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Complementary Use Of Noninvasive Ventilation And High Flow Therapy

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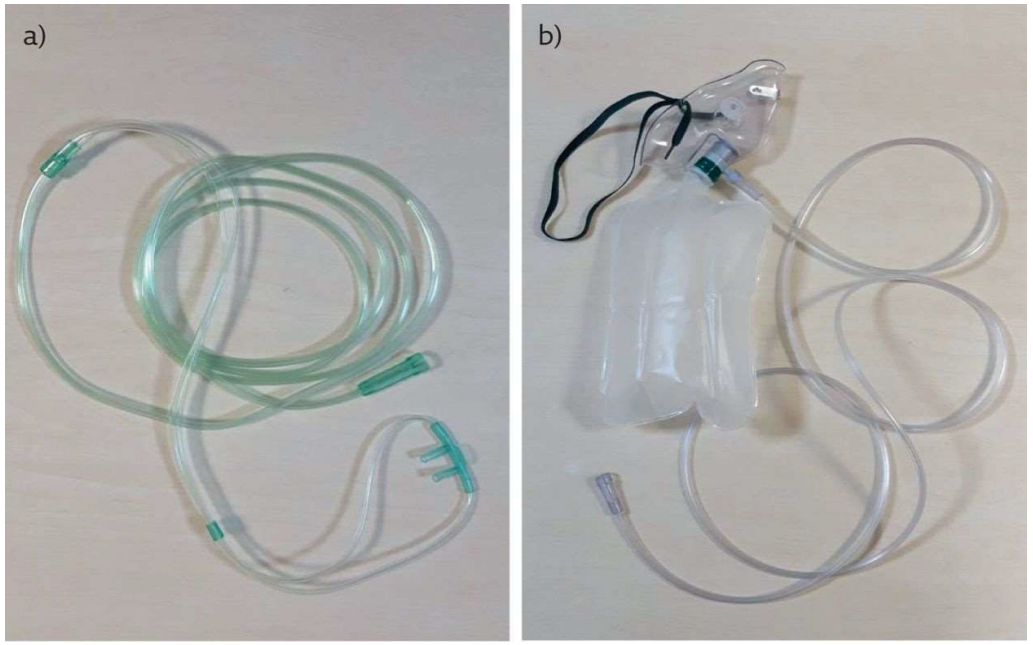
Objectives

- Discuss the characteristics of high flow oxygen therapy (HFT).
- Identify clinical use cases of HFT.
- Review current HFT and noninvasive ventilation (NIV) evidence-based recommendations and clinical practice guidelines.
- Describe which therapies support de novo hypoxemic respiratory failure.
- Evaluate commonly observed clinical practice when using HFT and NIV.
- Analyze the benefits of the complementary use of NIV and HFT in high risk post-extubation failure.

What Are The Typical Oxygen Flow Rates At Your Facility?

Conventional forms of Low Oxygen delivery devices

- Nasal cannula (a)
- Non-rebreather mask (b)



1. Hardavella G, et al. Oxygen devices and delivery systems. Breathe. 2019; 15:e108-e116

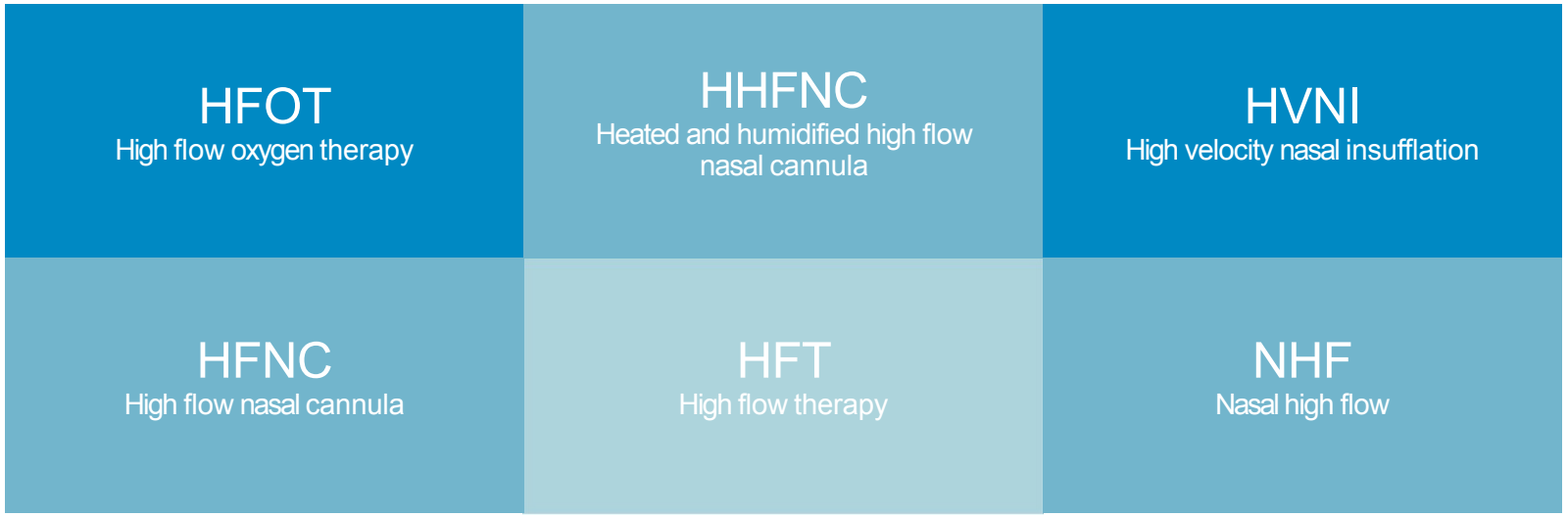
What Are The Typical Oxygen Flow Rates At Your Facility?

Conventional forms of High Oxygen delivery devices

- Venturi mask with different sized ports to change the FIO2 delivered (24–50%).
- FIO2 and oxygen flow are clearly stated on the bottom of each port.

