single center RCT in France 52 patients

JAMA 2015 – Multicenter RCT in France 374 pts

Hilbert NEJM 2001

Lemiale JAMA

Lemiale JAMA

Intubation

ICU mortality

NIMV: P/S

Standard O2
Non-invasive ventilation might be associated with an increased risk of intubation and mortality and should be used cautiously in immunocompromised patients with acute hypoxaemic respiratory failure.
Over the 8-month study period, 1,611 age 63 years old (IQR 54–71) were enrolled in the 68 participating ICUs. Immunosuppression was related to malignancy in 87%.

Acute hypoxemic respiratory failure in immunocompromised patients: the Efraim management affects the need for MV or hospital mortality.

Whether initial management affects the need for MV or hospital mortality.
Official ERS/ATS clinical practice guidelines: noninvasive ventilation for acute respiratory failure

Should NIV be used for ARF in immunocompromised patients?

- We suggest early NIV for immunocompromised patients with ARF - Conditional recommendation, moderate certainty of evidence
NIV in post-operative ARF

- ↓Pulmonary Volume
- Atelectasis associated with a Restrictive Syndrome
- Ventilation-Perfusion Mismatch
- Diaphragm Dysfunction
  - early after surgery
  - may last up to 7 days
  - could lead to ARF
Physiologic Effects of NIV on Post-op. Respiratory Function

Jaber S, Anesthesiology 2010; 112
Postoperative NONINVASIVE VENTILATION (NIV)

Curative

Grey Zone

Prophylactic (preventive)

Acute respiratory failure: YES (Present)
Objective: to avoid intubation

CPAP

NIV (=PSV+PEEP)

Acute respiratory failure: NO (not present, but at risk)
Objective: to avoid the development of acute respiratory failure

CPAP

NIV (=PSV+PEEP)
NIV in post-operative ARF-Curative

Mortality

1.1.2 Treatment of ARF in postop patients

<table>
<thead>
<tr>
<th></th>
<th>Auriant 2001</th>
<th>Squadrone 2005</th>
<th>Subtotal (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3</td>
<td>0</td>
<td>129</td>
</tr>
<tr>
<td></td>
<td>24</td>
<td>105</td>
<td>128</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>24</td>
<td>104</td>
<td></td>
</tr>
<tr>
<td></td>
<td>38.3%</td>
<td>14.9%</td>
<td>53.2%</td>
</tr>
<tr>
<td></td>
<td>0.33 [0.10, 1.08]</td>
<td>0.14 [0.01, 2.71]</td>
<td>0.28 [0.09, 0.84]</td>
</tr>
</tbody>
</table>

Total events: 3 \(\pm\) 12

Heterogeneity: Chi\(^2\) = 0.29, df = 1 (P = 0.59); I\(^2\) = 0%

Test for overall effect: Z = 2.28 (P = 0.02)

Intubation

1.2.2 Treatment of ARF in postop patients

<table>
<thead>
<tr>
<th></th>
<th>Auriant 2001</th>
<th>Squadrone 2005</th>
<th>Subtotal (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5</td>
<td>1</td>
<td>129</td>
</tr>
<tr>
<td></td>
<td>24</td>
<td>105</td>
<td>128</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td></td>
<td>24</td>
<td>104</td>
<td></td>
</tr>
<tr>
<td></td>
<td>42.9%</td>
<td>35.9%</td>
<td>78.9%</td>
</tr>
<tr>
<td></td>
<td>0.42 [0.17, 1.00]</td>
<td>0.10 [0.01, 0.76]</td>
<td>0.27 [0.12, 0.61]</td>
</tr>
</tbody>
</table>

Total events: 6 \(\pm\) 22

Heterogeneity: Chi\(^2\) = 1.85, df = 1 (P = 0.17); I\(^2\) = 46%

Test for overall effect: Z = 3.13 (P = 0.002)
Effect of Noninvasive Ventilation on Tracheal Reintubation Among Patients With Hypoxemic Respiratory Failure Following Abdominal Surgery: A Randomized Clinical Trial

Figure 2. Cumulative Incidence of Reintubation Between Randomization and Day 30 According to Study Group

![Graph showing cumulative incidence of reintubation between randomization and day 30. The graph compares standard oxygen therapy and noninvasive ventilation. Log-rank P = .03.]

<table>
<thead>
<tr>
<th>No. at risk</th>
<th>0</th>
<th>7</th>
<th>14</th>
<th>30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard oxygen therapy</td>
<td>145</td>
<td>79</td>
<td>76</td>
<td>71</td>
</tr>
<tr>
<td>Noninvasive ventilation</td>
<td>148</td>
<td>99</td>
<td>90</td>
<td>87</td>
</tr>
</tbody>
</table>

Figure 3. Probability of Survival Between Randomization and Day 90 According to Study Group

![Graph showing cumulative probability of survival between randomization and day 90. The graph compares noninvasive ventilation and standard oxygen therapy. Log-rank P = .15.]

<table>
<thead>
<tr>
<th>No. at risk</th>
<th>0</th>
<th>14</th>
<th>30</th>
<th>90</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard oxygen therapy</td>
<td>145</td>
<td>132</td>
<td>125</td>
<td>102</td>
</tr>
<tr>
<td>Noninvasive ventilation</td>
<td>148</td>
<td>141</td>
<td>131</td>
<td>109</td>
</tr>
</tbody>
</table>
Noninvasive positive pressure ventilation for acute respiratory failure following oesophagectomy: Is it safe? A systematic review of the literature

<table>
<thead>
<tr>
<th>Study Methodology and Results</th>
<th>Outcomes Extracted</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Study</strong></td>
<td><strong>Design</strong></td>
</tr>
<tr>
<td>Jaber et al.</td>
<td>Prospective observational single centre</td>
</tr>
<tr>
<td>Michelet et al.</td>
<td>Single centre case-control study</td>
</tr>
<tr>
<td>Yu et al.</td>
<td>Retrospective single centre case note analysis</td>
</tr>
<tr>
<td>Pawley et al.</td>
<td>Retrospective case note audit</td>
</tr>
</tbody>
</table>
Continuous positive airway pressure (CPAP) during the postoperative period for prevention of postoperative morbidity and mortality following major abdominal surgery

- Very low-quality evidence from this review suggests that CPAP initiated during the postoperative period might reduce:
  - Atelectasis
  - Pneumonia
  - Re-intubation
- Uncertain Effects on:
  - Mortality
- Evidence is not sufficiently strong to confirm the benefits or harms of CPAP during the postoperative period in those undergoing major abdominal surgery.

Cochrane Database of Systematic Reviews 2014;8
Official ERS/ATS clinical practice guidelines: noninvasive ventilation for acute respiratory failure

- Should NIV be used in ARF in the post-operative setting?

- We suggest NIV for patients with post-operative ARF. (Conditional recommendation, moderate certainty of evidence.)
Conclusion

When to start NIV

- Respiratory distress
- Respiratory failure (not corrected by oxygen therapy alone)
  - PO2/FiO2 < 300
  - PCO2 > 45
  - pH < 7.35
- Disease in which NIMV proven helpful
- Absence of Contraindications

When to stop NIV

- NIMV failure – need for intubation
- Avoid pt exhaustion – respiratory or cardiac arrest
- Markers of NIMV failure
- Disease-specific criteria COPD/HypoxemicRF
Protocol for NIV on the ward

Modified from: Huddle form and checklist, as used at the Massachusetts General Hospital @ Noninvasive Ventilation for Acute Respiratory Failure, D. Hess RESPIRATORY CARE • JUNE 2013