Evidence-based practice for noninvasive ventilation and high flow nasal cannula: a summary of the literature

Thomas Piraino, RRT, FCSRT

Topics included

• COPD exacerbation
• Community-acquired pneumonia
• Immunocompromised patients
• Hypoxemic respiratory failure
• Cardiogenic pulmonary edema
• Post-extubation (immediate)
• Postoperative patients

Topics excluded

• Extubation failure
• Do not intubate/resuscitate
• Acute asthma
• Pre-intubation oxygenation

* Mixed evidence exists in this category, without a clear consensus in the literature. Monitor patients closely and consider the presence of other risk factors.

Recommendations based on the author’s review of the currently available literature, including existing guidelines.

Executive summary of the current landscape

<table>
<thead>
<tr>
<th>Noninvasive clinical scenario</th>
<th>NIV</th>
<th>HFNC</th>
</tr>
</thead>
<tbody>
<tr>
<td>COPD exacerbation (pH 7.25–7.35)</td>
<td>![Highly recommended]</td>
<td>![Recommended]</td>
</tr>
<tr>
<td>Community-acquired pneumonia</td>
<td>![Mixed evidence]</td>
<td>![No data]</td>
</tr>
<tr>
<td>Immunocompromised patients</td>
<td>![Inferior]</td>
<td>![High risk]</td>
</tr>
<tr>
<td>Hypoxemic respiratory failure</td>
<td>![Highly recommended]</td>
<td>![Recommended]</td>
</tr>
<tr>
<td>PaO₂/FiO₂ 200-300</td>
<td>![Inferior]</td>
<td>![High risk]</td>
</tr>
<tr>
<td>PaO₂/FiO₂ &lt; 200</td>
<td>![Highly recommended]</td>
<td>![Recommended]</td>
</tr>
<tr>
<td>Cardiogenic pulmonary edema</td>
<td>![Inferior]</td>
<td>![High risk]</td>
</tr>
<tr>
<td>Post-extubation for high-risk patients (immediately post)</td>
<td>![Highly recommended]</td>
<td>![Recommended]</td>
</tr>
<tr>
<td>Post-extubation with COPD (early liberation)</td>
<td>![Highly recommended]</td>
<td>![Recommended]</td>
</tr>
<tr>
<td>Postoperative patients</td>
<td>![Highly recommended]</td>
<td>![Recommended]</td>
</tr>
</tbody>
</table>

* Mixed evidence exists in this category, without a clear consensus in the literature. Monitor patients closely and consider the presence of other risk factors.

Recommendations based on the author’s review of the currently available literature, including existing guidelines.
Evidence summary

COPD exacerbation

NIV

The current evidence continues to strongly support the use of NIV for the treatment of COPD exacerbation. There is an early Cochrane Review from 2004 that analyzed 14 studies, and clinical practice guidelines that reviewed 16 randomized controlled trials. The use of NIV to treat COPD exacerbation results in less intubation (treatment failure) and lower mortality compared to standard treatment (traditional oxygen therapy, and pharmacological agents).

Benefits are mostly related to the severity of COPD, particularly in patients with a pH < 7.35 with relative hypercarbia. Patients with a pH > 7.35 are less likely to show a significant difference in clinical outcomes when treated with NIV.

HFNC

Currently there is minimal data regarding HFNC use in COPD patients (without exacerbation), with mixed response. Lower respiratory rates, and lower PaCO₂ levels have been reported in studies. However, these patients were not in an acute exacerbation, and patients with pH < 7.35 were excluded. A case study demonstrated successful management of a patient with a pH of 7.31 who refused NIV. However, case studies are the lowest form of evidence and should not be generalized to clinical practice.

Community-acquired pneumonia

NIV

Early studies assessing the effect of NIV to treat community-acquired pneumonia (CAP) are conflicting and of low quality. More recent studies have demonstrated high failure rates of NIV, and NIV failure was associated with higher mortality. Another study found in an adjusted analysis that NIV failure patients had worse outcomes than patients invasively ventilated as first-line therapy. The close monitoring of these patients is key to successful treatment. Delaying intubation was also associated with higher mortality.

HFNC

There appears to be no studies assessing the use of HFNC in CAP specifically. The FLORALI study had a significant number of CAP patients enrolled in the study, but there is currently no subgroup analysis of the CAP patients. However, the HFNC patients had lower 90-day mortality.

Immunocompromised patients

NIV

Early data with a moderate quality of evidence suggested benefits using NIV over standard oxygen therapy for treating immunocompromised patients presenting with hypoxic respiratory failure (preventing invasive ventilation is preferred when mortality risk is high). However, a recent study showed no difference in outcomes comparing NIV with standard oxygen therapy.

