Thông khí không xâm lấn
(NonInvasive Ventilation – NIV)
và
Oxy lưu lượng cao
(High Flow Nasal Cannula Oxygenation – HFNC)

BS Nguyễn Bá Duy
Khoa HSCC – BV Chợ Rẫy

Nội dung trình bày

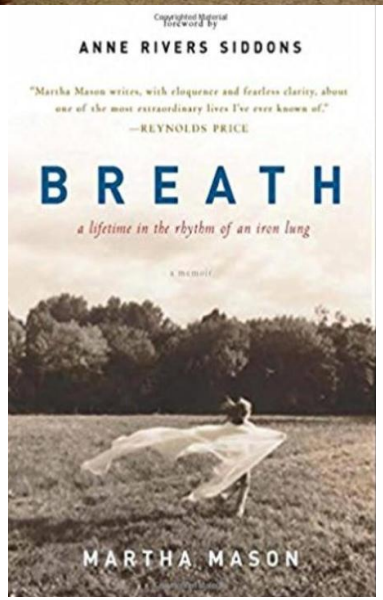
1. Tổng quan về NIV
2. Chỉ định và chống chỉ định
3. Các khía cạnh lâm sàng
4. HFNC: từ sinh lý đến bằng chứng
5. So sánh NIV vs. HFNC

Tổng quan về NIV

- Định nghĩa: Thông khí không xâm lấn (NIV) cung cấp thông khí cơ học (mechanical ventilation) đến phổi mà không yêu cầu việc sử dụng các đường thở xâm lấn nhân tạo (ống nội khí quản, mở khí quản).
- Mục đích của NIV:
  1. Cải thiện tình trạng thông khí và trao đổi khí tại phế nang
  2. Cung cấp thời gian để điều trị nguyên nhân suy hô hấp cấp
  3. Giảm công thở, quá tải cho cơ hô hấp
  4. Giảm PEEP nội sinh (auto-PEEP)
  5. Giảm triệu trứng khó thở, lo lắng..
  6. Tránh đặt nội khí quản và các biến chứng liên quan

Tổng quan về NIV: 2 loại NIV

NIV áp lực âm: “iron lung”



NIV áp lực dương

Tổng quan về NIV

Ưu điểm của NIV: không xâm lấn

- Dễ dàng, nhanh chóng cài đặt ban đầu và cai máy
- Cho phép thông khí ngắt quãng: nhu cầu cảu BN
- Cải thiện sự dễ chịu, hợp tác
- Giảm nhu cầu an thần
- Chức năng nói, ăn uống, ho khạc đàm được bảo tồn
- Tránh những biến chứng liên quan ống nội khí quản: biến chứng sớm và muộn
- Giảm biến chứng nhiễm trùng: VAP, nhiễm trùng huyết, khả năng kháng thuốc
- Giảm chi phí

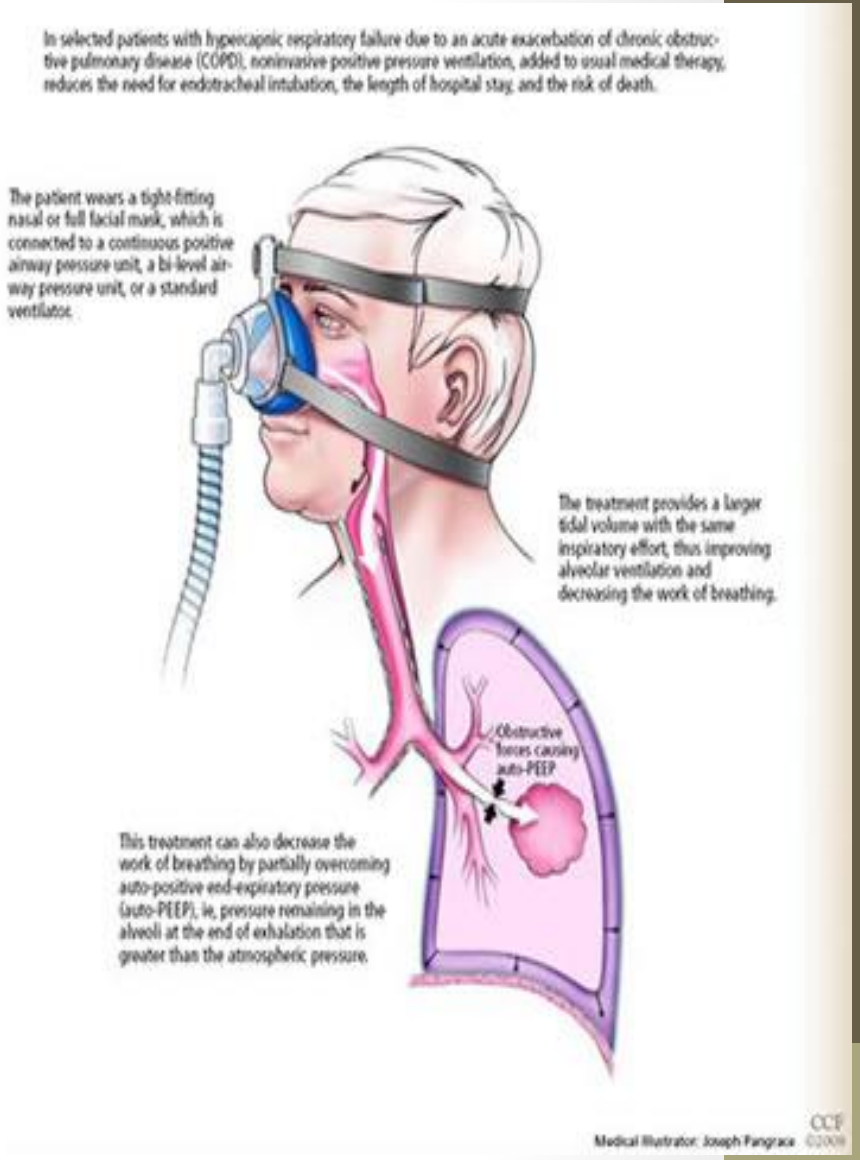
Tổng quan về NIV

Khuyết điểm của NIV:

- Hệ thống:
  - Có những trường hợp chống chỉ định tuyệt đối
  - Cải thiện chậm những bất thường trao đổi khí
  - Cần theo dõi sát đáp ứng ban đầu
  - Ứ hơi dạ dày, nôn ói và viêm phổi hít (< 2%)
- Liên quan mặt nạ:
  - Dò rỉ khí: BN không dung nạp
  - Cảm giác ngộp ngạt
  - Hoại tử, loét da mặt: biến chứng hay gặp nhất
  - Kích thích giác mạc
- Thiếu khả năng tiếp cận và bảo vệ đường thở: hút đàm, nội soi phế quản..

Cở sở sinh lý: NIV

Giảm công hô hấp
Tránh hiện thượng yếu, kiệt sức cơ hô hấp
Gia tăng thể thích khí lưu thông (VT)
Cải thiện khả năng trao đổi khí tại phế năng
CPAP hay ePAP giảm PEEP nội sinh
Cải thiện compliance của hệ hô hấp: mở một số phế nang xẹp, giảm shunt, huy động phế nang
Tăng dung tích cặn chức năng (FRC)
Tăng cường chức năng tim mạch: giảm hậu tải



Cở sở sinh lý: NIV

The Physiologic Effects of Noninvasive Ventilation

Richard H Kallet MSc RRT FAARC and Janet V Diaz MD

Table 4. Summary Findings on the Physiologic Effects of Noninvasive Ventilation

Category	Major Experimental Findings on NIV
Work of breathing	Uniformly decreased inspiratory effort and WOB in patients with diverse etiologies and severity of pulmonary disease. Near-uniform decrease in dyspnea scores At maximum inspiratory support (15 cm H_2O), WOB and patient effort were reduced approximately 60%. Decreased mean diaphragmatic electromyogram 17%–93%. No difference in effectiveness between proportional-assist ventilation and pressure-support ventilation Some studies found improved endurance, inspiratory muscle strength, and spirometry after NIV. NIV settings that minimize WOB and patient effort are not necessarily the settings that maximize patient comfort.
Breathing pattern	Maximal inspiratory support that minimized inspiratory work load increased mean V_T 47%. Respiratory-frequency response to maximal NIV support differed in patients with COPD. Respiratory frequency typically decreased in patients with acute cardiogenic pulmonary edema.
Respiratory-system mechanics	NIV generally increased dynamic lung compliance 17%–50% in patients with COPD, morbid obesity, or restrictive chest-wall disease. During NIV, applied PEEP of 5 cm H_2O decreased dynamic intrinsic PEEP in patients with COPD. High (15 cm H_2O) inspiratory support without applied PEEP tends to increase inspiratory dynamic intrinsic PEEP in patients with COPD.
Cardiovascular function	In healthy subjects, nasal CPAP of $\geq$ 15 cm H_2O decreased cardiac output 20%–30%. In patients with stable COPD, high (10–20 cm H_2O) pressure-support with low (3–5 cm H_2O) PEEP decreased cardiac output approximately 20%. In patients with ALI those NIV levels had negligible effects on cardiac output. In patients with congestive heart failure, NIV often increased cardiac output by decreasing inspiratory effort and left-ventricular afterload.
Pulmonary gas-exchange function	At settings that minimized WOB, NIV typically increased pH an average 0.06, increased P_{aO_2} 8 mm Hg, and decreased P_{aCO_2} 9 mm Hg. NIV typically increased P_{aO_2} in patients with acute cardiogenic pulmonary edema, but only decreased P_{aCO_2} in the subgroup of patients with hypercapnia.

Respir Care 2009;54(1): 102–114.

