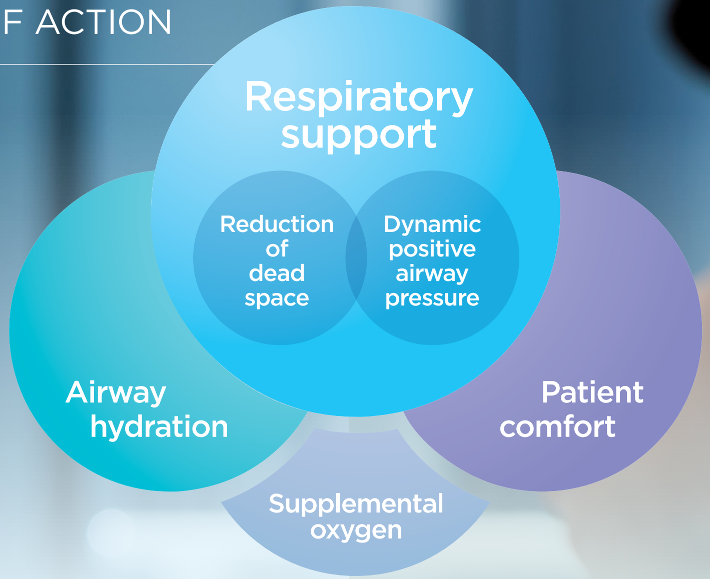
F&P Optiflow

Nasal High Flow Therapy

Fisher & Paykel
HEALTHCARE

Optiflow™ Nasal High Flow (NHF) therapy delivers respiratory support to your spontaneously breathing patients. It provides heated, humidified air and/or oxygen at flow rates up to 70 L/min through the unique Optiflow patient interfaces.

MECHANISMS OF ACTION



With Optiflow NHF, you can independently titrate flow and oxygen concentration (FiO_2 21 – 100%) according to your patient's needs.

The mechanisms of action differ from those of conventional therapies, as do the resulting physiological effects and clinical outcomes.

PHYSIOLOGICAL EFFECTS

- ↑ **IMPROVES** ventilation and gas exchange
  - ↓ **REDUCES** respiratory rate[1-7]
  - ↓ **REDUCES** carbon dioxide[8-10]
  - ↑ **INCREASES** end-expiratory lung volume[1]
- ↑ **IMPROVES** mucus clearance[11]
- ↑ **IMPROVES** oxygenation[1,2,4,7,12-16]

CLINICAL OUTCOMES

- ↓ **REDUCES** escalation of care when used:
  - as a first-line respiratory support[14]
  - post-extubation[13,17-20]
- ↓ **REDUCES** mortality rate[14]
- ↑ **IMPROVES** symptomatic relief[2,3,14]
- ↑ **IMPROVES** comfort and patient compliance[2,3,13,17,20]

F&P Optiflow

MECHANISMS OF ACTION

RESPIRATORY SUPPORT

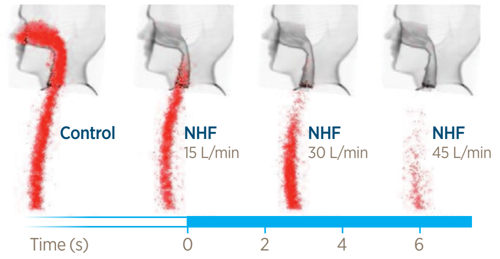
Reduction of dead space

Clearance of expired air in the upper airways[8]

Reduces rebreathing of gas with high CO_2 and depleted O_2[8]

Increases alveolar ventilation[8]

The effects of flow rate on clearance of rebreathing CO_2



Adapted from Möller et al.[8]

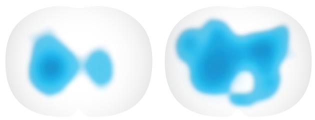
Dynamic positive airway pressure

Breath- and flow-dependent airway pressure[9,21]

Promotes slow and deep breathing[9]

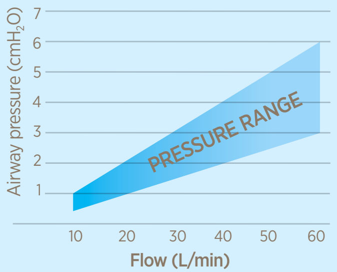
Increases alveolar ventilation[1,8]

The effects of NHF on airway pressure, end-expiratory lung volume and tidal volume



Adapted from Corley et al.[1]

Mean airway pressure
(For illustrative purposes only)



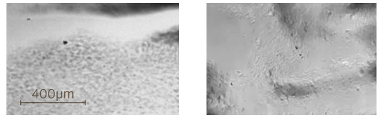
Airway hydration

Optimal Humidity

Prevents desiccation of the airway epithelium[22]

Improves mucus clearance[11,22]

The effects of high flows of warm, humidified air on mucociliary transport



100% Humidity | Dry epithelium after 1 hour

Patient comfort

Optimal Humidity

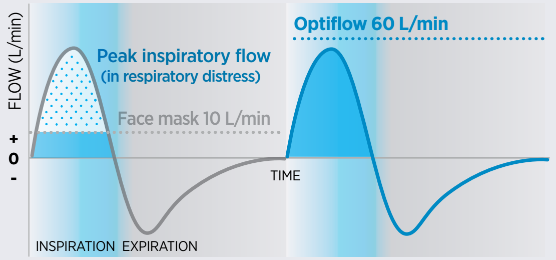
Open system
No seal required

Comfortable[2,13] and easy to use

Patient tolerance[2,14]