1. Hardavella G, et al. Oxygen devices and delivery systems. Breathe. 2019; 15:e108-e116

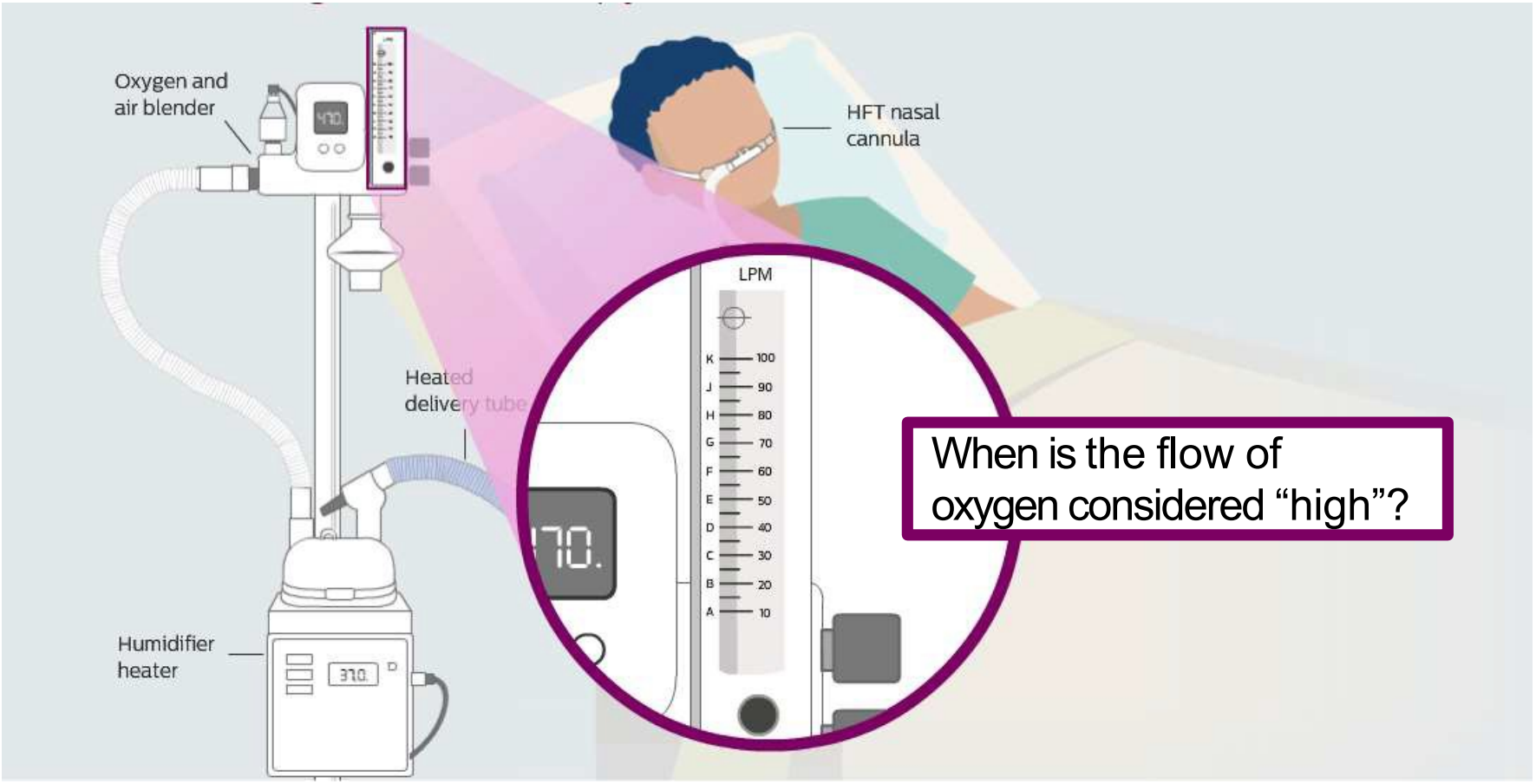
What is High Flow Therapy?



High Flow Therapy is an oxygen supply system capable of delivering up to 100% humidified and heated oxygen at a flow rate of up to 60 liters per minute or more [2] in order to meet or exceed the flow demand of the patient. [3]

2. Sharma S, Danckers M, Sanghavi D, et al. High Flow Nasal Cannula. StatPearls. [Updated 2020 Feb 25]; https://www.ncbi.nlm.nih.gov/books/NBK526071/
3. Fratzke M, Kirkenss J, Lamb K., Adult Nasal High Flow Therapy: Informed and Educated. AARC News (Updated: June 26, 2019); https://www.aarc.org/nn19-nasal-high-flow-therapy/

What is High Flow Therapy?



What is High Flow Therapy?

20-30 LPM	Increased
At rest during tidal breathing without respiratory distress	During increased effort or acute distress, the patient's flow demand increases

Flow of oxygen that meets or exceeds patient inspiratory flow

3. Fratzke M, Kirkenss J, Lamb K., Adult Nasal High Flow Therapy: Informed and Educated. AARC News (Updated: June 26, 2019); https://www.aarc.org/nn19-nasal-high-flow-therapy/

Attributes of High Flow Therapy [2]

Meets or exceeds inspiratory flow demand

- Average adult inspiratory flow demand during at-rest breathing 20-30L/min
- Shortness of breath à inspiratory flow demand increases
- Some devices may deliver up to 40-80L/min

Heated humidification

- More comfortable than traditional face masks
- Maintains mucociliary function

Delivers a wide range of FiO2 up to 100%

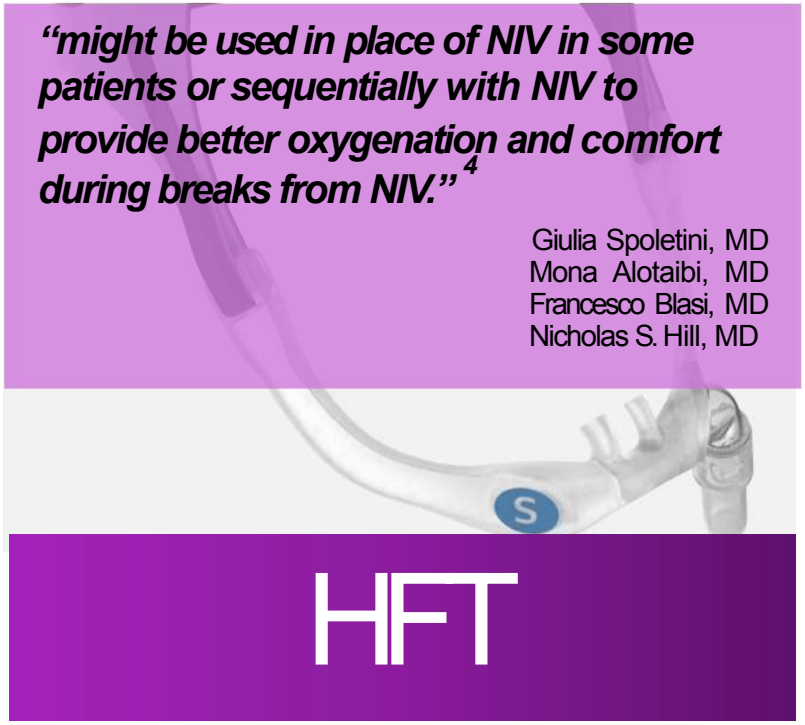
- High flow rate prevents entrainment of room air and reduces FiO2 dilution

Provides small PEEP effect

- Depends largely on the amount of flow, naso-cannula and mouth leak

CO_2 washout from anatomical deadspace

- Nasopharyngeal airway



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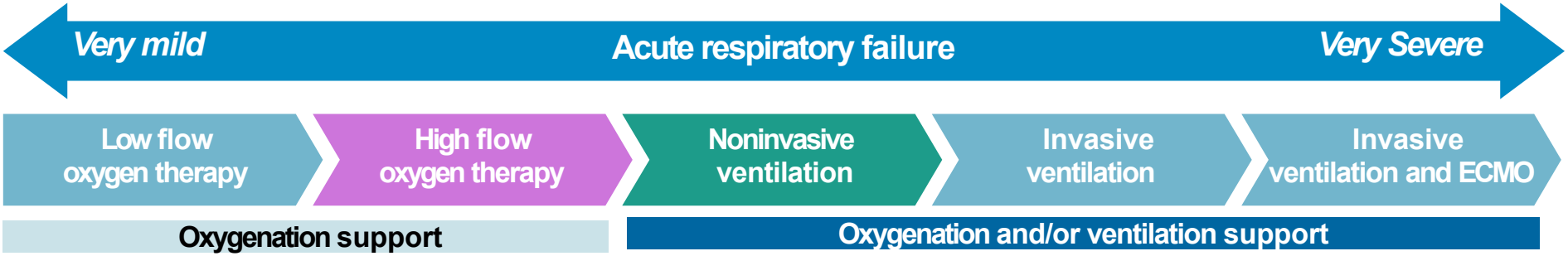
Clinical Observations in the Escalation and De-escalation of Patient Care