Chống chỉ định của NIV

- Ngưng hô hấp – tuần hoàn
- Huyết động không ổn định
- Suy đa cơ quan
- Thay đổi tri giác
- BN không hợp tác
- Encephalopathy (GCS < 10)
- Động kinh
- Không có khả năng bảo về đường thở, tăng tiết đàm
- Chấn thương: mặt, phù nề đường thở, sau PT đường thở trên, biến dạng mặt
- Xuất huyết tiêu hóa, sau PT đường tiêu hóa
- Khối u vùng đầu, mặt, chèn ép đường thở
- Tắc nghèn đường thở do dị vật
- PT thần kinh gần đây
- Tràn khí màng phổi (chưa kiểm soát)

Chống chỉ định của NIV

BOX 19-3 Exclusion Criteria for NIV

1. Respiratory arrest or the need for immediate intubation
2. Hemodynamic instability
3. Inability to protect the airway (impaired cough or swallowing)
4. Excessive secretions
5. Agitated and confused patients
6. Facial deformities or conditions that prevent mask from fitting
7. Uncooperative or unmotivated patients
8. Brain injury with unstable respiratory drive

Chỉ định NIV

Outcomes of Noninvasive Ventilation for Acute Exacerbations of Chronic Obstructive Pulmonary Disease in the United States, 1998–2008

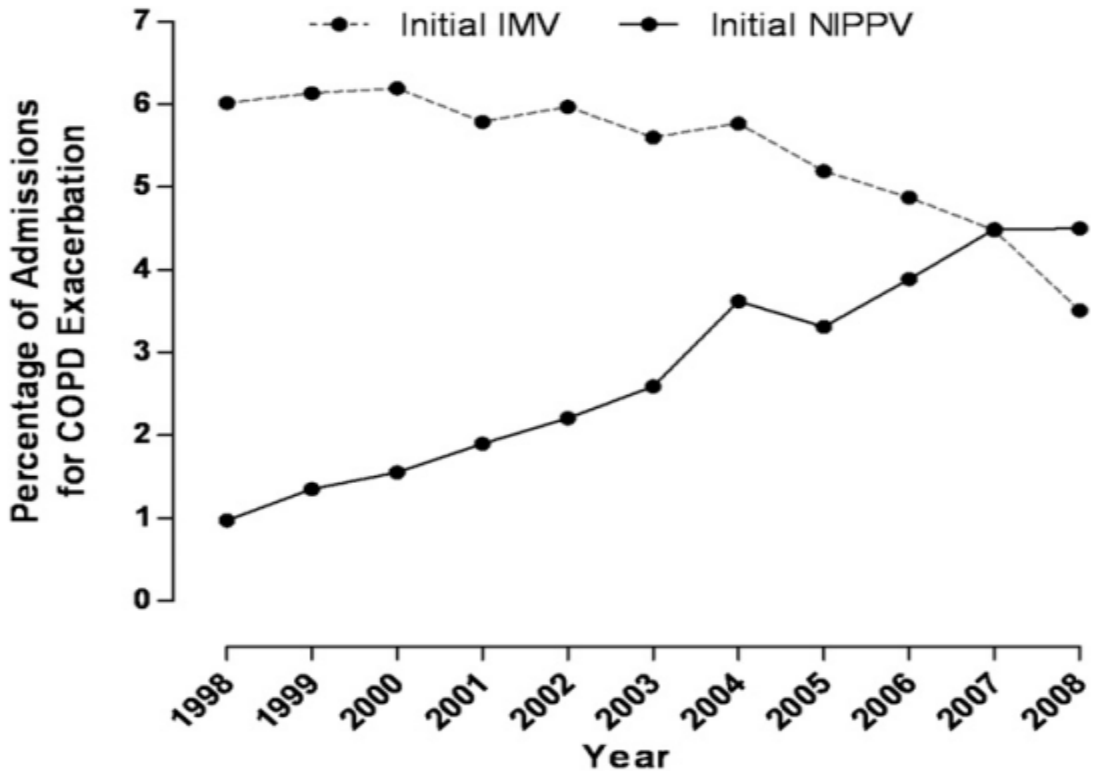


Figure 1. Temporal trends in the use of noninvasive positive pressure ventilation (NIPPV) and invasive mechanical ventilation (IMV) as the initial form of respiratory support in patients hospitalized with acute exacerbations of chronic obstructive pulmonary disease (COPD) in the United States, 1998–2008.

Am J Respir Crit Care Med Vol 185, Iss. 2, pp 152–159, Jan 15, 2012

Chỉ định NIV

Outcomes of Noninvasive Ventilation for Acute Exacerbations of Chronic Obstructive Pulmonary Disease in the United States, 1998–2008

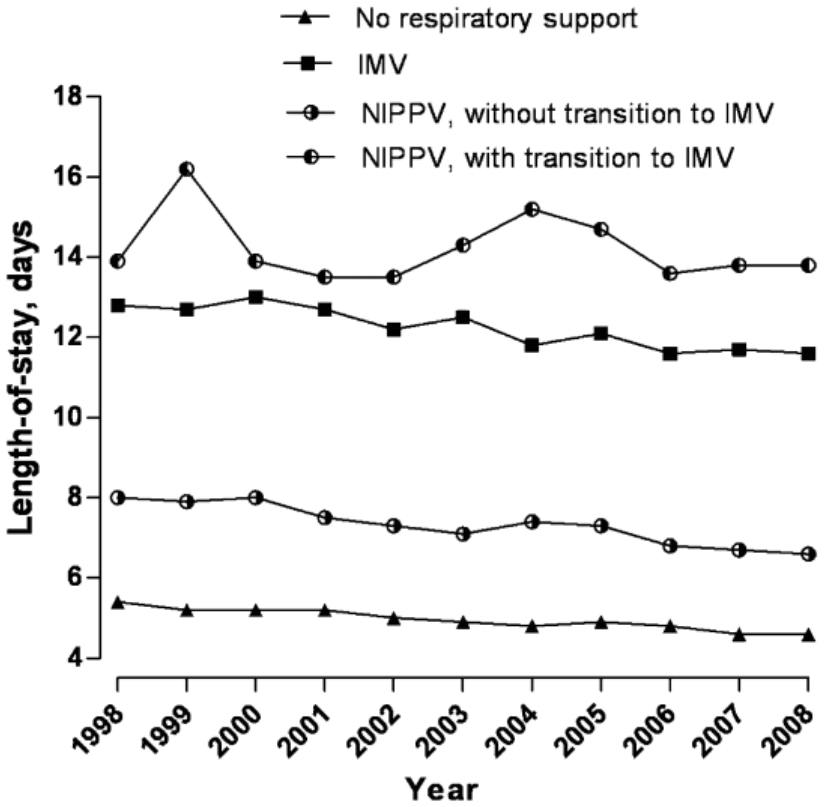


Figure 8. Length-of-stay in days for patients admitted with acute exacerbations of chronic obstructive pulmonary disease grouped by type or respiratory support used during the hospitalization, 1998–2008. IMV = invasive mechanical ventilation; NIPPV = noninvasive positive pressure ventilation.

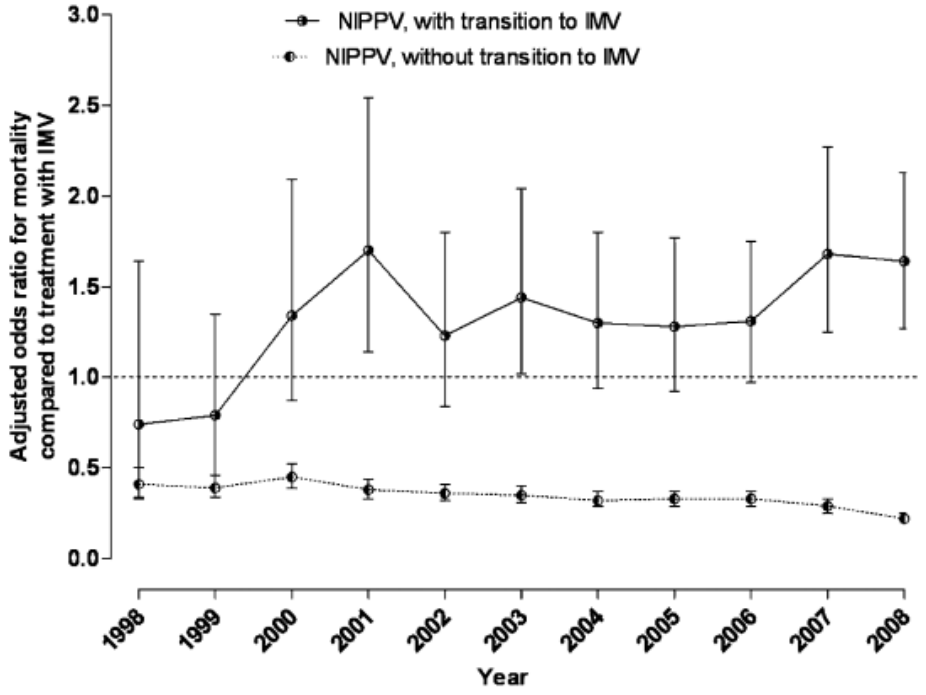


Figure 6. Multivariable analysis of in-hospital mortality compared with primary invasive mechanical ventilation (IMV) among patients treated with noninvasive positive pressure ventilation (NIPPV) with and without subsequent transition to IMV for acute exacerbation of chronic obstructive pulmonary disease, 1998–2008. Multivariate analyses are adjusted for sex, age group, income, payor, hospital region, hospital location and teaching status, and the presence of each comorbidity listed in Table 1.