Supplemental oxygen when required

Confidence in the delivery of mixed, humidified oxygen[3,12], from 21% to 100%



Summary of applications for NHF therapy

Medical society	Primary support – Medical	Primary support – Surgical	Pre-escalation support	De-escalation support	Complementary support	Prophylactic support
AARC. Piraino et al. 2021[23]	● A					●
ACP. Qaseem et al. 2021[24]	●			●		
SSC. Evans et al. 2021[25]	●					
ESICM. Rochwerg et al. 2020[26]	● B	●	● C	●		
ERS. Oczkowski et al. 2021[27]	●	●		●	●	
TSANZ. Barnett et al. 2022[28]	●					●
WHO. WHO Guideline Development Group 2022[29]	● D					

AARC: American Association for Respiratory Care. ACP: American College of Physicians. SSC. Surviving Sepsis Campaign. ESICM: European Society of Intensive Care Medicine. ERS: European Respiratory Society. TSANZ: Thoracic Society of Australia and New Zealand. WHO: World Health Organization.

A. Hypoxemia and immunocompromised patients with ARF. B. Sepsis induced hypoxemic respiratory failure
C. Continue to use NHF if already receiving therapy during intubation. D. Acute Hypoxemic patients with severe to critical COVID-19.

Clinical practice guidelines

AARC CLINICAL PRACTICE GUIDELINES

Piraino T, et al. Respiratory Care. 2021.[23]

Primary support – Medical

General recommendations for the delivery of supplemental oxygen for patients who require oxygen

Aim for SpO_2 range of 94–98% for most of hospitalized patients (included critically ill patients).

Aim for 88–92% for patients with COPD.

Aim for 88–95% for patients with ARDS.

Consider early initiation of NHF.

LEVEL C

De-escalation support

NHF is preferred to COT immediately post-extubation in patients who require supplemental oxygen.

LEVEL B

Prophylactic support

NHF is preferred to COT to avoid escalation to NIV or invasive ventilation in patients who require supple-mental oxygen.

LEVEL B

Immuno-compromised

Either NHF or COT may be used in patients who require supplemental oxygen.

LEVEL B

ACP CLINICAL GUIDELINES

Qaseem A, et al. Annals of Internal Medicine. 2021.[24]

Primary support – Medical

NHF is preferred to NIV in patients with AHRF.

CONDITIONAL RECOMMENDATION

De-escalation support

NHF is preferred to COT in patients with post-extubation AHRF.

CONDITIONAL RECOMMENDATION

SSC INTERNATIONAL GUIDELINES

Evans L, et al. Critical Care Medicine. 2021.[25]

Primary support - Medical

NHF is preferred to NIV in patients with sepsis-induced hypoxemic respiratory failure.

WEAK RECOMMENDATION

ENDORSED BY:

- *Society of Critical Care Medicine*
- *American Association of Critical Care Nurses*
- *American College of Chest Physicians*
- *American College of Emergency Physicians*
- *American Thoracic Society*

ESICM CLINICAL PRACTICE GUIDELINES

Rochwerg B, et al. Intensive Care Medicine. 2020.[26]

Primary support – Medical

NHF is preferred to COT for patients with hypoxemic respiratory failure.

STRONG RECOMMENDATION

Primary support – Surgical

NHF is preferred to COT in high risk and/or obese patients undergoing cardiac or thoracic surgery to prevent respiratory failure in the immediate postoperative period.

Prophylactic NHF to prevent respiratory failure in other postoperative patients is not recommended.

CONDITIONAL RECOMMENDATION

Pre-escalation support

No recommendation is made regarding use of NHF in the peri-intubation period.

NHF during intubation should be continued for patients who are already receiving NHF.

CONTINUE NHF

De-escalation support

NHF is preferred to COT following extubation in patients with any high-risk feature who were intubated for > 24 hours.

NIPPV is preferred to NHF in patients who would normally be extubated to NIPPV.

CONDITIONAL RECOMMENDATION

ERS CLINICAL PRACTICE GUIDELINES

Oczkowski S, et al. European Respiratory Journal. 2021.[27]

Primary support – Medical

NHF is preferred to COT or NIV in patients with acute hypoxemic respiratory failure.

CONDITIONAL RECOMMENDATION

Primary support – Medical

Trialling NIV prior to use of NHF in patients with COPD or acute hypercapnic respiratory failure.

CONDITIONAL RECOMMENDATION

De-escalation support

NHF is preferred to COT in low-risk non-surgical patients.

NIV is preferred to NHF in non-surgical patients at high risk of extubation failure, unless NIV is contraindicated.

CONDITIONAL RECOMMENDATION

Primary support – Surgical

Either NHF or COT can be used in post-operative patients at low risk of respiratory complications.

Either NHF or NIV can be used in post-operative patients at high risk of respiratory complications.

CONDITIONAL RECOMMENDATION

Complementary support

NHF is preferred to COT during breaks from NIV in patients with acute hypoxemic respiratory failure.