Applying respiratory support for gas exchange 'buys time' while clinical treatment, and patient healing reverse the underlying causes. At the same time, clinicians are attentive to minimizing the potential injurious effects of intervention - such as ventilator-induced lung injury - particularly associated with more invasive interventions.[5]

5. Pierson D. History and Epidemiology of Noninvasive Ventilation in the Acute-Care Setting. Respiratory Care Jan 2009, 54 (1) 40-52

HFT Benefits and Limitations [6]

Benefits	Limitations
Ease of interface application	Few interface options
Ease of device titration/operation	Lack of monitored parameters
Minimal device alarms	Lack of backup ventilation
Minimizes speaking interference	Lack of patient alarms
Minimizes claustrophobia	
Minimizes sedation	
Easily tolerated	

Experienced use of high flow in adults is limited, and currently there is no corresponding clinical guideline. Further large sample research is required to determine the long-term effect of this technique, and to identify the patient population to whom High Flow Therapy is most beneficial. [7]

6. Nishimura M. High-Flow Nasal Cannula Oxygen Therapy in Adults: Physiological Benefits, Indication, Clinical Benefits, and Adverse Effects. Respiratory Care Apr 2016, 61 (4) 529-541.
7. Lyu S, An Y. [The application of actively heated humidified high flow nasal cannula oxygen therapy in adults]. Zhonghua Wei Zhong Bing Ji Jiu Yi Xue. 2016 Jan;28(1):84-8. doi: 10.3760/cma.j.issn.2095-4352.2016.01.018. Chinese.

Check Point

During at rest tidal breathing, the expected adult inspiratory flow is:

A. 0 – 6 L/min
B. 20 – 30 L/min
C. 60 to 80 L/min
D. None of the above

Check Point

During at rest tidal breathing, the expected adult inspiratory flow is:

A. 0 – 6 L/min
B. 20 – 30 L/min
C. 60 to 80 L/min
D. None of the above

Check Point

Patients in respiratory distress experience:

A. Increased inspiratory flow demand
B. Decreased inspiratory flow demand

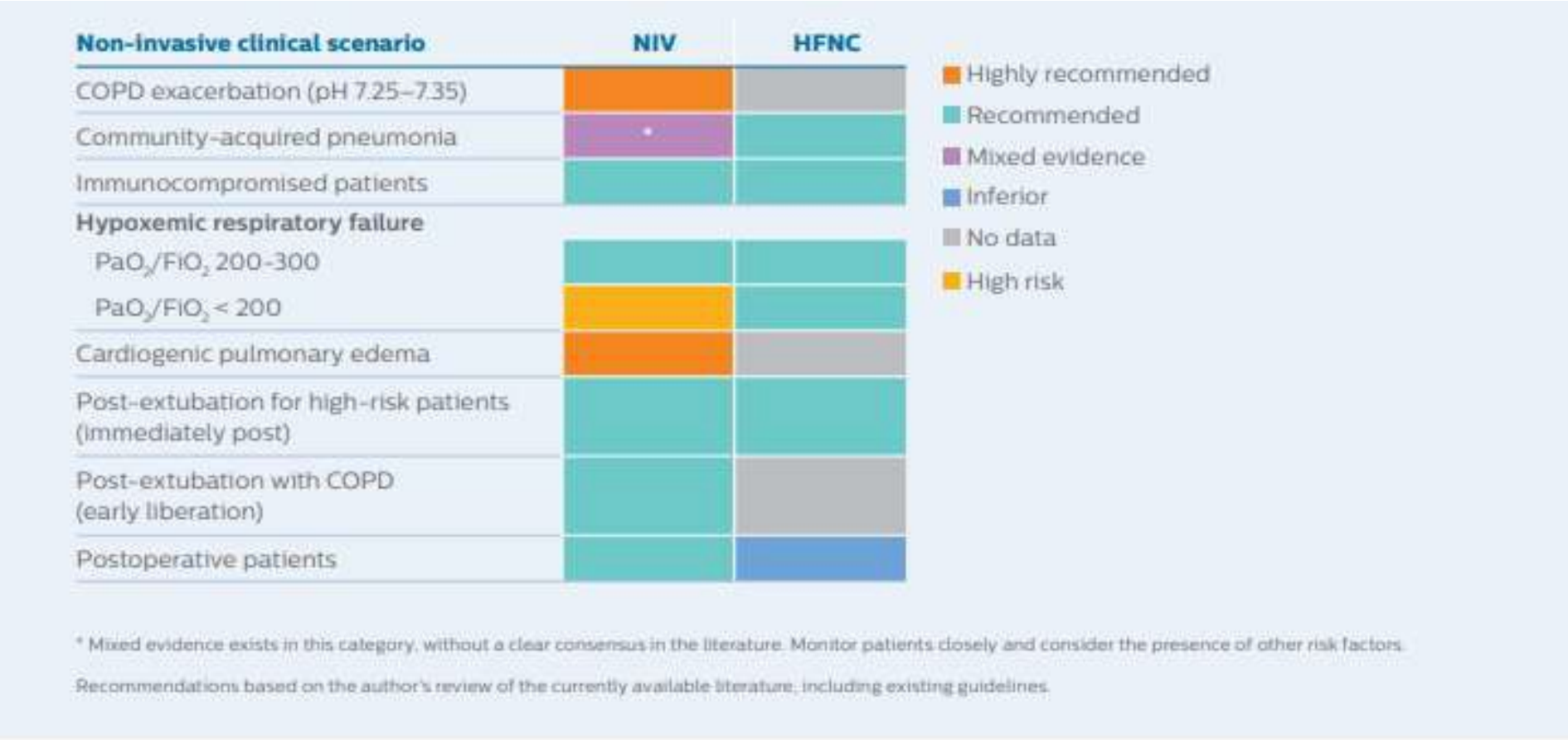
Check Point

Patients in respiratory distress experience:

A. **Increased inspiratory flow demand**
B. Decreased inspiratory flow demand

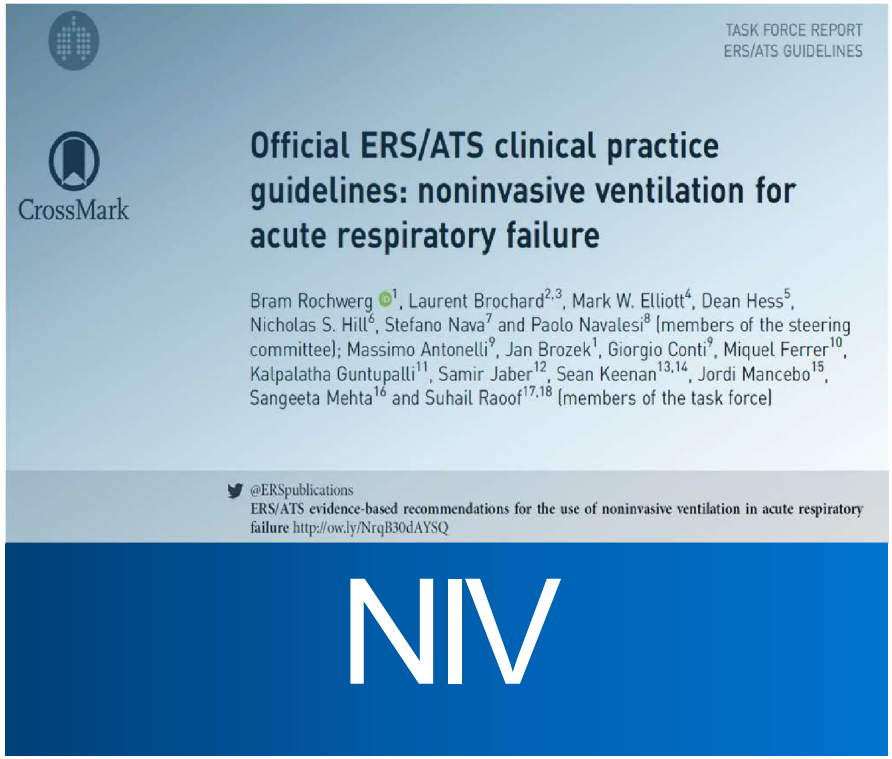
Recommendations of Non-invasive Clinical Scenario

Executive Summary



8. Piraino T, Noninvasive Respiratory Support in Acute Hypoxemic Respiratory Failure. Respir Care 2019;64(6):638 –646.

ERS/ATS Clinical Practice Guidelines: 2017

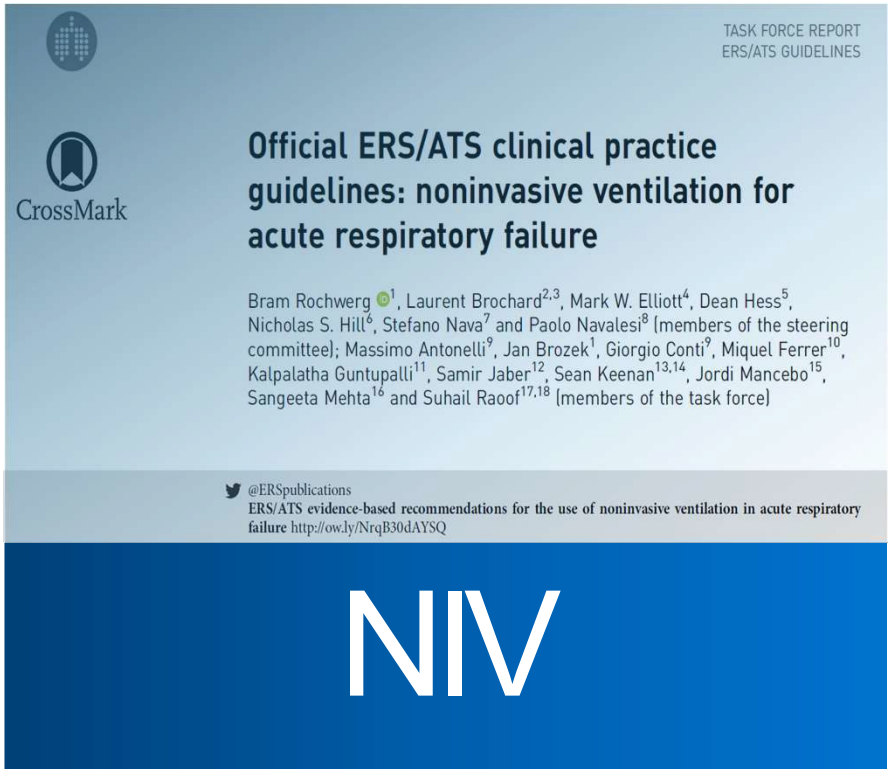


NIV Practice guidelines for Acute Respiratory Failure

- COPD
- Cardiogenic pulmonary edema (CHF)
- Chest Trauma (Flail Chest)
- Palliative Care
- Post-Op Care
- Post extubation (high risk)

9. Rochwerg B, et al. Official ERS/ATS clinical practice guidelines: noninvasive ventilation for acute respiratory failure. European Respiratory Journal Aug 2017, 50 (2) 1602426

ERS/ATS Clinical Practice Guidelines: 2017



NIV Clinical Practice Guidelines for Acute Respiratory Failure

- Bilevel NIV should be considered when the pH is ≤7.35, P_{aCO2} is >45 mmHg and the respiratory rate is >20–24 breaths·min^{-1} despite standard medical therapy.
- Bilevel NIV remains the preferred choice for patients with COPD who develop acute respiratory acidosis during hospital admission. There is no lower limit of pH below which a trial of NIV is inappropriate; however, the lower the pH, the greater risk of failure, and patients must be very closely monitored with rapid access to endotracheal intubation and invasive ventilation if not improving.

9. Rochwerg B, et al. Official ERS/ATS clinical practice guidelines: noninvasive ventilation for acute respiratory failure. European Respiratory Journal Aug 2017, 50 (2) 1602426

FLORALI Study : June 2015

HFNC demonstrated better outcomes in "de novo" acute hypoxemic respiratory failure than NIV.

De novo acute hypoxemic respiratory failure

Inclusion criteria:
- P/F ratio ≤ 200
- Tachypnea 30-35/min
- Acute infiltrates
- ARF generally caused by Pneumonia, mild to moderate ARDS

Exclusion criteria:
- Hypercarbic COPD
- Underlying cardiac issue
- Post-op respiratory failure

10. Frat J-P, et al. High-Flow Oxygen through Nasal Cannula in Acute Hypoxemic Respiratory Failure N Engl J Med. June 4, 2015; 372:2185-2196

NIV and High Flow Therapy

Enhances ventilation (tidal volume), oxygenation (alveolar recruitment) and offload work of breathing

- COPD Exacerbation, pH 7.25-7.35
- Cardiogenic Pulmonary Edema
- Weaning
- Immunosuppressed
- At risk COPD, post extubation
- Chest trauma, palliative care, post-op

NIV

Meets or exceeds inspiratory flow demand while delivering a range of FiO2 up to 100%

- Non hypercarbic COPD
- Pneumonia, Mild ARDS
  - De novo hypoxemic respiratory failure

HFT

Check Point

The FLORALI study indicated that high flow therapy showed better results in patients with de novo hypoxemic respiratory failure than NIV. Which of the following is an exclusion criteria of de novo hypoxemic respiratory failure?

A. P/F ratio ≤ 200
B. Pneumonia
C. Mild to moderate ARDS
D. Hypercarbic COPD

Check Point

The FLORALI study indicated that high flow therapy should better results in patients with de novo hypoxemic respiratory failure than NIV. Which of the following is an exclusion criteria of de novo hypoxemic respiratory failure

A. P/F ratio ≤ 200
B. Pneumonia
C. Mild to moderate ARDS
D. Hypercarbic COPD

Check Point

True of False? HFT delivers a consistent, known PEEP.