Chỉ định NIV

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

BTS/ICS Guidelines for the Ventilatory Management of Acute Hypercapnic Respiratory Failure in Adults

British Thoracic Society/Intensive Care Society Acute Hypercapnic Respiratory Failure Guideline Development Group

IC Manual
best practice guidelines for intensive care

Non-invasive Ventilation Guidelines for Adult Patients with Acute Respiratory Failure

British Thoracic Society Quality Standards for acute non-invasive ventilation in adults

Chỉ định NIV

Patient Selection

- **COPD Exacerbation**
- **Cardiogenic Pulmonary Edema**
- **Post-Extubation**
- **Immunocompromised Patients**
- **ARDS**
- **Acute Asthma**
- **Community-Acquired Pneumonia**
- **Do Not Intubate or Do Not Resuscitate**
- **Pre-oxygenation Before Intubation**
- **Post-Operative Respiratory Failure**
- **Obesity Hypoventilation Syndrome**
- **Bronchoscopy**

Đợt cấp COPD

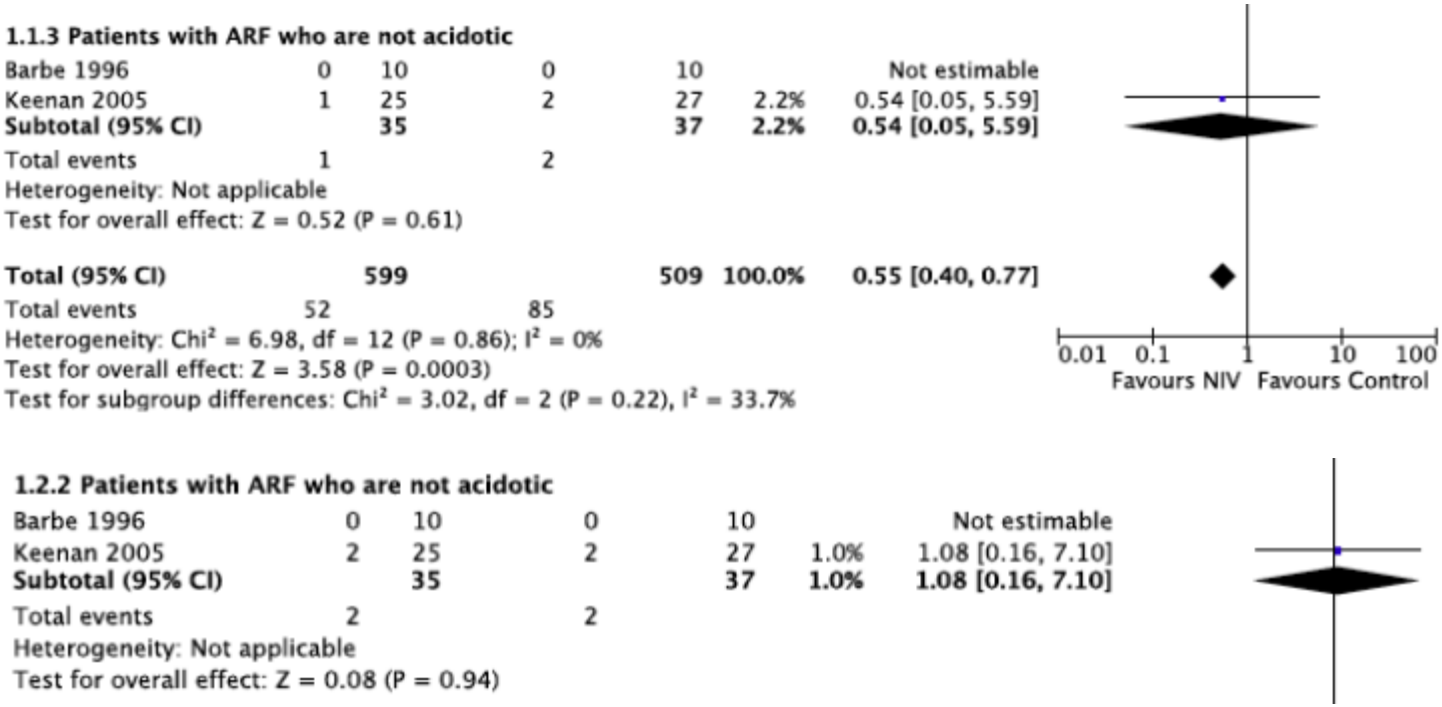
Vai trò của NIV trong đợt cấp COPD: 3 trường hợp

1. Ngăn chặn diễn tiến toan hô hấp cấp: $PaCO_2$ có thể bình thường hoặc tăng nhưng pH ở ngưỡng bình thường.
2. Giảm nguy cơ đặt nội khí quản ở BN suy hô hấp có toan hô hấp mực độ nhẹ đến trung bình.
3. Điều trị thay thế cho thông khí xấm lấn ở BN toan hô hấp nặng.

Đợt cấp COPD

1a. Should NIV be used in ARF due to a COPD exacerbation to prevent the development of respiratory acidosis ?

Mortality



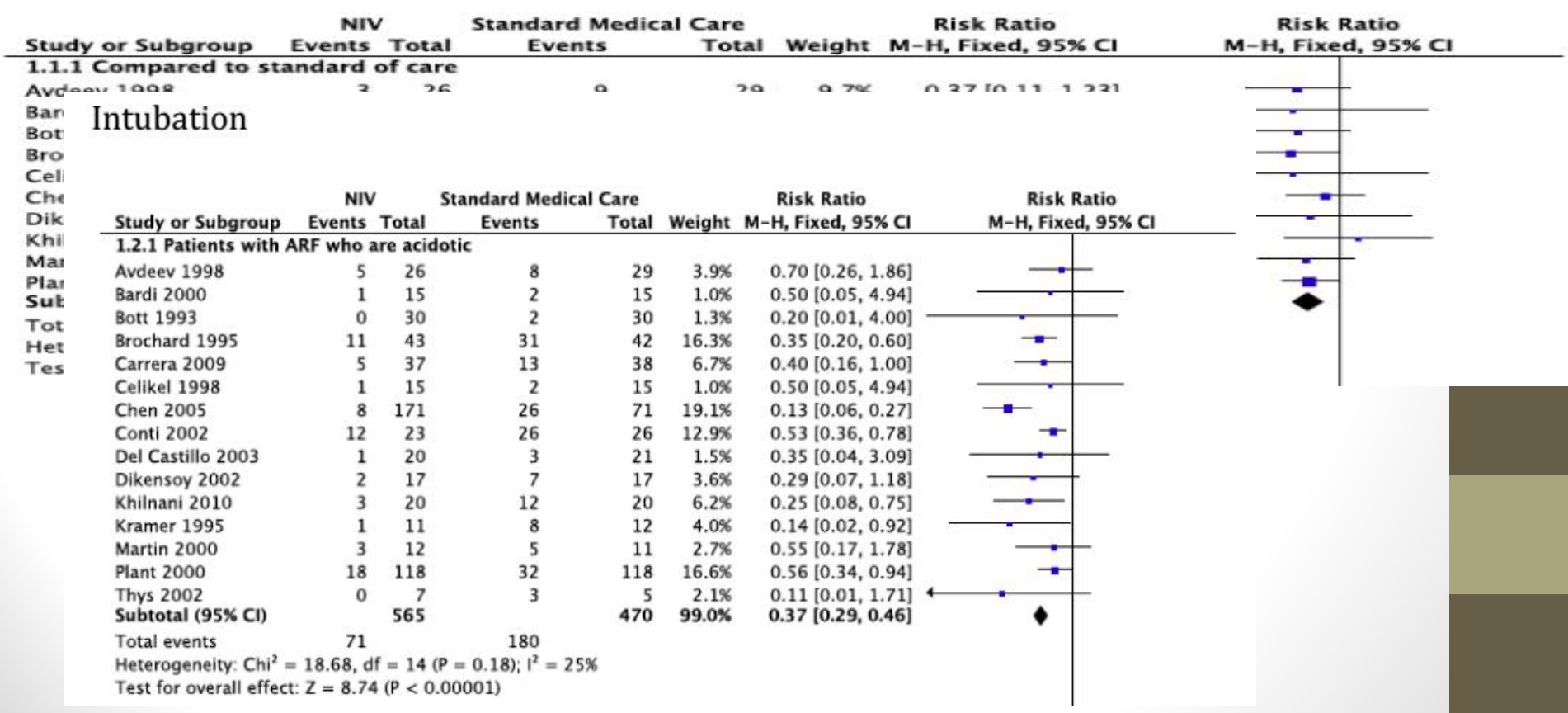
Recommendation

We suggest NIV not be used in patients with hypercapnia who are not acidotic in the setting of a COPD exacerbation. (Conditional recommendation, low certainty of evidence.)

Đợt cấp COPD

Question 1b: Should NIV be used in established acute hypercapnic respiratory failure due to a COPD exacerbation ?

- NIV giảm tỷ lệ đặt NKQ, giảm tỷ lệ tử vong
- NIV như biện pháp điều trị đầu tay thay thế thông khí xấm lấn



Đợt cấp COPD

NIV giảm tỷ lệ đặt NKQ:

→ NNT (number needed to treat) 4

NIV giảm tỷ lệ tử vong:

→ NNT: 10

Recommendations

We recommend bilevel NIV for patients with ARF leading to acute or acute-on-chronic respiratory acidosis (pH ⩽7.35) due to COPD exacerbation. (Strong recommendation, high certainty of evidence.)