CONDITIONAL RECOMMENDATION

Frat et al. 2015[14]

The New England Journal of Medicine

High-flow oxygen through nasal cannula in acute hypoxemic respiratory failure.

Study

A 23-center study compared NHF to use of a non-rebreather mask (standard oxygen) and NIV as a primary treatment.

The primary outcome was the number of patients intubated at day 28 (not attained).

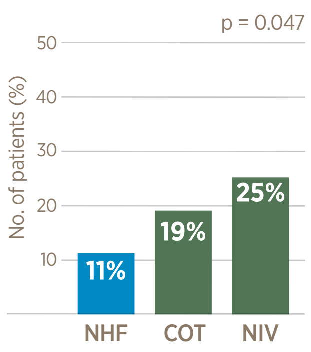
Method

310 pre-intubation patients in acute hypoxemic respiratory failure (PaO_2:$FiO_2 \leq 300$ mmHg) were randomized to receive NHF, non-rebreather mask or NIV.

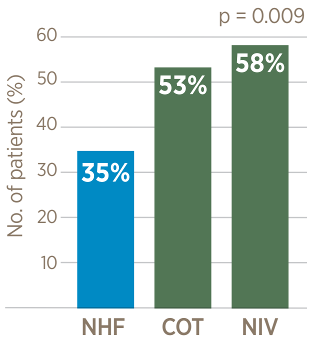
Results

- **NHF significantly reduced ICU** (p = 0.047) **and 90-day mortality** (p = 0.02)
- The primary outcome was not met for all patients (p = 0.18), however, **NHF significantly reduced the need for intubation in more acute patients (PaO_2:$FiO_2 \leq 200$ mmHg)** (p = 0.009)
- Significant increase in ventilator-free days on NHF (p = 0.02)
- NHF significantly reduced intensity of respiratory discomfort (p < 0.01) and dyspnea (p < 0.001)

ICU mortality



Reduced intubation rate*

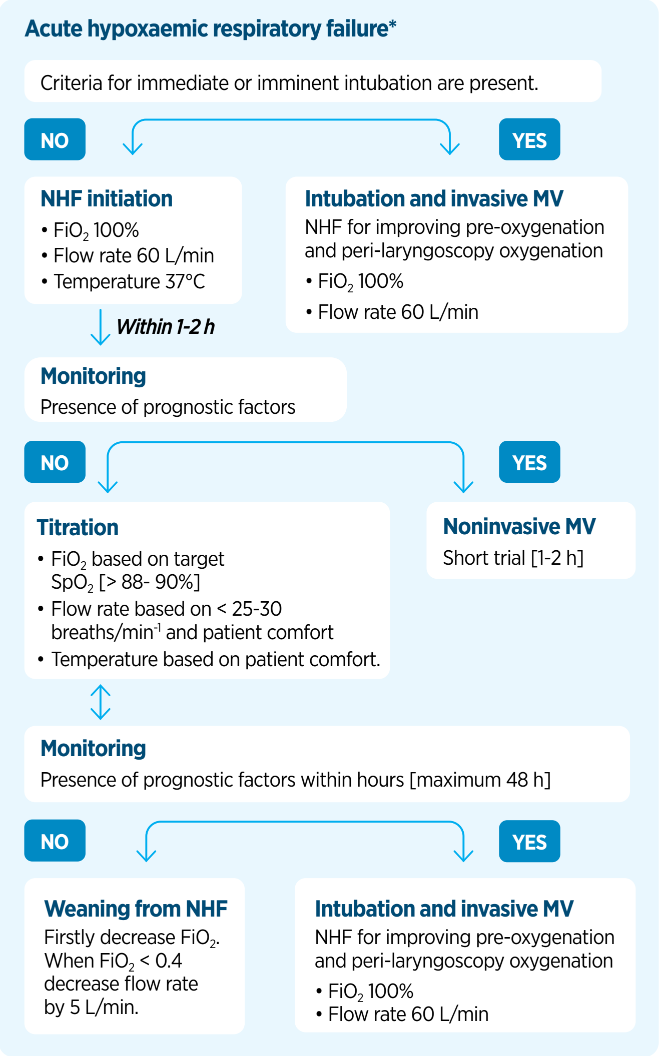


*Patients with PaO_2:$FiO_2 \leq 200$ mmHg

Ischaki et al. 2017[30]

European Respiratory Review

Nasal high flow therapy: a novel treatment rather than a more expensive oxygen device.



MV = mechanical ventilation; SOT = standard oxygen treatment.

Adapted from original paper (Ischaki et al. Eur Respir Rev. 2017.); used under Creative Commons licence 4.0.

Cortegiani et al. 2020[31]

Critical Care

High flow nasal therapy versus noninvasive ventilation as initial ventilatory strategy in COPD exacerbation: a multicenter non-inferiority randomized trial.

Study

A 9-center RCT compared NHF to NIV as an initial ventilatory strategy in hypercapnic COPD exacerbation.