A. True
B. False

Check Point

True or False? HFT delivers a consistent, known PEEP.

A. True
B. False

Check Point

True or False?

Bilevel NIV remains the preferred choice for patients with COPD who develop acute respiratory acidosis during hospital admission. There is no lower limit of pH below which a trial of NIV is inappropriate; however, the lower the pH, the greater risk of failure, and patients must be very closely monitored with rapid access to endotracheal intubation and invasive ventilation if they are not improving.

A. True
B. False

Check Point

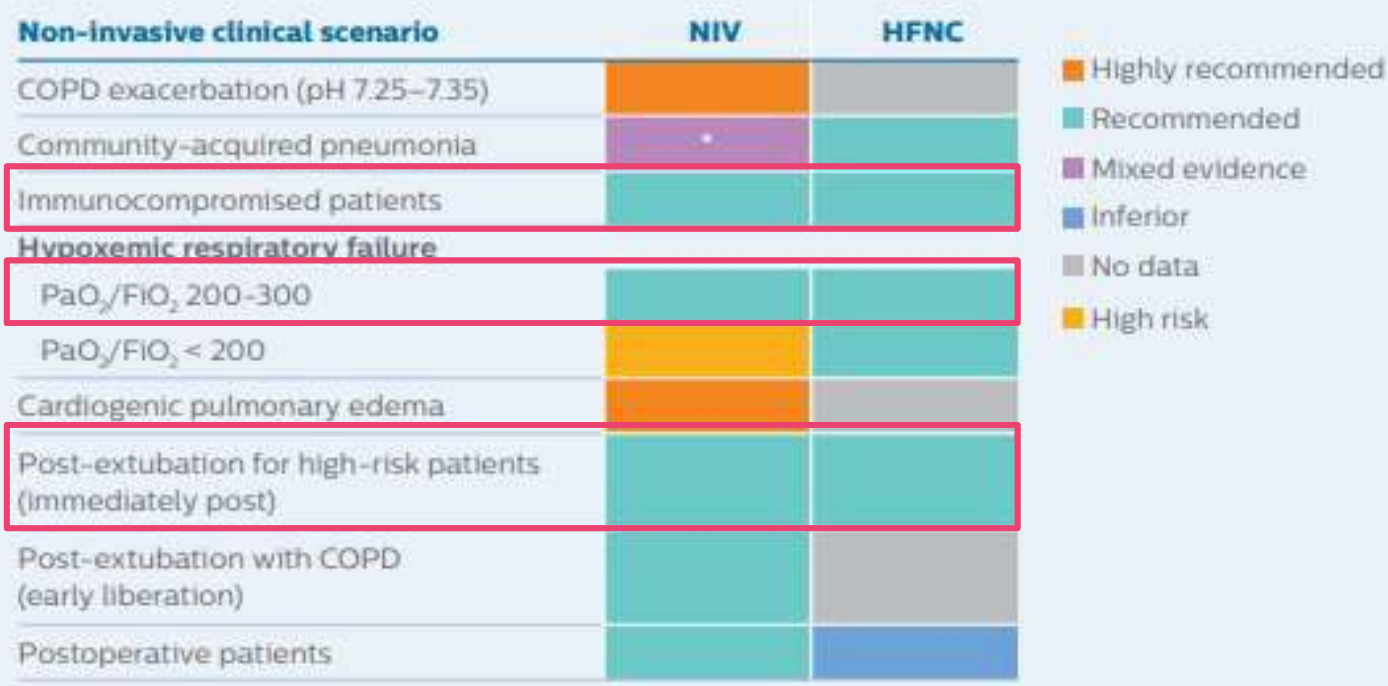
True or False?

Bilevel NIV remains the preferred choice for patients with COPD who develop acute respiratory acidosis during hospital admission. There is no lower limit of pH below which a trial of NIV is inappropriate; however, the lower the pH, the greater risk of failure, and patients must be very closely monitored with rapid access to endotracheal intubation and invasive ventilation if they are not improving.

A. True

B. False

What if the Recommendation is Unclear for Either NIV or HFT?



* 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.

8. Piraino T, Noninvasive Respiratory Support in Acute Hypoxemic Respiratory Failure. Respir Care 2019;64(6):638 –646.

What if the Recommendation is Unclear for Either NIV or HFT?

Observations on HFT vs. NIV

- If there is not an integrated noninvasive solution that includes both NIV and HFT functionality, clinicians may often alternate their patients between NIV and HFT devices.
- 68% of clinicians reported alternating to and from one device to the other on the same patients.

Different - but Complementary Modalities

Noninvasive ventilation (NIV) support delivers:

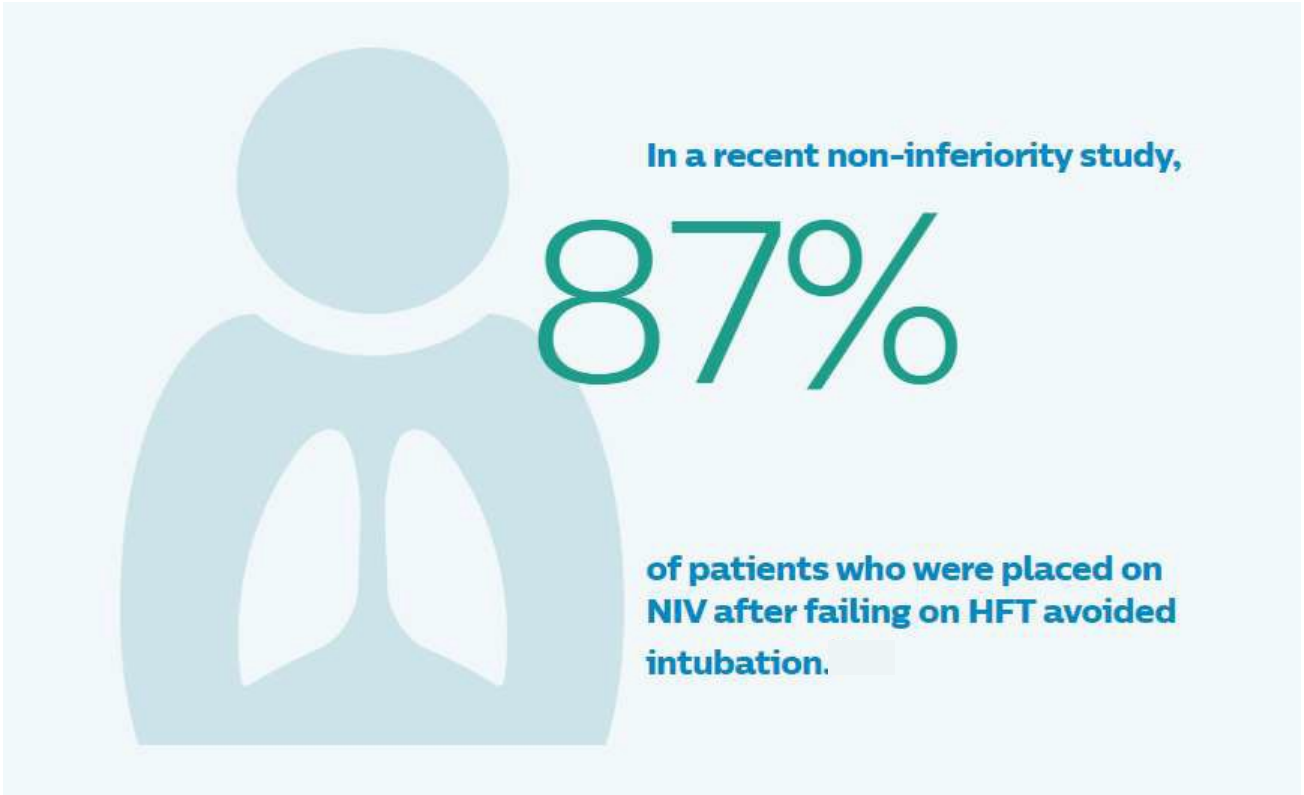
- Appropriate noninvasive ventilatory support
- Adjustable IPAP (Pressure Support) levels
- Adjustable EPAP (PEEP) levels
- Back-up rate
- Wide range of FiO_2
- Patient monitored parameters and alarms
- The same physiological effect as invasive mechanical ventilation