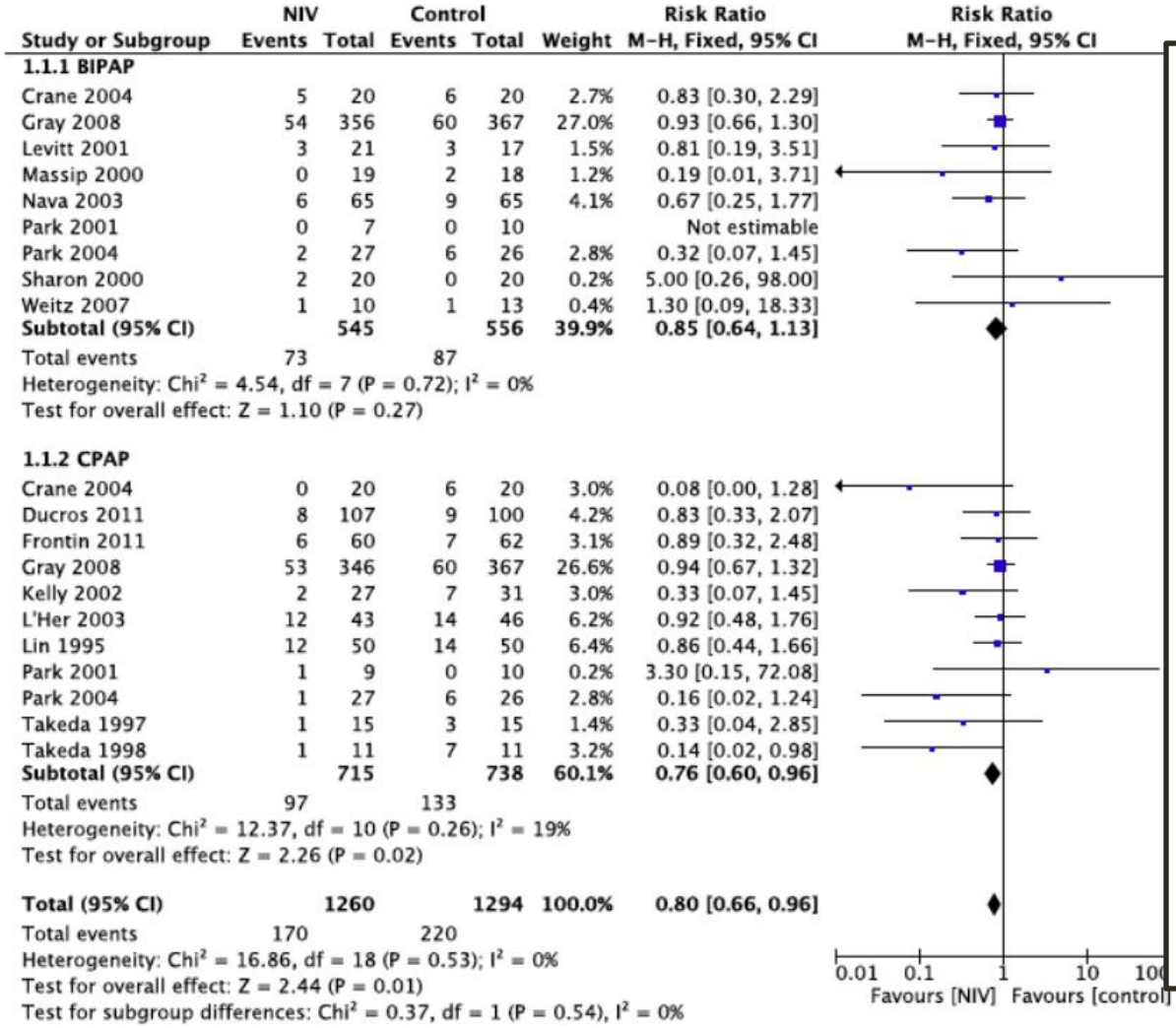
We recommend a trial of bilevel NIV in patients considered to require endotracheal intubation and mechanical ventilation, unless the patient is immediately deteriorating. (Strong recommendation, moderate certainty of evidence.)

Implementation considerations

1) Bilevel NIV should be considered when the pH is ⩽7.35, P_aCO_2 is >45 mmHg and the respiratory rate is >20–24 breaths·min^{-1} despite standard medical therapy.
2) 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.

Phù phổi cấp do tim

Mortality



- NIV giảm tỷ lệ tử vong: RR 0.8; (5% CI 0.66 – 0.96
→ NNT 13
- NIV giảm tỷ lệ đặt NKQ: RR 0.6 95% CI 0.44 – 0.80
→ NNT 8
- Không có sự khác biệt về hiệu quả điều trị giữa Bilevel NIV và CPAP

Phù phổi cấp do tim

Recommendation

We recommend either bilevel NIV or CPAP for patients with ARF due to cardiogenic pulmonary oedema. (Strong recommendation, moderate certainty of evidence.)

Recommendation

We suggest that CPAP or bilevel NIV be used for patients with ARF due to cardiogenic pulmonary oedema in the pre-hospital setting. (Conditional recommendation, low certainty of evidence.)

Chỉ định NIV: sau rút NKQ

The Role of Noninvasive Ventilation in the Ventilator Discontinuation Process

Dean R Hess PhD RRT FAARC

In recent years, there has been increasing interest in the use of noninvasive ventilation (NIV) in the post-extubation period to shorten the length of invasive ventilation, to prevent extubation failure, and to rescue a failed extubation. The purpose of this review is to summarize the evidence related to the use of NIV in these settings. NIV can be used to allow earlier extubation in selected patients who do not successfully complete a spontaneous breathing trial (SBT). Its use in this setting should be restricted to patients who are intubated during an exacerbation of COPD or patients with neuromuscular disease. This category of patients should be good candidates for NIV and should be extubated directly to NIV. In patients who successfully complete an SBT, but are at risk for extubation failure, NIV can be used to prevent extubation failure. These patients should also be good candidates for NIV and should be extubated directly to NIV. NIV should be used cautiously in patients who successfully complete an SBT, but develop respiratory failure within 48 hours post-extubation. In this setting, NIV is indicated only in patients with hypercapnic respiratory failure. Reintubation should not be delayed if NIV is not immediately successful in reversing the post-extubation respiratory failure. Evidence does not support routine use of NIV post-extubation.
Key words: COPD, extubation, mechanical ventilation, noninvasive ventilation, spontaneous breathing trail, weaning. [Respir Care 2012;57(10):1619–1625.

Chỉ định NIV: sau rút NKQ

Question 10: Should NIV be used in ARF following extubation from invasive mechanical ventilation?

Recommendations

We suggest that NIV be used to prevent post-extubation respiratory failure in high-risk patients post-extubation. (Conditional recommendation, low certainty of evidence.)

We suggest that NIV should not be used to prevent post-extubation respiratory failure in non-high-risk patients. (Conditional recommendation, very low certainty of evidence.)

Question 10b: Should NIV be used in the treatment of respiratory failure that develops post-extubation?

Recommendation

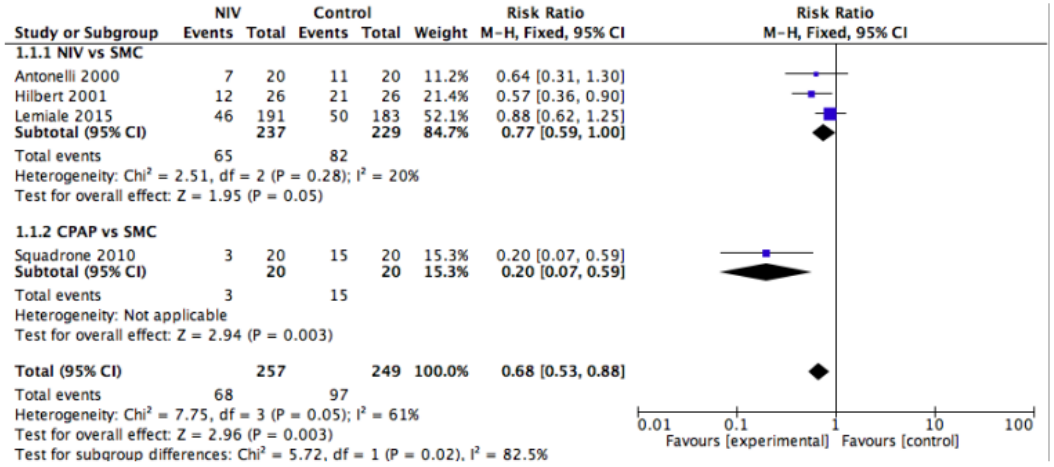
We suggest that NIV should not be used in the treatment of patients with established post-extubation respiratory failure. (Conditional recommendation, low certainty of evidence.)

BN suy giảm miễn dịch

Question : Should NIV be used for ARF in immunocompromised patients?

Question #4: Should NIV be used in acute respiratory failure in immunecompromised patients?

Mortality



Recommendation
We suggest early NIV for immunocompromised patients with ARF. (Conditional recommendation, moderate certainty of evidence.)

Justification

See forest plots and the evidence profile in the supplementary material for further details regarding included evidence. Pooled analysis demonstrated that NIV use led to a decrease in mortality (RR 0.68, 95% CI 0.53–0.88; moderate certainty), the need for intubation (RR 0.71, 95% CI 0.58–0.87; moderate certainty) and the rates of nosocomial pneumonia (RR 0.39, 95% CI 0.20–0.76; low certainty) in this population. Based on this evidence review, the anticipated desirable effects of NIV in immunocompromised patients with ARF outweigh undesirable consequences in most settings. The

ARDS

- Chỉ định NIV trên BN ARDS còn bàn cãi, thiếu bằng chứng lâm sàng.
- Nhóm đối tượng trong nghiên cứu NIV: BN ARDS mức độ nhẹ và không có chỉ định đặt NKQ

→Bằng chứng hiện tại: thận trọng khi sử dụng NIV trên BN chẩn đoán ARDS

- Rana et al: yếu tố tiên lượng thất bại với NIV
  - Tất cả BN có sốc đều thất bại với NIV
  - Toan chuyển hóa (OR 1.27, 95% CI 1.03 – 1.07) cho mỗi đơn vị BE
  - Giảm oxy máu nặng (OR 1.03, 95% CI 1.01 – 1.05) cho mỗi đơn vị giảm P/F

Failure of non-invasive ventilation in patients with acute lung injury: observational cohort study. Crit Care 2006;10(3):R79

ARDS

Noninvasive Ventilation for Patients With Acute Lung Injury or Acute Respiratory Distress Syndrome

Stefano Nava MD, Ania Schreiber MD, and Guido Domenighetti MD

Few studies have been performed on noninvasive ventilation (NIV) to treat hypoxic acute respiratory failure in patients with acute lung injury (ALI) or acute respiratory distress syndrome (ARDS). The outcomes of these patients, for whom endotracheal intubation is not mandatory, depend on the degree of hypoxia, the presence of comorbidities and complications, and their illness severity. The use of NIV as an alternative to invasive ventilation in severely hypoxemic patients with ARDS (ie, $P_{aO_2}/F_{IO_2} < 200$) is not generally advisable and should be limited to hemodynamically stable patients who can be closely monitored in an intensive care unit by highly skilled staff. Early NIV application may be extremely helpful in immunocompromised patients with pulmonary infiltrates, in whom intubation dramatically increases the risk of infection, pneumonia, and death. The use of NIV in patients with severe acute respiratory syndrome and other airborne diseases has generated debate, despite encouraging clinical results, mainly because of safety issues. Overall, the high rate of NIV failure suggests a cautious approach to NIV use in patients with ALI/ARDS, including early initiation, intensive monitoring, and prompt intubation if signs of NIV failure emerge. *Key words:*