Patients

n = 79, Mild-to-moderate AECOPD
(pH 7.25–7.35, $PaCO_2 \geq 55$ mmHg before ventilator support)

Intervention	Control
NHF	NIV

Outcome

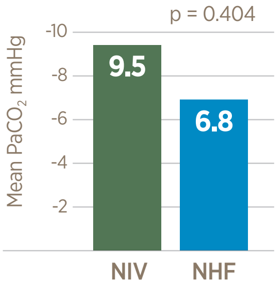
Primary: $PaCO_2$ from baseline to 2 h
(non-inferiority margin 10 mmHg)

Secondary: non-inferiority of NHF to NIV in reducing $PaCO_2$ at 6 h rate of treatment changes, dyspnea, discomfort, RR, ABG, hospital LoS, mortality

Results

- NHF was non-inferior to NIV in reduction of $PaCO_2$
- Both treatments had a significant effect on $PaCO_2$ reductions over time, and trends were similar between groups.

Mean $PaCO_2$ reduction from baseline at 2 hours



Pantazopoulos et al. 2020[32]

COPD: Journal of Chronic Obstructive Pulmonary Disease

Nasal high flow use in COPD patients with hypercapnic respiratory failure: treatment algorithm & review of the literature.

Study

A revlew of the evidence for NHF use for treatment of stable hypercapnic COPD patients and acute hypercapnic exacerbation of COPD, (21 studles: 9 AECOPD/12 stable COPD studles), with proposed evidence-based algorithm for the dinical application of NHF In patients with AECOPD.

Conclusions

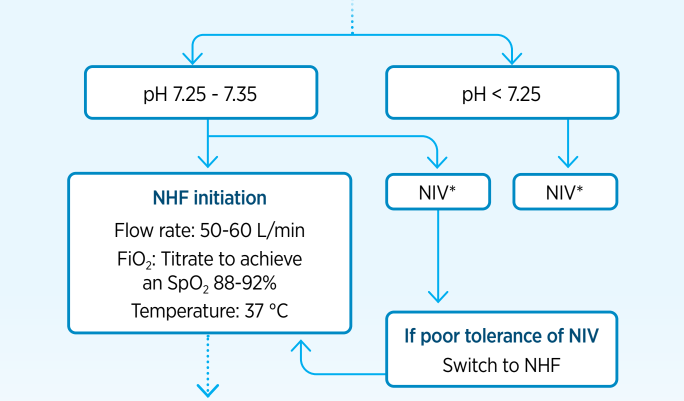
It may well also be used in place of NIV in the least tolerant and compliant patients, or in association with NIV to reduce mask-related side effects.

NHF seems to be effective in improving clinical and gas exchange parameters in patients with moderate hypercapnic respiratory failure, with an acceptable rate of non-responders who required additional ventilatory support.

Results

NHF recommended for patients with:
- pH: 7.25 - 7.35
- escalate to NIV if pH < 7.25

Algorithm for NHF use in acute hypercapnic exacerbation of COPD



Adapted from original paper (Pantazopoulos et al. COPD. 2020.); used under Creative Commons licence 4.0.

Hernández et al. (Oct) 2016[18]

Journal of the American Medical Association

Effect of post-extubation high-flow nasal cannula vs noninvasive ventilation on reintubation and post-extubation respiratory failure in high-risk patients: A randomized clinical trial.

Design

3 center RCT

Patients

n = 604, Patients at high risk for reintubation

Intervention	Control
NHF	NIV

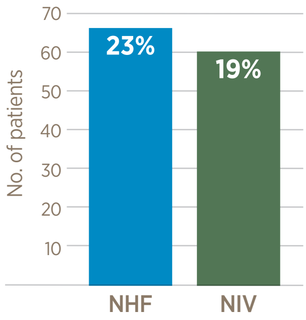
Outcome

Reintubation and post-extubation respiratory failure within 72 hours

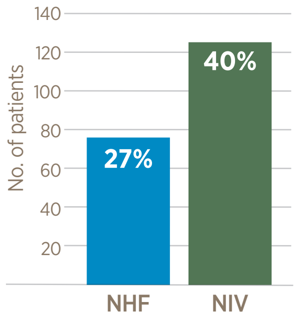
Results

- NHF was non-inferior to NIV for preventing reintubation and post-extubation respiratory failure.
- No patients in the NHF group suffered adverse effects requiring withdrawal of the therapy, compared to 42.9% of patients in the NIV group.

Reintubation



Post-extubation respiratory failure



Hernández et al. (Apr) 2016[19]

Journal of the American Medical Association

Effect of post-extubation high-flow nasal cannula vs conventional oxygen therapy on reintubation in low-risk patients.

Design

7 center RCT

Patients

n = 527, Patients at low risk for reintubation

Intervention

NHF for 24 hrs post extubation

Control

COT for 24 hrs post extubation

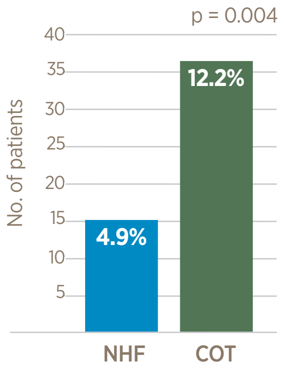
Outcome

Primary: reintubation within 72 hours

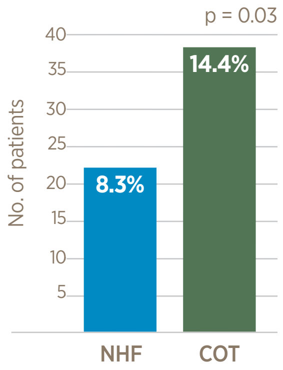
Secondary: post-extubation respiratory failure, adverse events, and time to reintubation, ICU and hospital LoS