HFNC

A recent study looked at NIV versus HFNC in the management of immunocompromised patients with hypoxic respiratory failure. with results favoring HFNC. In a recent post-hoc analysis of immunocompromised patients in the FLORALI trial, age and the use of NIV as first-line therapy was associated with needing intubation and higher mortality, therefore HFNC would be the preferred option.

Hypoxemic respiratory failure

NIV

Early meta-analyses on the role of NIV in treating hypoxic respiratory failure demonstrated a risk reduction for endotracheal intubation and mortality. However, due to the heterogeneity of the studies, a recommendation for the routine use of NIV with hypoxic respiratory failure was not recommended. The effectiveness of NIV in patients with hypoxic respiratory failure is likely related to the specific population of patients, and many studies looked at general acute respiratory failure (including many patients with different etiologies).

Severity of illness, comorbidities, and severity of hypoxemia play a major role in determining the appropriateness of using NIV to prevent intubation. NIV failure has been associated with higher mortality in these patients. Delaying intubation is a key contributor to worse outcomes.
ARDS patients
Treating patients with acute respiratory distress syndrome (ARDS) using NIV has long been controversial. The current Berlin Definition of ARDS refers to patients with PaO$_2$/FiO$_2$ 200 – 300 as “mild ARDS”, but in previous literature it was referred to as “acute lung injury”. The current literature supports the idea that caution needs to be taken with patients with lower PaO$_2$/FiO$_2$, particularly in patients with moderate and severe ARDS (PaO$_2$/FiO$_2$ < 200 and < 100 respectively) as it is associated with a high failure rate, and failure is associated with increased risk of mortality. However, patients with mild ARDS can be safely managed with NIV, but HFNC may be preferred.

ARDS patients – helmet interface
A randomized controlled trial comparing a helmet interface to the standard full-face mask to deliver NIV in ARDS patients was published in 2016. The control group (standard full-face mask) had a NIV failure rate (intubation rate) of 61.5%, which is comparable to previous studies considering the median PaO$_2$/FiO$_2$ was quite low at 144.14. The helmet group had a failure rate of only 18%. The authors suggest this benefit may be related to the ability to apply higher levels of PEEP to the patients using the helmet interface. This was a single center study, the helmet interface is a relatively novel approach, and there is a risk of bias since the groups could not be blinded. However, there was strict criteria for meeting failure/intubation to minimize bias. Further randomized trials with the helmet interface are needed to confirm these results, especially considering the high failure associated with NIV in this population.

HFNC
There is currently no evidence to suggest a benefit in managing acute cardiogenic pulmonary edema with HFNC, and therefore should not be used until there is supportive evidence.

Post-extubation
NIV – early liberation
The use of NIV is recommended for centers with NIV expertise to allow for early ventilator liberation in patients with COPD after a failed spontaneous breathing trial, provided there is resolution of underlying cause of respiratory failure (example, infection).

NIV – prevent post-extubation failure
The use of NIV post-extubation is recommended in patients with high risk of extubation failure, but not for patients with low risk of extubation failure.

HFNC – prevent post-extubation failure
There are two randomized trials looking at post-extubation use of HFNC. One study compared HFNC to standard oxygen therapy post-extubation in low risk patients and found a significant reduction in post-extubation failure. The same author compared HFNC to NIV in patients at high risk of post-extubation failure in a non-inferiority randomized trial and found HFNC was not inferior to NIV in patients at high risk of post-extubation failure. The presence of COPD as a risk factor was low and reasonably balanced in both groups. One limitation is that the risk factors for post-extubation failure were quite broad as there is no currently accepted standard in the literature.

Postoperative patients
NIV
The use of NIV has good supportive evidence in postoperative abdominal surgery patients, lung resection patients, and cardiac surgery patients. The use of NIV resulted in improvements in patient outcomes such as lower reintubation rates and improved oxygenation, and lower mortality.

HFNC
The use of HFNC has been compared to standard oxygen therapy in cardiac surgery patients with positive effects such as reduced escalation of respiratory support, increased end–expiratory lung impedance, better oxygenation, and lower respiratory rates. However, no trials have shown a reduction in intubation rates or other important clinical outcomes in postoperative patients being treated with HFNC.
References


© 2018 Koninklijke Philips N.V. All rights are reserved.
Philips reserves the right to make changes in specifications and/or to discontinue any product at any time without notice or obligation and will not be liable for any consequences resulting from the use of this publication. Trademarks are the property of Koninklijke Philips N.V. or their respective owners.