Respiratory Care 2011 Oct 1; 56(10): 1583-8

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

TABLE 2 Recommendations for actionable PICO questions

Clinical indication[#]	Certainty of evidence[¶]	Recommendation
Prevention of hypercapnia in COPD exacerbation	⊕⊕	Conditional recommendation against
Hypercapnia with COPD exacerbation	⊕⊕⊕⊕	Strong recommendation for
Cardiogenic pulmonary oedema	⊕⊕⊕	Strong recommendation for
Acute asthma exacerbation		No recommendation made
Immunocompromised	⊕⊕⊕	Conditional recommendation for
***De novo* respiratory failure**		No recommendation made
Post-operative patients	⊕⊕⊕	Conditional recommendation for
Palliative care	⊕⊕⊕	Conditional recommendation for
Trauma	⊕⊕⊕	Conditional recommendation for
Pandemic viral illness		No recommendation made
Post-extubation in high-risk patients (prophylaxis)	⊕⊕	Conditional recommendation for
Post-extubation respiratory failure	⊕⊕	Conditional recommendation against
Weaning in hypercapnic patients	⊕⊕⊕	Conditional recommendation for

[#]: all in the setting of acute respiratory failure; [¶]: certainty of effect estimates: ⊕⊕⊕⊕, high; ⊕⊕⊕, moderate; ⊕⊕, low; ⊕, very low.

NIV: các khía cạnh lâm sàng

- Lựa chọn BN, cài đặt ban đầu
- Theo dõi đáp ứng điều trị
- Thất bại với NIV, chỉ định đặt NKQ
- Protocol thoe dõi, hướng dẫn điều trị
- Vấn đề an thần
- Các khía cạnh kỹ thuật: mặt nạ, làm ẩm, máy thở…

Lựa chọn BN: khi nào bắt đầu NIV ?

Table 11-2 Selection of appropriate patients for noninvasive ventilation

- **Step 1: Patient needs mechanical ventilation**
  - Respiratory distress with dyspnea, use of accessory muscles, abdominal paradox
  - Respiratory acidosis; pH < 7.35 with $Paco_2$ > 45 mm Hg
  - Tachypnea; respiratory rate > 25 breaths/min
  - Diagnosis that responds well to NIV (eg, COPD exacerbation, cardiogenic pulmonary edema)
- **Step 2: No exclusions for NIV**
  - Airway protection: respiratory arrest, unstable hemodynamics, aspiration risk, copious secretions
  - Unable to fit mask: facial surgery, craniofacial trauma or burns, anatomic lesion of upper airway
  - Uncooperative patient; anxiety
  - Patient wishes

Abbreviations: COPD, chronic obstructive pulmonary disease; NIV, noninvasive ventilation.

Cài đặt ban đầu

- BN nên được theo dõi ở khoa/phòng thích hợp
- Nằm đầu cao 30^o
- Nên sử dụng Oronasal mask hoặc full-face mask
- Khuyến khích BN giữ mask
- Kiểm tra dò rỉ khí: điều chỉnh dây dai khi cần (tránh siết quá chặt)
- Mode BiPAP: cài đặt ban đầu IPAP 10 cm H2O và EPAP 4-5 cm H2O
- IPAP nên gia tăng 2 -5 cmH2O mỗi 10 phút, mục tiêu IPAP thông thường là 20 cm H2O: cho đến khi đạt được đáp ứng điều trị và BN dung nạp
- Điều chỉnh FiO2 (qua bộ trộn hoặc lưu lượng Oxy) → SpO2 > 88-92%

→ BN cảm thấy dễ chịu và dung nạp với NIV là yếu tố tiên lượng thành công.

Cài đặt ban đầu ?

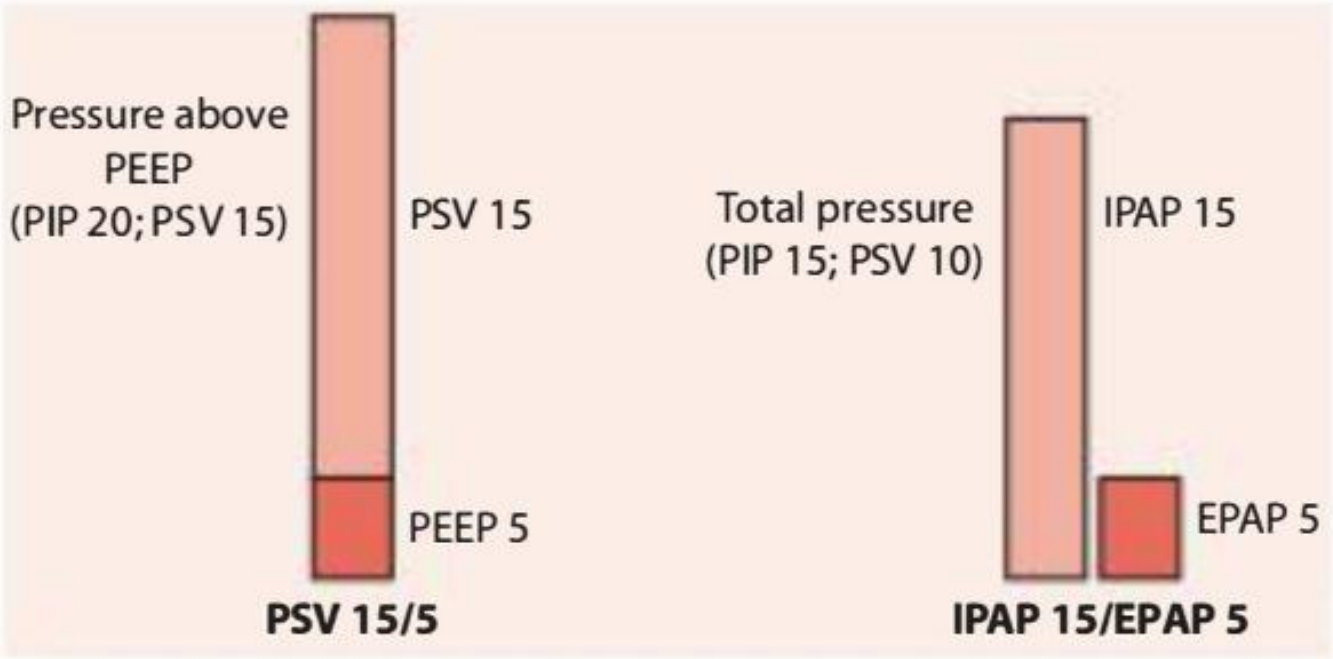


Figure 11-2 Comparison of pressure support with a critical care ventilator and inspiratory positive airway pressure (IPAP) with a bilevel ventilator. Note that the IPAP is the peak inspiratory pressure (PIP) and includes the expiratory positive airway pressure (EPAP), whereas pressure support is provided on top of the positive end-expiratory pressure (PEEP); thus, PIP is the pressure support setting plus the PEEP setting.

Theo dõi đáp ứng với NIV : yếu tố tiên lượng thành công

BOX 19-5 Predictors of Success with NIV

- Higher level of consciousness
- Younger age
- Less severe illness; no comorbidities
- Less severe gas exchange abnormalities (pH 7.10 to 7.35; arterial partial pressure of carbon dioxide [P_aCO_2] <92 mm Hg)
- Minimal air leakage around the interface
- Intact dentition
- Synchronous breathing efforts with ventilator
- Lower quantity of secretions
- Absence of pneumonia
- Positive initial response to NIV within 1 to 2 hours
  - Correction of pH
  - Decreased respiratory rate
  - Reduced P_aCO_2

Theo dõi đáp ứng với NIV: yếu tố tiên lượng thất bại

Table 2. Risk Factors for Noninvasive Ventilation Failure

Acute hypercapnic respiratory failure
Poor neurologic score: Glasgow Coma Score < 11
Tachypnea: > 35 breaths/min
pH < 7.25
Acute Physiology and Chronic Health Evaluation score > 29
Asynchronous breathing
Edentulous
Excessive air leak
Agitation
Excessive secretions
Poor tolerance
Poor adherence to therapy
No initial improvement within first 2 h of noninvasive ventilation
No improvement in pH
Persistent tachypnea
Persistent hypercapnia
Acute hypoxemic respiratory failure
Diagnosis of ARDS or pneumonia
Age > 40 y
Hypotension: systolic blood pressure < 90 mm Hg
Metabolic acidosis: pH < 7.25
Low P_{aO_2}/F_{IO_2}
Simplified Acute Physiology Score II > 34
Failure to improve oxygenation within first hour of noninvasive ventilation: $P_{aO_2}/F_{IO_2} > 175$ mm Hg

Thất bại điều trị NV: chỉ định đặt NKQ

1. Toan hô hấp diễn tiến
2. Thở nhanh, co kéo > 30 lần/phút
3. Huyết động học không ổn định
4. SpO2 < 90% (với FiO2 > 60%)
5. Suy giảm mức độ tri giác (GCS < 10)
6. Không có khả năng bảo vệ đường thở
7. Không dụng nạp với mask hoặc với NIV
8. Ứ hơi trong dạ dày, liệt ruột, nôn ói dai dẳng → nguy cơ viêm phổi hít

Thất bại điều trị NV: chỉ định đặt NKQ

QUAN TRỌNG NHẤT

→ Quyết định thời điểm đặt nội khí quản khi thất bại điều trị với NIV

“**Decision making on when to switch to invasive mechanical ventilation in a setting of failure of NIV “**