Results

Reduced reintubation

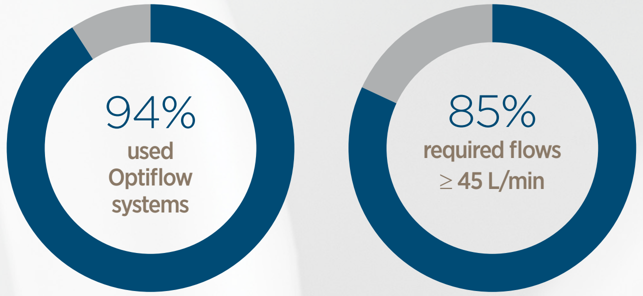


Reduced respiratory failure



Flow usage

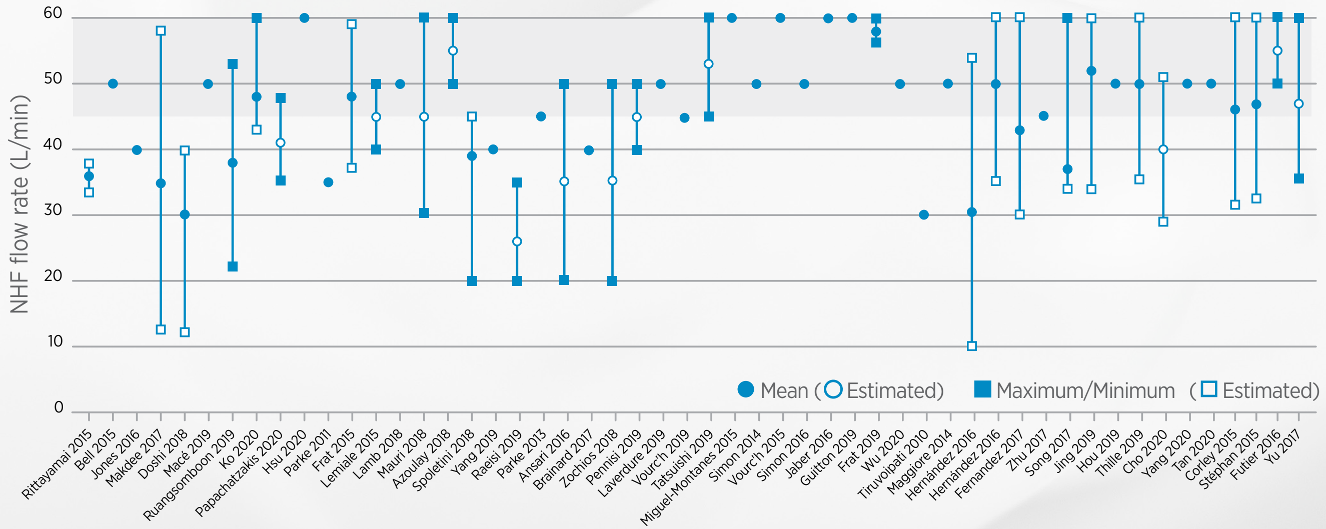
Guidelines for the use of NHF for acute respiratory support in adults are supported by peer-reviewed and published evidence.



What flow rates and ranges are used?

Systematic search of PubMed database for acute adult NHF controlled studies with subjects n > 39.

Flow rates used in the 52 controlled studies on acute adult NHF (with subjects n >39)*



*Systematic search of the PubMed database: Conducted on 17 September 2020 using pre-defined search terms. Filtered using an Excel database and checked by an internal clinical team.

Physiological indicators for stability

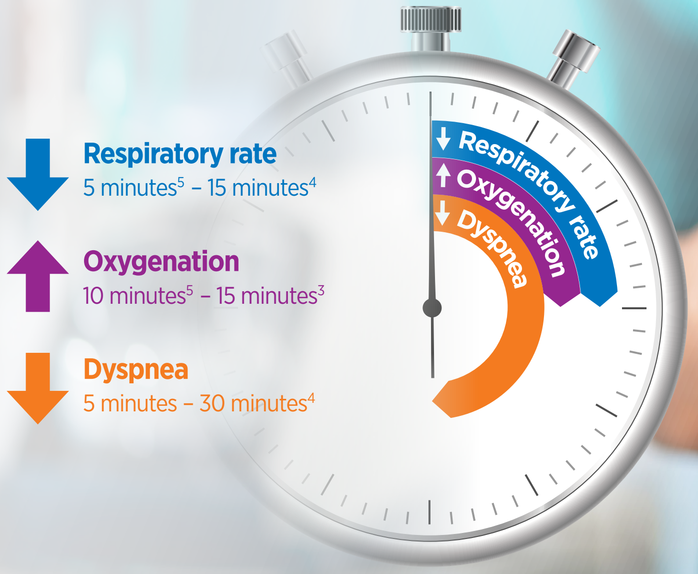
There is an ever-increasing body of clinical literature which may provide guidance on the day-to-day application of Optiflow NHF therapy.

When are the effects of Optiflow NHF seen?