High flow therapy (HFT) delivers:

- Appropriate flow demand
- Wide range of FiO_2
- Small PEEP effect
- CO_2 washout
- Heated humidification

Benefits of Complementary Use

Non-inferiority Study in Undifferentiated Respiratory Failure



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Interpreting the Data

Non-inferiority Study in Undifferentiated Respiratory Failure

"NIPPV rescued 20 patients (87%) who previously failed on HVNI, thus preventing further escalation to intubation."

What if NIPPV was NOT used as a mitigation? Likely, HVNI à intubation

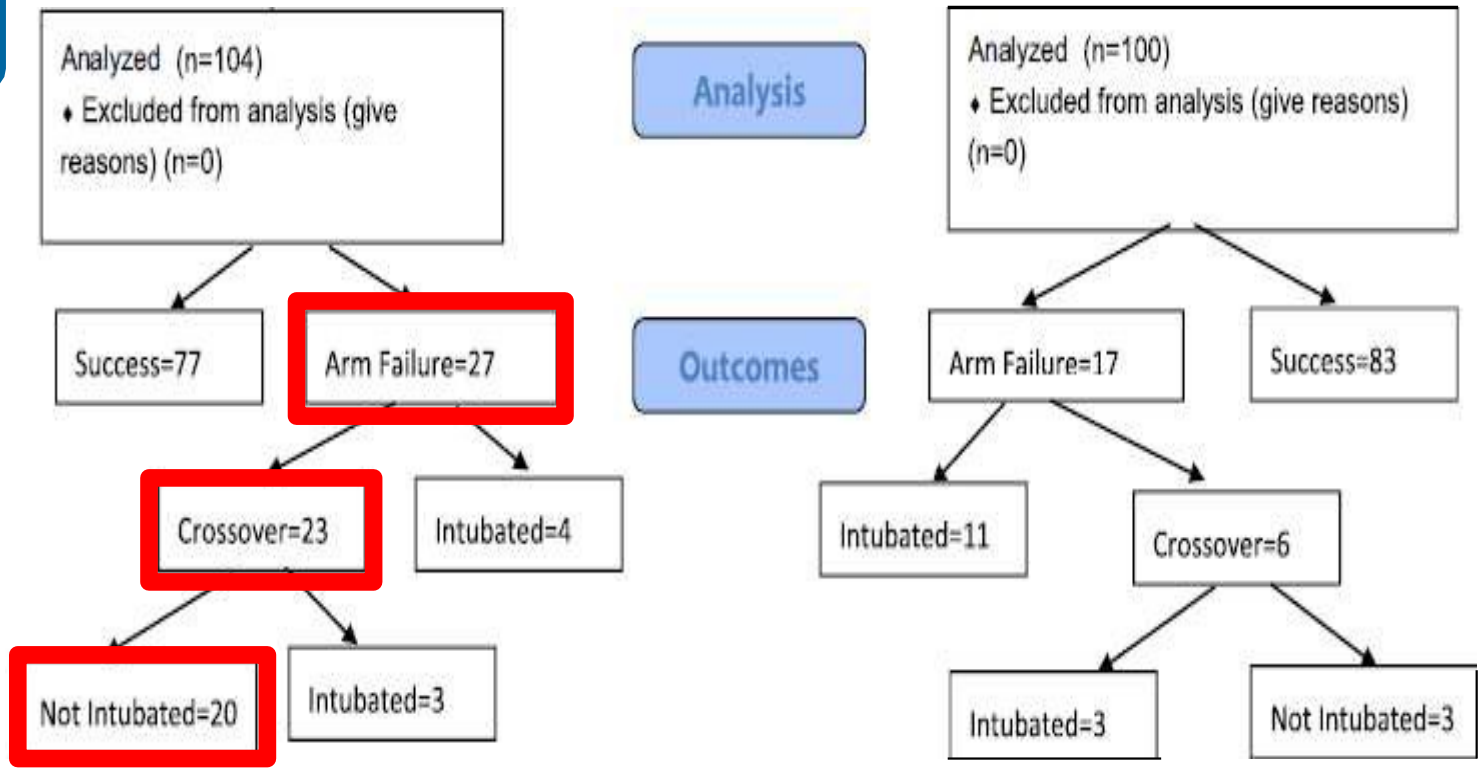
HVNI (N=104)	NIPPV (N=100)
Success = 77 (74%)	Success = 83 (83%)
Failed = 27 (26%)	Failed = 17 (17%)

HVNI Fails (N=27)	NIPPV Fails (N=17)
Immediate intubation = 4	Immediate intubation = 11
Placed on NIPPV = 23	Placed on HVNI = 6
Rescued by NIPPV = 20 (87%)	Rescued by HVNI = 3

8. Piraino T, Noninvasive Respiratory Support in Acute Hypoxemic Respiratory Failure. Respir Care 2019;64(6):638 –646.

Interpreting the Data

HVNI



NIPPV

87% NIPPV success rate

8. Piraino T, Noninvasive Respiratory Support in Acute Hypoxemic Respiratory Failure. Respir Care 2019;64(6):638 –646.

Check Point

In the non-inferiority study, _____% of patients who failed HFT and crossed over to NIPPV did not require escalation to intubation.

A. 20
B. 50
C. 70
D. 87

Check Point

In the non-inferiority study, _____% of patients who failed HFT and crossed over to NIPPV did not require escalation to intubation.