Protocol theo dõi điều trị NIV

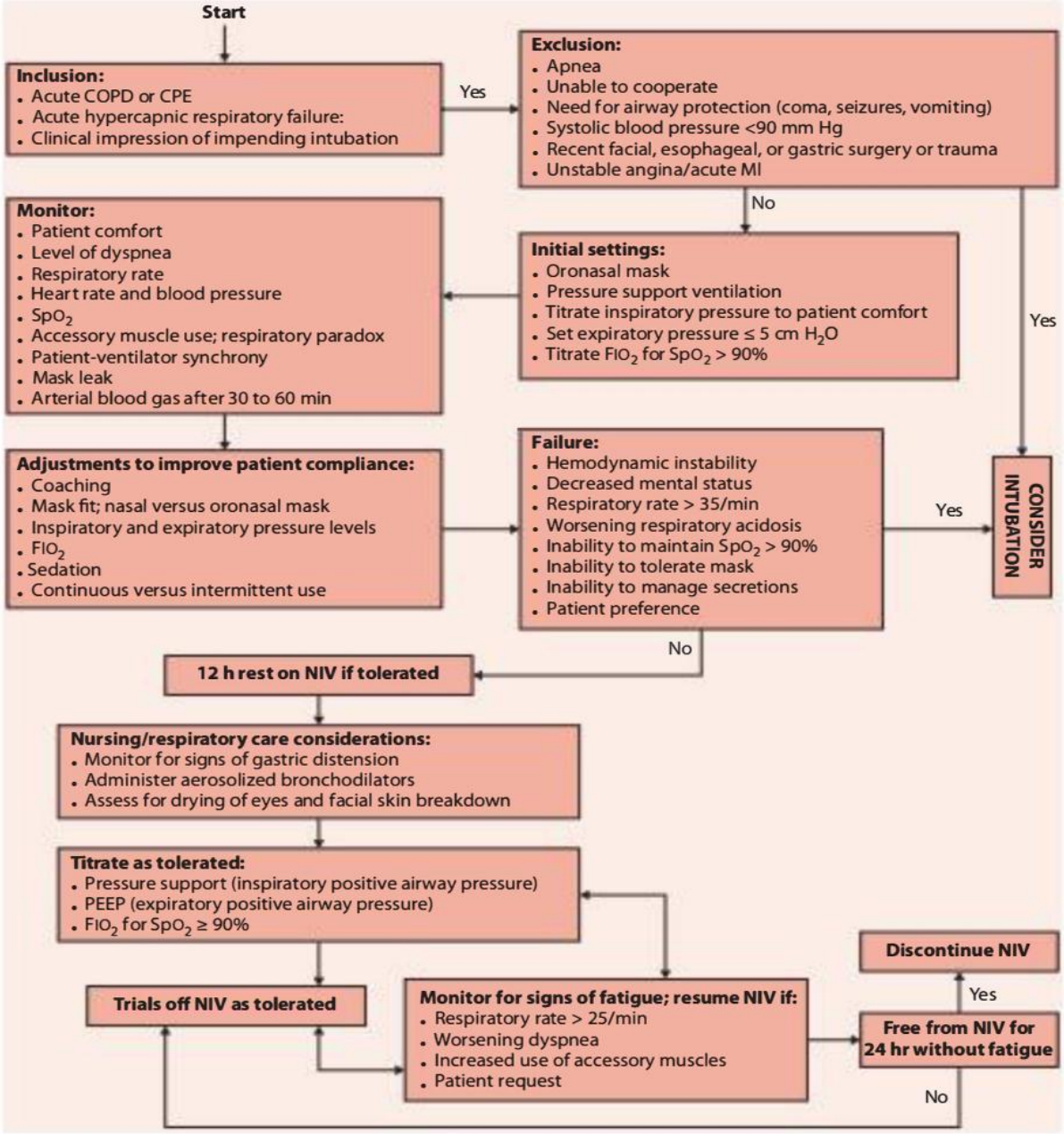


Figure 11-3 Algorithm for initiation of noninvasive ventilation for acute respiratory failure.

Khía cạnh kỹ thuật: mặt nạ NIV

Fig. 4. Interfaces for noninvasive ventilation. Top (left to right): nasal mask, nasal pillows, oronasal mask, hybrid mask. Bottom (left to right): oral mask, total face mask, helmet. (From Reference 115.)

Khía cạnh kỹ thuật: mặt nạ NIV

Table 3. Advantages and Disadvantages of Various Types of Interfaces for Noninvasive Ventilation

Interface	Advantages	Disadvantages
Nasal	Less risk for aspiration	Mouth leak
	Easier secretion clearance	Higher resistance through nasal passages
	Less claustrophobia	Less effective with nasal obstruction
	Easier speech	Nasal irritation and rhinorrhea
	Easy to fit and secure	Mouth dryness
Oronasal	Better mouth leak control	Increased aspiration risk
	More effective in mouth breathers	Difficulty speaking, eating, clearing secretions
		Asphyxiation with ventilator malfunction
Mouthpiece	Less interference with speech	Less effective for acute respiratory failure
	Little dead space	Requires nasal or oronasal interface when sleeping
	May not require headgear	Nasal leak
Total face mask	More comfortable for some patients	Cannot deliver aerosolized medications
	Easier to fit	
	Less facial skin breakdown	
Helmet	More comfortable for some patients	Rebreathing
	Easier to fit	Poor patient-ventilator synchrony
	Less facial skin breakdown	Hearing loss
		Less respiratory muscle unloading
		Cannot deliver aerosolized medications

Non-Invasive Ventilation for Adult Patients with Acute Respiratory Failure

IC Manual — best practice guidelines for intensive care

ACI — NSW Agency for Clinical Innovation

INDICATIONS & CONTRA-INDICATIONS

1 Prior to commencement of NIV patients are to be assessed for:

- capacity to protect own airway;
- level of consciousness (the exception being suitable "do not intubate" unconscious patients with hypercapnic COPD);
- anticipated level of compliance with interface;
- capacity to manage their respiratory secretions; and
- potential to recover to a quality of life acceptable to the patient.

Failure to meet any one of these criteria renders the patient ineligible for NIV and review of alternate care or escalation of therapy should be undertaken **Consensus**

INDICATIONS

- Severe (acute) exacerbation of COPD (pH<7.35 and relative hypercarbia)
- ACPO and ARF in the absence of shock or acute pulmonary syndrome requiring acute coronary revascularization
- Immunosuppressed patients with acute respiratory failure
- High risk recurrent acute respiratory failure after planned extubation (not indicated post extubation for low risk patients) .
- Weaning from mechanical ventilation, particularly in patients with a background of COPD.
- Acute respiratory failure post lung resection surgery or post abdominal surgery.
- Asthma
- Acute respiratory failure in selected 'not for intubation' patients
- Acute deterioration of disorders associated with sleep hypoventilation such as neuromuscular and chest wall restrictive disorders and obesity hypoventilation syndrome.
- Palliation for symptom relief, in combination with opioids and benzodiazepines to treat breathlessness. A medical team decision will be made when NIV is deemed no longer beneficial to the patient's management

CONTRAINDICATIONS

- Heliox therapy in combination with NIV for severe exacerbation of COPD
- Life threatening hypoxemia (PaO_2 <60mmHg on FiO_2 100%)
- CPAP in acute lung injury (ALI)
- Respiratory arrest
- Untreated pneumothorax
- Life threatening dysrhythmias
- Inability to protect own airway
- Copious, unmanageable respiratory secretions
- Facial burns/trauma/recent facial or upper airway surgery

Grading of Recommendations	
A	Body of evidence can be trusted to guide practice
B	Body of evidence can be trusted to guide practice in most situations
C	Body of evidence provides some support for recommendation/s but care should be taken in its application
D	Body of evidence is weak and recommendation must be applied with caution
CONSENSUS	Expert opinion where consensus was set as a median of ≥ 7 (Likert 1-9)

ASSESSMENT

2	All patients receiving NIV are to have a documented plan of care. This plan is to be developed on commencement of NIV, reviewed on a regular basis (minimum of every 24 hours and on change in patient condition) and updated as required. Where available this care plan is to be developed by a critical care or respiratory medical officer or designated clinically qualified respiratory proxy. **Consensus**
3	All patients receiving NIV are to have a formal assessment and documentation of full body skin integrity at least daily. This includes the skin under the interface: that is nose, face and neck. **Consensus**

OBSERVATIONS

Baseline

Respiratory	• ABGs, RR, SpO2, Evaluate level of breathlessness (e.g. Borg scale
Cardiac	• HR, BP, Rhythm monitoring
Neurological	• Level of consciousness
Patient Comfort	• Pain Score

NB consider other systems as pertains to patient co-morbidities

Ongoing

Repeat ABGs	• After 1 hour of therapy and 1 hour after every subsequent setting change • After 4 hours or earlier if patient is not clinically improving
Frequent clinical monitoring of acutely ill patients	• Every 15 minutes in the first hour • Every 30 minutes in the 1-4 hour period • Then hourly
Observations	• RR, continuous pulse oximetry, HR, BP, AVPU, • Pain Score • Patient Comfort, including interface skin integrity • Chest wall movement, ventilator synchrony, accessory muscle use

INTERFACE

4	Assessment of mask fit, interface type, head strap tightness, skin integrity of mask contact point, ventilation synchrony and degree of mask leak are to be completed each time the interface is adjusted and minimally second hourly. **Consensus**
5	Interventions to prevent pressure injury secondary to the interface are to be implemented on commencement of NIV. **Consensus**
6	When deterioration in skin integrity is identified, immediate strategies are to be employed to reduce further injury. **Consensus**

The guideline can be found at http://aci.health.nsw.gov.au/networks/intensive-care/ic-manual

Factors affecting Patient Comfort & Compliance

- Choice of suitable interface.
- Levels of pressure applied.
- Position of the patient.
- Synchrony of Ventilation.
- Pharmacotherapy for dyspnoea, anxiety and pain.
- Humidification.
- Palliation of symptoms.