Sztrymf[4] associated Optiflow NHF therapy with sustained beneficial effects on oxygenation and physiological parameters for patients with acute respiratory failure.

Similarly Rittayamai[5] showed significant improvement in post-extubation patients.

These studies may provide guidance on patient responses to the therapy.



Is there a way to predict the outcome of NHF?

The validated ROX index[33] predicts failure in adults with AHRF receiving NHF, at 4 time intervals: 2, 6, 12 and > 12 hours. It's an easy-to-use dynamic bedside tool.

ROX index: Predicting NHF success and failure

$$\frac{SpO_2 \div FiO_2}{\text{Respiratory rate}} = \text{ROX index}$$

'Healthy' example

$$\frac{95 \div 0.21}{15} = 30.2$$

'Patient' example

$$\frac{95 \div 0.85}{37} = 3.0$$

ROX index trend over time is more important than a single measurement.

The trend of FiO_2 required to maintain target SpO_2 (i.e. 95%) and patient respiratory rate directly effect ROX trend.

NHF success

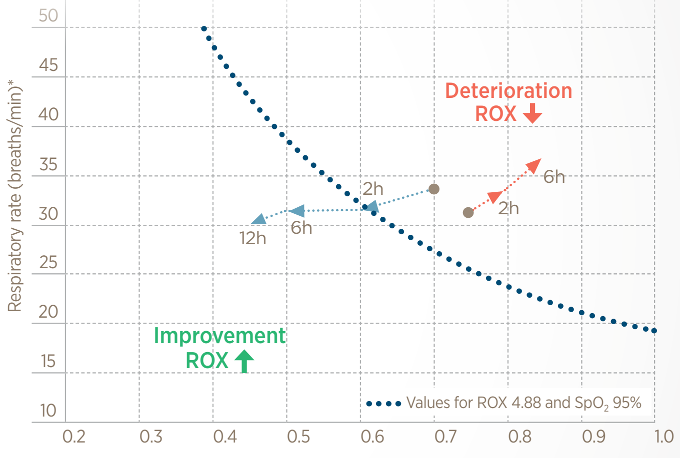
SpO_2 ÷ FiO_2 ↓ / Respiratory rate ↓ = ROX index ↑

NHF failure

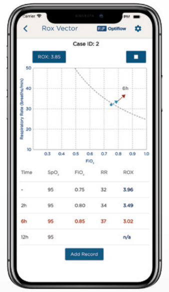
SpO_2 ÷ FiO_2 ↑ / Respiratory rate ↑ = ROX index ↓

XY plot between respiratory rate and FiO_2

The blue arrows in a vector form demonstrate a change towards NHF success and the red arrows demonstrate the change towards NHF failure. The dotted line shows the values for ROX at 4.88 and the SpO_2 of 95%.



* for the highest tolerable flow rate (e.g. ≥45 L/min)



EDUCATIONAL APP

F&P ROX Vector App

The ROX Vector App proposes a model for considering the trend in ROX values over time.

Optiflow in practice:
IOWA METHODIST MEDICAL CENTER, DES MOINES, IOWA

Jackson et al. 2021[34]

Respiratory Care

Implementation of high-flow nasal cannula therapy outside the intensive care setting.

Design

Single center cohort observational study (pre and post NHF implementation)

Patients

n = 346

Intervention

18-month after implementing NHF therapy

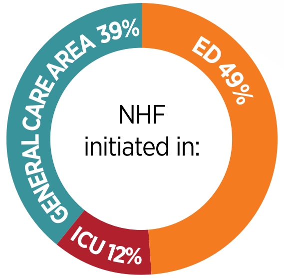
Control

Prior to NHF implementation

Outcome

Share education and implementation process. Report patient outcomes.

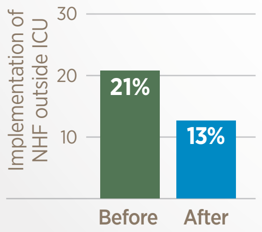
Results



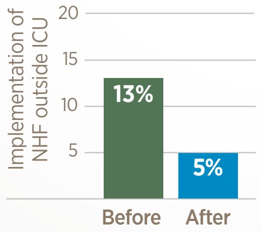
After implementation:

- **53% (n = 184) of NHF patients avoided the ICU completely**
- **486 ICU days were avoided**

Mortality



Escalation to MV



Implementation strategy

1. Protocol of NHF written (for undifferentiated respiratory compromise and increased oxygen requirement).
2. Education of hospital staff: Key groups included respiratory therapists; internal medicine and surgery residents; internal medicine, pulmonology, trauma, cardiology, and emergency medicine physicians; and nurses on all patient floors and in the ED.
3. At least 4 hourly assessment by respiratory therapist.
4. Study team regular review of patient safety and adverse events.

NHF education topics by audience	Physicians and residents	Nurses	Respiratory therapists
Theory and physiology of NHF therapy	●	●	●
NHF protocol	●	●	●
NHF device setup and electronic medical record documentation			●
NHF device maintenance		●	●
De-escalation and weaning	●	●	●

Nasal high flow therapy in infants and children

ED | PICU | GENERAL CARE

The body of literature helps to define the role of NHF in pediatric respiratory care and supports:

- **the use of NHF early in the course of respiratory distress is associated with improved physiological outcomes compared with standard oxygen therapy, including:** [35-40]
  - improved breathing patterns and rapid unloading of the respiratory muscles
  - significant reduction in the work of breathing
  - rapid improvement to respiratory distress
  - improved mucosal function and secretion clearance through the delivery of heated and humidified gas
- **the early use of NHF in bronchiolitis outside of the PICU, either as primary support or early rescue therapy, can lead to reduced escalation of care.**[41-45]

What flow rates are used?

