PHILIPS

Hospital respiratory care

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

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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

Executive summary of the current landscape

Non-invasive clinical scenario	NIV	HFNC
COPD exacerbation (pH 7.25–7.35)	Highly recommended	No data
Community-acquired pneumonia	Mixed evidence *	Recommended
Immunocompromised patients	Recommended	Recommended
Hypoxemic respiratory failure		
PaO_2/FiO_2 200-300	Recommended	Recommended
PaO_2/FiO_2 < 200	High risk	Recommended
Cardiogenic pulmonary edema	Highly recommended	No data
Post-extubation for high-risk patients (immediately post)	Recommended	Recommended
Post-extubation with COPD (early liberation)	Recommended	No data
Postoperative patients	Recommended	Inferior

Highly recommended
Recommended
Mixed evidence
Inferior
No data
High risk

* 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.

Key risk factors of treatment failure[32-35]

- High severity of illness score
  - SOFA, SAPS II, APACHE
- Use of vasopressors (shock)
- Low PaO_2/FiO_2 ratio (< 150)
- ARDS severity on initial assessment
- SpO_2 < 90% for > 5 min
- pH < 7.25 (COPD) pH < 7.35 (hypoxemic RF)
- Older age
- Tidal volume > 9.5 ml/kg of PBW
- HACOR score > 5 (needs further validation)
- Level of consciousness
- Failure to improve within 1-2 hour

Early intervention and close monitoring of risk factors before and after NIV are extremely important. Delaying intubation in ANY patient is strongly discouraged and leads to poor outcomes.[7,14-16,36]

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 analysed 14 studies,[1] and clinical practice guidelines that reviewed 16 randomised controlled trials.[2] 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.[2]

HFNC

Currently there is minimal data regarding HFNC use in COPD patients (without exacerbation), with mixed response. Lower respiratory rates, and lower $PaCO_2$ levels have been reported in studies.[3,4] However, these patients were not in an acute exacerbation, and patients with pH < 7.35 were excluded.[5] 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 generalised to clinical practice.[4]

Community-acquired pneumonia

NIV

Early studies assessing the effect of NIV to treat community-acquired pneumonia (CAP) are conflicting and of low quality.[2] More recent studies have demonstrated high failure rates of NIV, and NIV failure was associated with higher mortality.[6,7] Another study found in an adjusted analysis that NIV failure patients had worse outcomes than patients invasively ventilated as first-line therapy.[8] The close monitoring of these patients is key to successful treatment. Delaying intubation was also associated with higher mortality.[7]

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.[6]

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 hypoxemic respiratory failure (preventing invasive ventilation is preferred when mortality risk is high).[2] However, a recent study showed no difference in outcomes comparing NIV with standard oxygen therapy.[9]

HFNC

A recent study looked at NIV versus HFNC in the management of immunocompromised patients with hypoxic respiratory failure, with results favoring HFNC.[10] 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.[11]

Hypoxemic respiratory failure

NIV

Early meta-analyses on the role of NIV in treating hypoxemic respiratory failure demonstrated a risk reduction for endotracheal intubation and mortality.[12,13] However, due to the heterogeneity of the studies, a recommendation for the routine use of NIV with hypoxemic respiratory failure was not recommended. The effectiveness of NIV in patients with hypoxemic 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.[14] NIV failure has been associated with higher mortality in these patients. Delaying intubation is a key contributor to worse outcomes.[14-16]

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".[7,18] 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.[17-19] However, patients with mild ARDS can be safely managed with NIV, but HFNC may be preferred.[6,18]

ARDS patients – helmet interface

A randomised controlled trial comparing a helmet interface to the standard full-face mask to deliver NIV in ARDS patients was published in 2016.[20] 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 minimise bias. Further randomised trials with the helmet interface are needed to confirm these results, especially considering the high failure associated with NIV in this population.

HFNC

The previously mentioned FLORALI trial saw a lower, yet insignificant, difference in endotracheal intubation in the overall population of patients with hypoxemic respiratory failure (35% HFNC vs 50% NIV). However, there was a significant difference in intubation rates for patients with a PaO_2/FiO_2 < 200 (38% HFNC vs. 58% NIV). The overall 90-day mortality rate was also lower in patients treated with HFNC compared to NIV (hazard ratio for death at 90 days 2.50 [95% CI,to 4.78]). Although ARDS patients were not clearly identified through strict definition, the PaO_2/FiO_2 ranges were consistent with the Berlin definition, and they did report that a high percentage of patients enrolled had bilateral infiltrates (75% HFNC, 77% NIV).[6]

Cardiogenic pulmonary edema

NIV

The management of cardiogenic pulmonary edema is well established in the literature. There is a significant reduction in intubation rates and mortality using NIV compared to standard oxygen therapy. Although data suggests there is no difference in outcomes between using CPAP or BiPAP, BiPAP should be used to address any work of breathing, or underlying comorbidities such as COPD.

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 centres 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).[2]

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.[2]

HFNC – prevent post-extubation failure

There are two randomised 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.[21] The same author compared HFNC to NIV in patients at high risk of post-extubation failure in a non-inferiority randomised 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 post-operative abdominal surgery patients,[23-25] lung resection patients,[25,26] and cardiac surgery patients.[27] The use of NIV resulted in improvements in patient outcomes such as lower reintubation rates and improved oxygenation,[23,24-27] and lower mortality.[26]

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.[28,29] However, no trials have shown a reduction in intubation rates or other important clinical outcomes in postoperative patients being treated with HFNC.[28-31]

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