INITIATION & TITRATION OF THERAPY

7	a. Initial settings for Bilevel Positive Airway Pressure (BPAP) : Inspiratory Positive Airway Pressure (IPAP) of 10cmH_2O and Expiratory Positive Airway Pressure (EPAP) of 4-5cmH_2O= Pressure Support (PS) level of 5 6cm H_2O. **b.** Initial settings for Continuous Positive Airway Pressure (CPAP) 5cm H_2O **Grade C**
8	Increases to IPAP of 2-5cmH_2O can be undertaken every 10 minutes or as clinically indicated, until therapeutic response is achieved. The maximum IPA should not exceed 20 – 23 cmH2O. **Grade C**
9	The target tidal volume of 6-8mls/Kg (ideal body weight) is aimed for all adult patients. **Grade C**
10	Optimal Non-invasive Positive Pressure Ventilation (NIV) is the lowest pressure and lowest $Fi0_2$ that achieve $Sa0_2$ of 90% or $Pa0_2$ of 60mmHg witho further clinical deterioration. **Consensus**

HUMIDIFICATION

11	All NIV circuits are to be actively humidified. **Grade C**
12	Heat Moisture Exchangers (HME's) ARE NOT to be used for humidification o NIV circuits. **Grade C**
13	Gas temperatures during NIV are to be based on patient comfort. **Consensu**

PATIENT COMFORT & COMPLIANCE

14	Assessment of patient comfort and pain is to be completed minimally second hourly and documented. **Consensus**
15	Assessment of patient tolerance for higher levels of NIV to be completed minimally hourly until highest level of compliance reached. **Consensus**
16	Patients receiving NIV are to be positioned to achieve maximal chest wall movement and prevent upper airway obstruction. **Consensus**
17	A total face mask or oronasal mask provide a similar clinical outcome and are preferred over the nasal mask in the acute setting The choice of mask is influenced by: • patient comfort • clinical effectiveness • equipment availability The helmet face mask could be considered; however due to the limited use i Australia and limited evidence of greater efficacy it is not the first line therapy **Grade C**

Oxy lưu lượng cao (HFNC) từ sinh lý đến bằng chứng lâm sàng

- Tên đầy đủ: **Heated and humidified high flow nasal cannula:** phân phối dòng khí ấm và ẩm (sinh lý) với lưu lượng cao (dòng khí 20 đến 60 lít/phút) thông qua cannula mũi.

HFNC

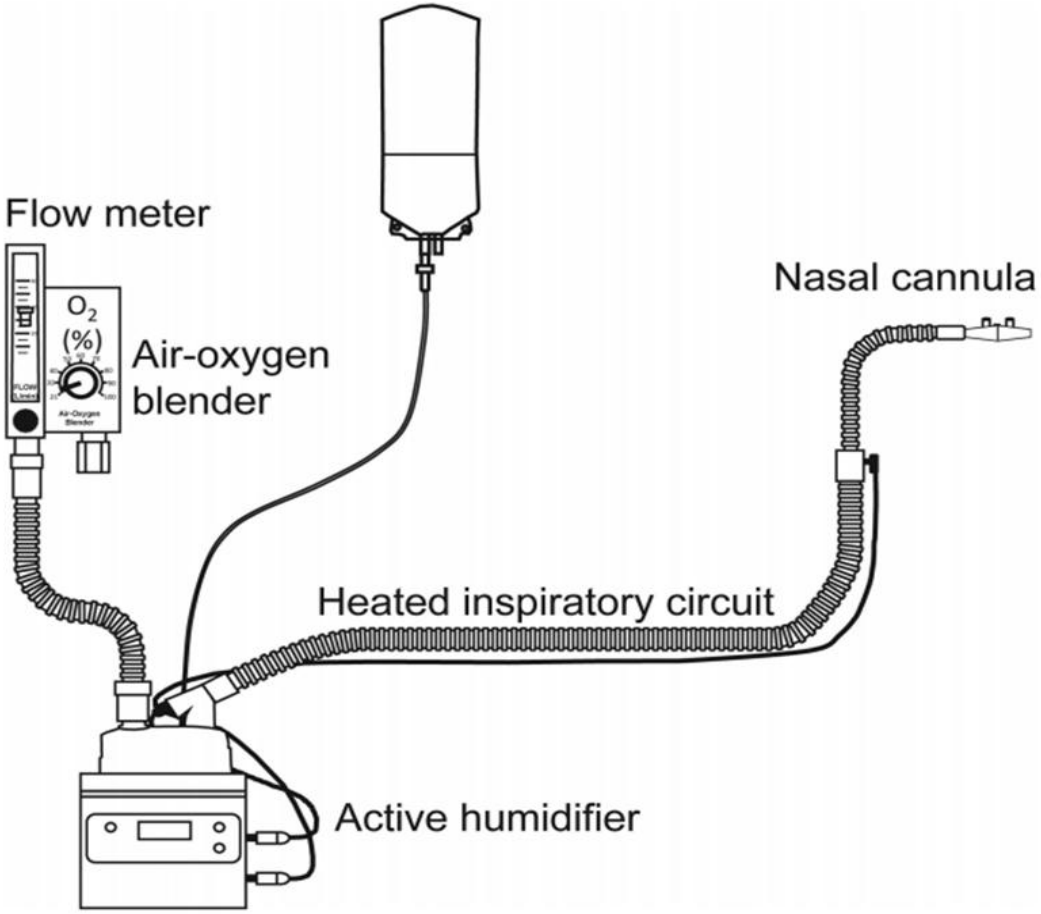


Fig. 1. Basic setup for high-flow nasal cannula oxygen delivery. An air-oxygen blender, allowing from 0.21 to 1.0 F_{IO_2}, generates up to 60 L/min flow. The gas is heated and humidified through an active heated humidifier and delivered via a single-limb heated inspiratory circuit. The patient breathes adequately heated and humidified medical gas through large-diameter nasal cannulas. (Modified from Reference 9.)

Hiệu quả sinh lý của HFNC

H: Heated & Humidified - Provides heated and humidified gas

I: Inspiratory Demands - Can better meet elevated peak inspiratory flow demands

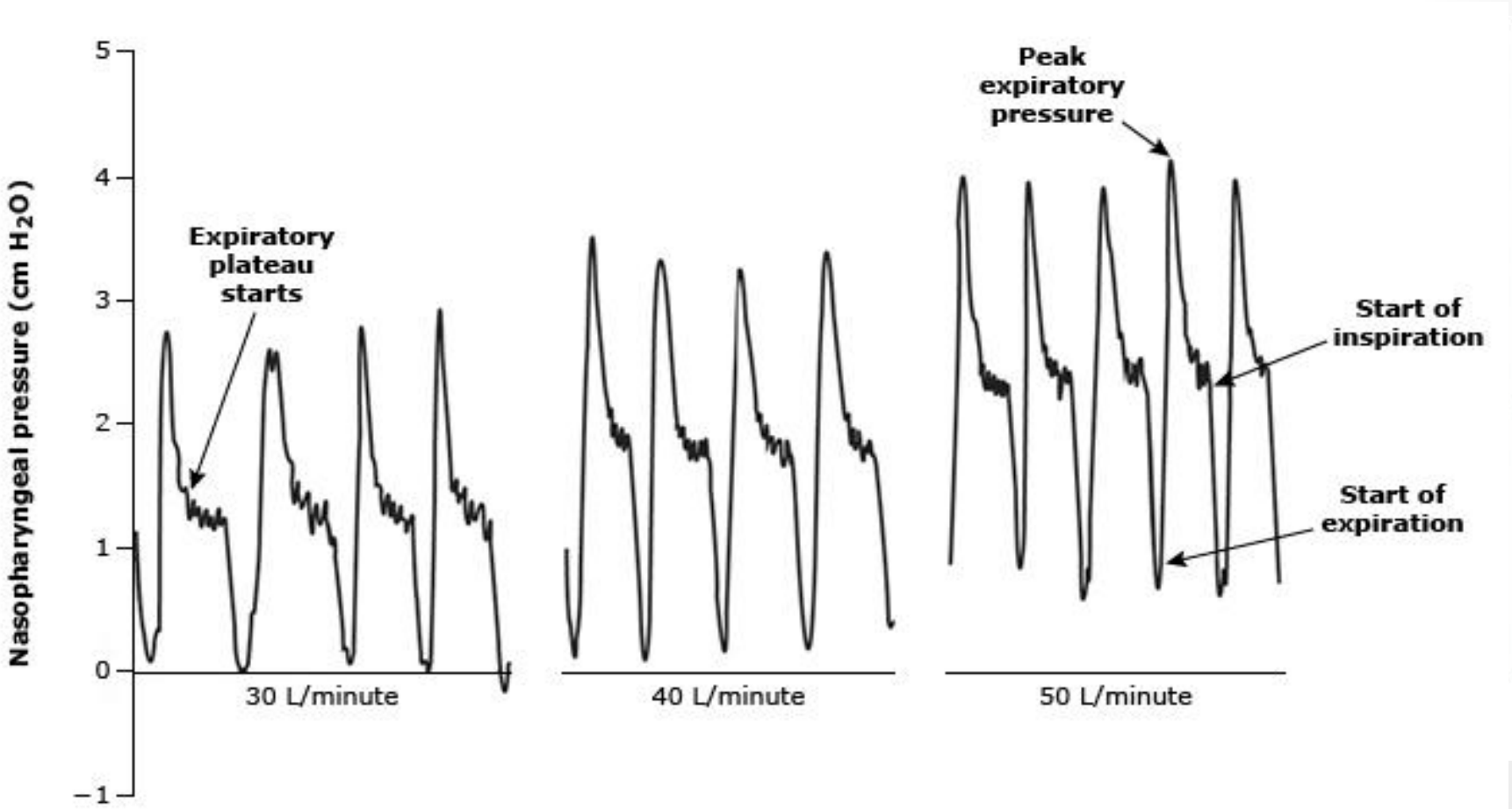
F: Functional Residual Capacity - Increases FRC likely via delivery of PEEP

L: Lighter - More easily tolerable than CPAP or BiPAP

O: Oxygen Dilution - Can minimize oxygen dilution by meeting flow demands

W: Washout of dead space - Provides high flow rates leading to wash out of pharyngeal dead space (CO_2 removal)

Hiệu quả sinh lý của HFNC **Functional Residual Capacity (PEEP effect)**



Hiệu quả sinh lý của HFNC

Functional Residual Capacity (Hemodynamic effect)

Patients with New York Heart Association class III heart failure may benefit with high flow nasal cannula supportive therapy