- **2 L/kg/min for patients up to 12 kg** in weight has been shown to produce a rapid improvement in respiratory distress, and a reduced need for escalation of therapy.
- Flow rates for those over 12 kg have been protocolized by the PARIS[46] and FIRST-ABC[47] research groups.

Weight (kg)	≤ 12	13 – 15	16 – 30	31 – 50	> 50
Starting flow rate	2 L/min/kg	25 – 30 L/min	35 L/min	40 L/min	50 L/min

How do I know if my patient is responding to NHF?

Schibler 2011, Intensive Care Med Mayfield 2014, J Pediatric Child Health[45]

Within **60** minutes

IMPROVEMENT IN:

Respiratory rate (RR) | Heart rate (HR) | Work of breathing

An improvement to these indicators within 60 minutes may help to identify infants who are likely to respond to NHF. No improvement may help identify infants who are likely to require escalation of care.[5,11]

Note: Standard O_2 = 100% O_2 NHF at 2 L/kg/min = Total flow/kg/min; FiO_2 titrated

Franklin et al. 2018[35]

New England Journal of Medicine

ED | GENERAL CARE

A randomized trial of high-flow oxygen therapy in infants with bronchiolitis.

Design

17 centered RCT

Patients

n = 1472, infants < 12 months old with bronchiolitis

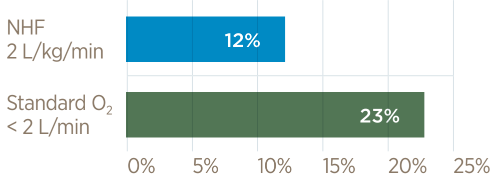
Intervention	Comparator
NHF starting at 2 L/kg/min	Standard oxygen therapy at < 2 L/min

Primary outcome

Therapy failure requiring therapy escalation or PICU admission

Results

Use of NHF as a primary treatment in the ED and general care areas resulted in a significantly lower rate of therapy failure compared with standard oxygen therapy (12 vs. 23%, $p < 0.001$)



1 in 9 patients experienced therapy failure on NHF 2 L/kg/min

1 in 4 patients experienced therapy failure on standard O_2 < 2 L/min

There were no significant differences between the secondary outcomes (PICU admissions, intubation rates and adverse events).

Ramnarayan et al. 2022[48]

Journal of the American Medical Association

Step up | PICU

Effect of high-flow nasal cannula therapy vs. continuous positive airway pressure therapy on liberation from respiratory support in acutely ill children admitted to pediatric critical care units: a randomized clinical trial.

Design

24 centered non-inferiority RCT

Patients

n = 573 (0 - 15 years, median age: 9 months), admitted to critical care requiring respiratory support

Intervention	Comparator
NHF starting at 2 L/kg/min	CPAP at 7-8 cm H_2O

Primary outcome

Time to liberation from respiratory support

Results

- When used as first-line therapy, NHF met the noninferiority criteria when compared with CPAP for time on respiratory support (NHF: 52.9 hours vs. CPAP: 47.9 hours; adjusted hazard ratio: 1.03 (95% CI: 0.86 – 1.22))
- Therapy failure occurred more frequently in the CPAP group compared with the NHF group

31% of patients switched to NHF — Predominantly due to discomfort

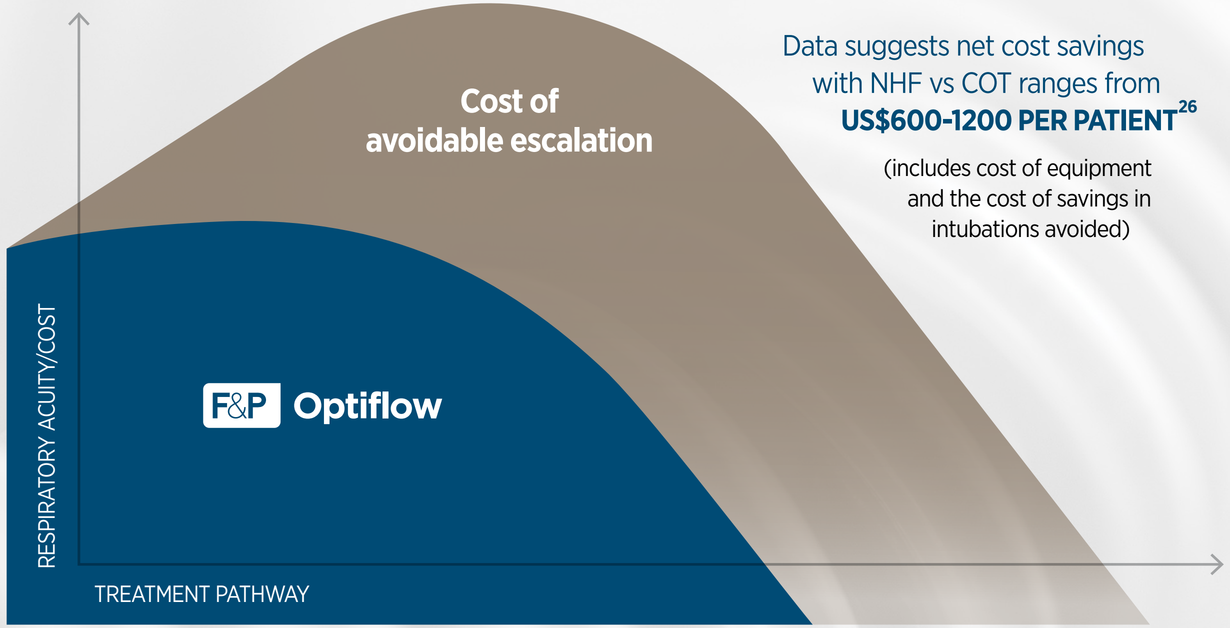
20% of patients switched to CPAP — Predominantly due to clinical deterioration