A. 20
B. 50
C. 70
D. 87

Benefits of Complementary Use

Postextubation Failure

In mechanically ventilated patients at high risk of extubation failure, the use of high-flow nasal oxygen with NIV immediately after extubation ***significantly decreased the risk of reintubation*** *compared with high-flow nasal oxygen alone.*

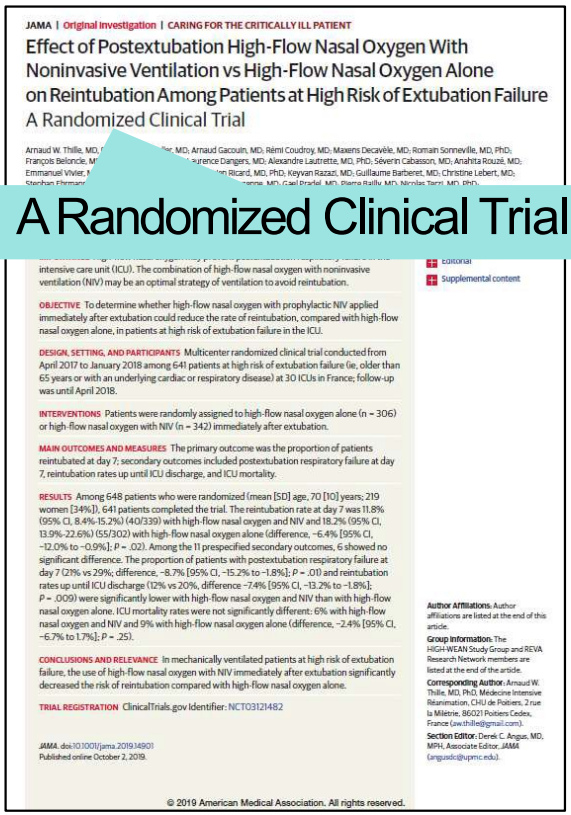
Reintubation rate at day 7

11.8%

NIV with HFT

18.2%

HFT only



JAMA | Original Investigation | CARING FOR THE CRITICALLY ILL PATIENT

Effect of Postextubation High-Flow Nasal Oxygen With Noninvasive Ventilation vs High-Flow Nasal Oxygen Alone on Reintubation Among Patients at High Risk of Extubation Failure

A Randomized Clinical Trial

A Randomized Clinical Trial

Arnaud W. Thille, MD; ... Arnaud Gacouin, MD; Rémi Coudroy, MD; Maxens Decavèle, MD; Romain Sonneville, MD, PhD; François Beloncle, MD; ... Laurence Dangers, MD; Alexandre Lautrette, MD, PhD; Séverin Cabasson, MD; Anahita Rouzé, MD; Emmanuel Vivier, MD; ... Jean Ricard, MD, PhD; Keyvan Razazi, MD; Guillaume Barberet, MD; Christine Lebert, MD; ...

intensive care unit (ICU). The combination of high-flow nasal oxygen with noninvasive ventilation (NIV) may be an optimal strategy of ventilation to avoid reintubation.

OBJECTIVE To determine whether high-flow nasal oxygen with prophylactic NIV applied immediately after extubation could reduce the rate of reintubation, compared with high-flow nasal oxygen alone, in patients at high risk of extubation failure in the ICU.

DESIGN, SETTING, AND PARTICIPANTS Multicenter randomized clinical trial conducted from April 2017 to January 2018 among 641 patients at high risk of extubation failure (ie, older than 65 years or with an underlying cardiac or respiratory disease) at 30 ICUs in France; follow-up was until April 2018.

INTERVENTIONS Patients were randomly assigned to high-flow nasal oxygen alone (n = 306) or high-flow nasal oxygen with NIV (n = 342) immediately after extubation.

MAIN OUTCOMES AND MEASURES The primary outcome was the proportion of patients reintubated at day 7; secondary outcomes included postextubation respiratory failure at day 7, reintubation rates up until ICU discharge, and ICU mortality.

RESULTS Among 648 patients who were randomized (mean [SD] age, 70 [10] years; 219 women [34%]), 641 patients completed the trial. The reintubation rate at day 7 was 11.8% (95% CI, 8.4%-15.2%) (40/339) with high-flow nasal oxygen and NIV and 18.2% (95% CI, 13.9%-22.6%) (55/302) with high-flow nasal oxygen alone (difference, −6.4% [95% CI, −12.0% to −0.9%]; $P = .02$). Among the 11 prespecified secondary outcomes, 6 showed no significant difference. The proportion of patients with postextubation respiratory failure at day 7 (21% vs 29%; difference, −8.7% [95% CI, −15.2% to −1.8%]; $P = .01$) and reintubation rates up until ICU discharge (12% vs 20%, difference −7.4% [95% CI, −13.2% to −1.8%]; $P = .009$) were significantly lower with high-flow nasal oxygen and NIV than with high-flow nasal oxygen alone. ICU mortality rates were not significantly different: 6% with high-flow nasal oxygen and NIV and 9% with high-flow nasal oxygen alone (difference, −2.4% [95% CI, −6.7% to 1.7%]; $P = .25$).

CONCLUSIONS AND RELEVANCE In mechanically ventilated patients at high risk of extubation failure, the use of high-flow nasal oxygen with NIV immediately after extubation significantly decreased the risk of reintubation compared with high-flow nasal oxygen alone.

TRIAL REGISTRATION ClinicalTrials.gov Identifier: NCT03121482

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Editorial

Supplemental content

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Group Information: The HIGH-WEAN Study Group and REVA Research Network members are listed at the end of the article.

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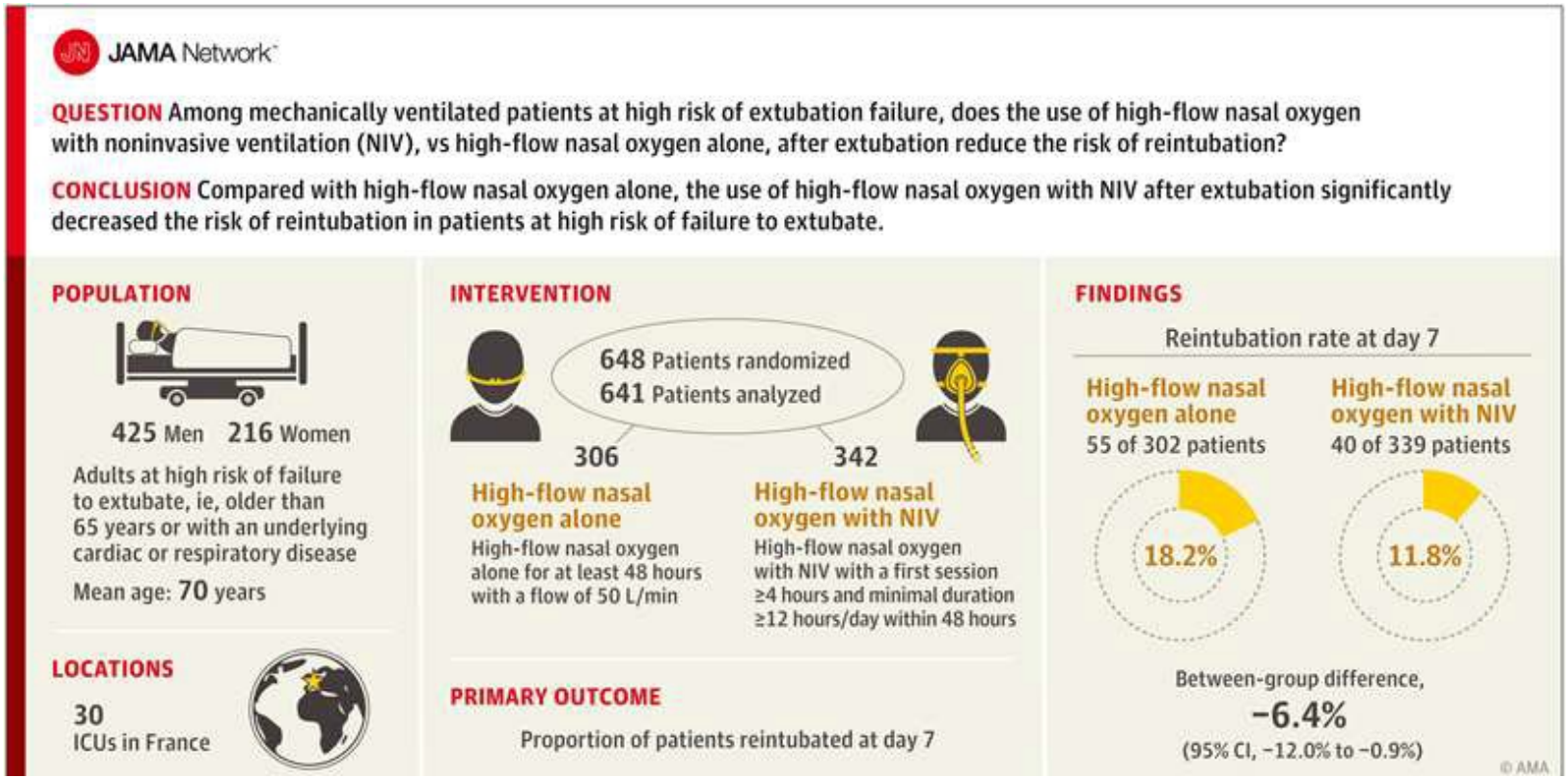
Section Editor: Derek C. Angus, MD, MPH, Associate Editor, JAMA (angusdc@upmc.edu).