Of the secondary outcomes, the NHF group had significantly:

Lower use of sedation	Fewer occurrences of adverse events	Shorter mean duration of PICU stay	Shorter mean duration of acute hospital stay
NHF 27.7% vs. CPAP 37.0%	NHF 8.1% vs. CPAP 14.0%	Mean difference -3 days	Mean difference -7.6 days

Cost benefits

Use Optiflow NHF to reduce escalation[14,18] thereby avoiding associated costs.



Data suggests net cost savings with NHF vs COT ranges from **US$600-1200 PER PATIENT**[26]

(includes cost of equipment and the cost of savings in intubations avoided)

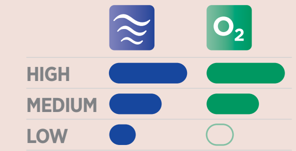
Using Optiflow NHF as a first-line therapy (both pre-intubation and post-extubation) may reduce a patient's escalation 'up the acuity curve', resulting in better patient outcomes and reduced costs of care.

Apply Airvo early for stabilization and benefit the patient throughout their stay

ED

- Superiority to COT
- Reduced need for therapy escalation
- Easy communication during assessment
- Physiological markers of stabilization
- ED exit to a lower acuity setting

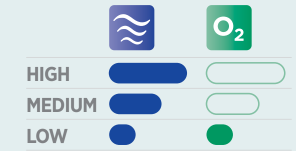
ICU



- Superiority to COT
- Reduced need for intubation/re-intubation
- Reduced ICU length of stay*
- Non-inferiority to NIV*
- ICU discharge to a lower acuity setting

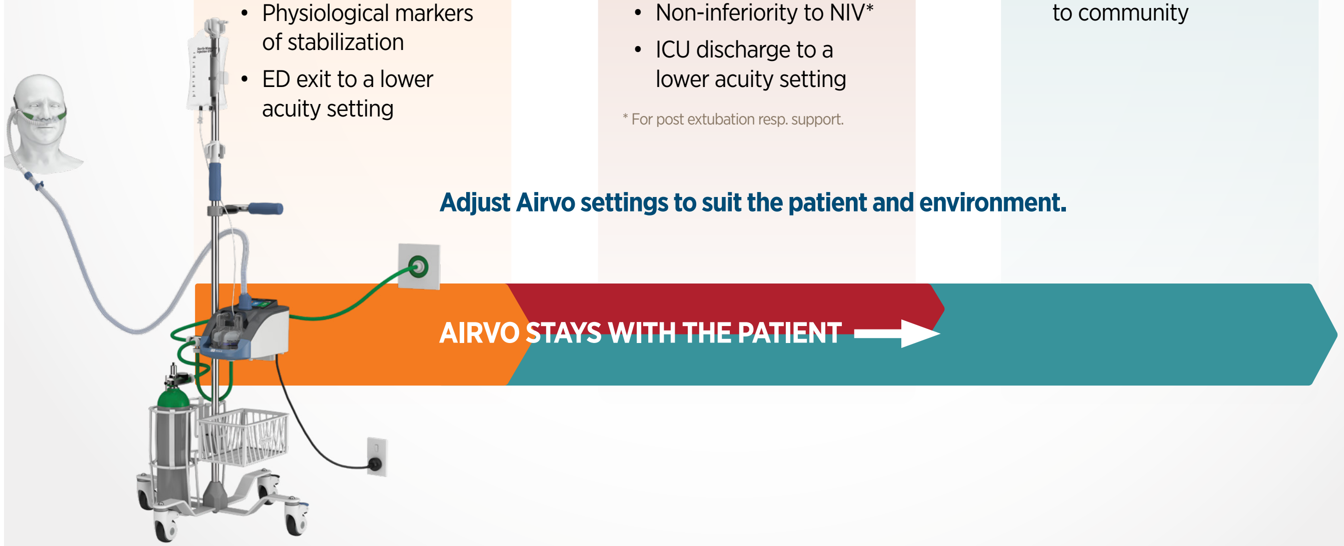
* For post extubation resp. support.

General Care



- Superiority to COT
- Continue patient stability outside ICU
- Airway hydration
- Hospital discharge to community

Adjust Airvo settings to suit the patient and environment.



SCAN ME

F&P Optiflow

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