11. Thille AW, et al. Effect of Postextubation High-Flow Nasal Oxygen With Noninvasive Ventilation vs High-Flow Nasal Oxygen Alone on Reintubation Among Patients at High Risk of Extubation Failure: A Randomized Clinical Trial. JAMA. 2019 Oct 2;322(15):1465-1475.

Benefits of Complementary Use

Postextubation Failure



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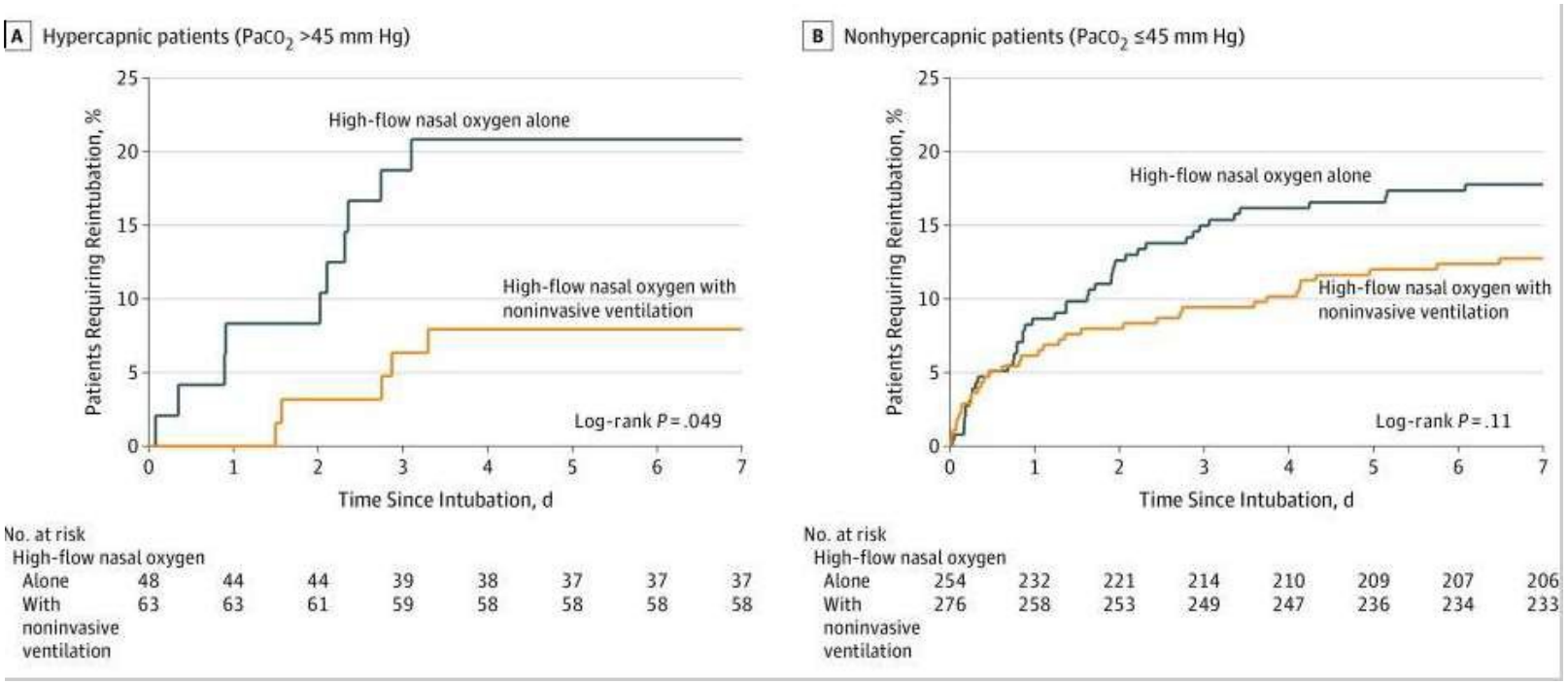
Benefits of complementary use

Postextubation Failure



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Check Point

True or False?

In the post-extubation failure study, patients treated with both NIV and HFT had better outcomes than those treated with HFT only.

A. True
B. False

Check Point

True or False?

In the post-extubation failure study, patients treated with both NIV and HFT had better outcomes than those treated with HFT only.

A. True

B. False

Benefits of two device options

Benefits of two devices options

Alternating

- Rotation technique, de-escalating care from NIV to High Flow Therapy
- Escalating care from High Flow Therapy to NIV

From NIV to HFT

- Weaning from NIV
- Intermittent rotation to allow patient to eat or drink
- Interface rotation strategy to help minimize skin breakdown

From HFT to NIV

- Delay in escalation of care
- Readily provide nocturnal support

Challenges

Challenges of two devices in the same room

Space

- One of the main challenges of a second device in the room is it takes up valuable space and may also pose as a tripping and cord hazard.

Financial cost

- Clinicians often find themselves using two different circuits, which may pose a financial cost to the institution.

Tie up devices

- Two devices in one room may also tie up the other device that is currently not being used; thus preventing that device from being used on a different patient who may need it.

Leaving the patient's bedside to locate and find the second device

Highlights

- Increased utilization of HFT
- Steady and necessary utilization of NIV

HFT is a form of oxygenation therapy used to treat acute hypoxemic respiratory failure. Its use should not be recommended as a substitute for NIV in cases where NIV is strongly recommended (acute exacerbation of COPD, CHF.)

NIV is the standard of care for decreasing morbidity and mortality in patients hospitalized with an exacerbation of COPD and acute hypercapnic respiratory failure.

Distinct and complementary

References

1. Hardavella G, et al. Oxygen devices and delivery systems. Breathe. 2019; 15:e108-e116
2. Sharma S, Danckers M, Sanghavi D, et al. High Flow Nasal Cannula. StatPearls. [Updated 2020 Feb 25]; https://www.ncbi.nlm.nih.gov/books/NBK526071/
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