High flow nasal cannula in heart failure

Abstract

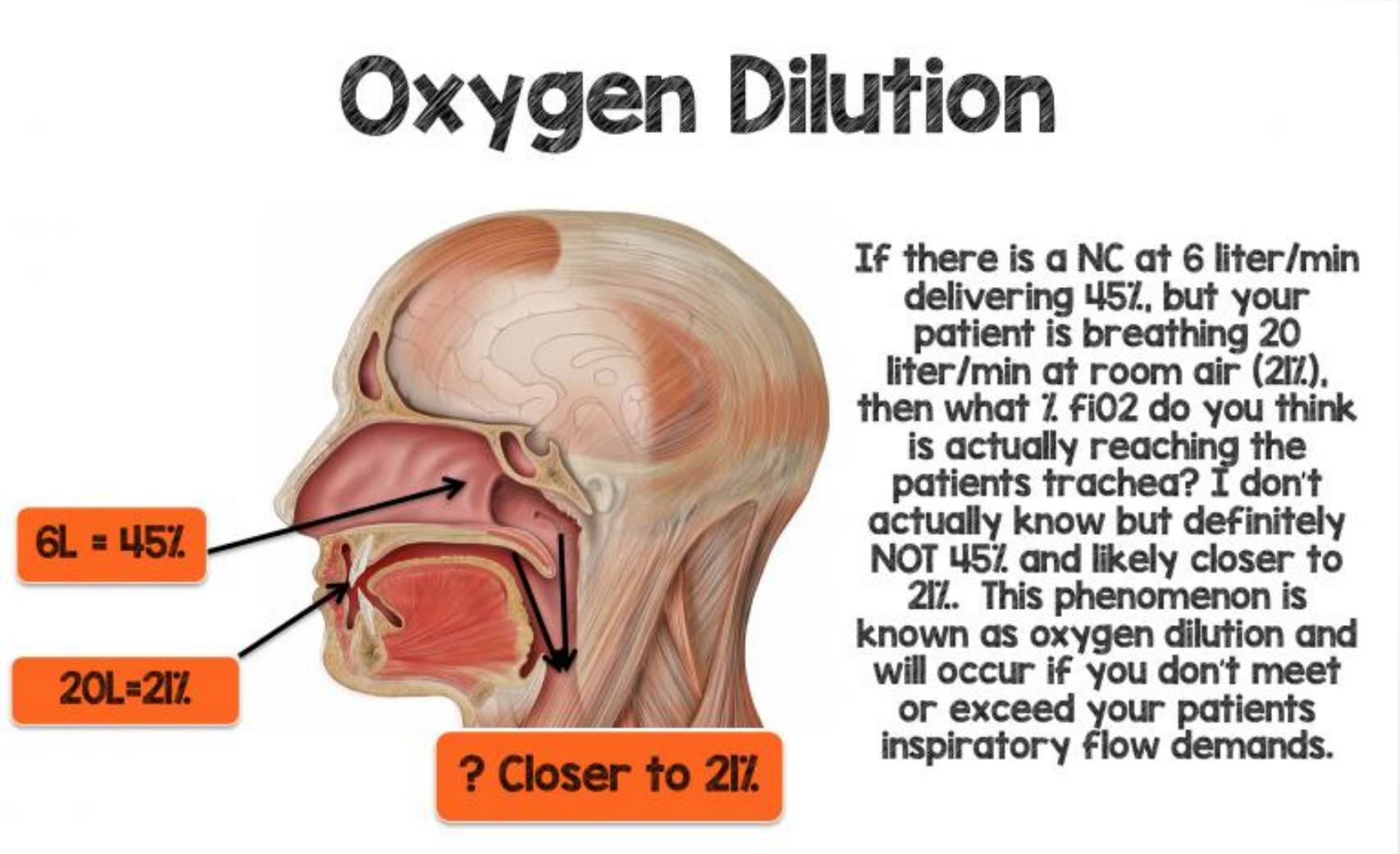
Purpose: High flow nasal cannula (HFNC) may decrease preload being associated with beneficial hemodynamic and respiratory effects in adults with heart failure.

Methods: This is a sequential intervention prospective study including 10 adults with New York Heart Association (NYHA) class III and left ventricle ejection fraction 45% or less. High flow gas was administered (fraction of inspired oxygen, 0.21) through nasal cannula (Optiflow™; Fisher & Paykel, Auckland, New Zealand). Sequential echocardiographies were performed at baseline, using HFNC with 20 lpm and 40 lpm and post-HFNC. A reduction greater than 20% in the estimated inspiratory collapse of the inferior vena cava (IVC) from baseline was considered clinically significant.

Results: Ten patients were included, with median age of 57 (44-65) years; 6 (60%) were female, and 8 (80%) had dilated cardiomyopathy. Median IVC inspiratory significantly ($P < .05$) decreased from baseline (37%) to HFNC with 20 lpm (28%) and HFNC with 40 lpm (21%), representing mean attributable reductions of 20% (95% confidence interval, 6-55) and 53% (95% confidence interval, 36-67) from baseline. Changes in the IVC inspiratory collapse were reversible after HFNC withdrawal. Respiratory rate was significantly reduced from 23 breaths per minute at baseline to 17 breaths per minute at HFNC with 20 lpm and 13 breaths per minute at HFNC with 40 lpm. In contrast, no significant changes in other echocardiographic or clinical variables were documented.

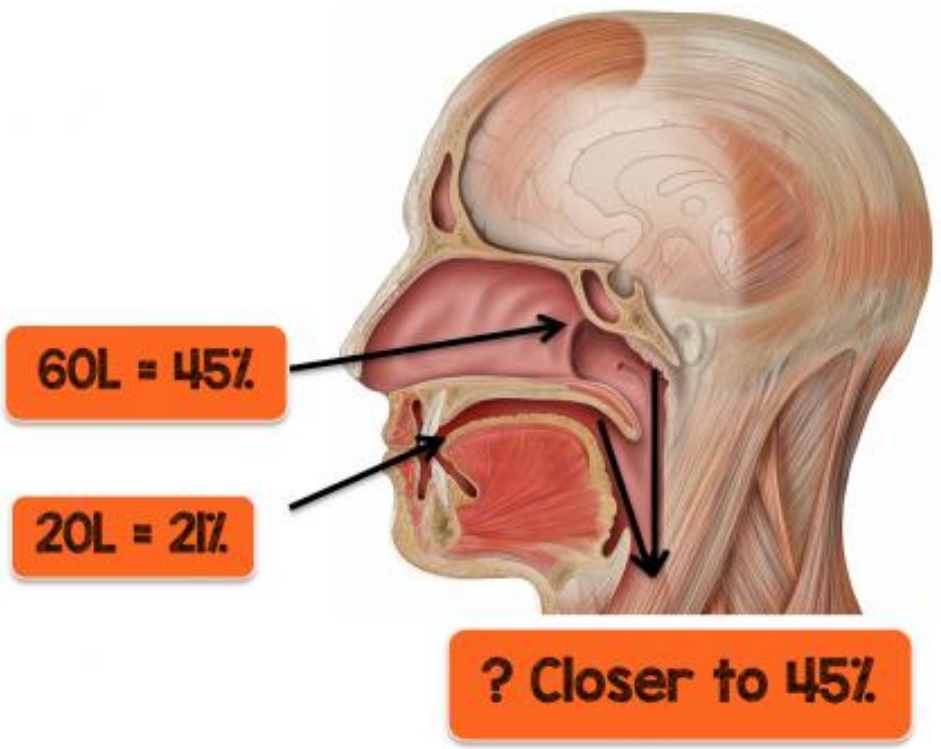
Conclusion: These findings suggest that patients with NYHA class III heart failure may benefit with HFNC supportive therapy.

Hiệu quả sinh lý của HFNC
O2 Dilution effect



Hiệu quả sinh lý của HFNC
O2 Dilution effect

On HiFlow



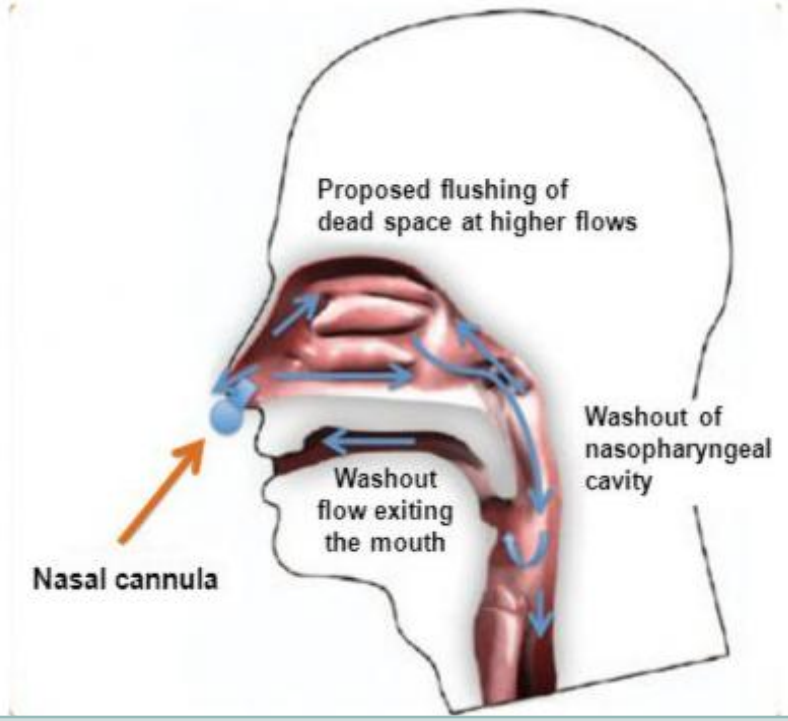
Now place your patient on a hiflow NC delivering 60L at 45%, with your patient still breathing 20 liter/min at room air (21%), and what % fiO2 do you think is actually reaching the patients trachea? I still don't actually know, but I believe it will now be closer to 45%. To deliver higher fiO2 concentrations you must not only match, but exceed your patients inspiratory flow to minimize oxygen dilution.

Hiệu quả sinh lý của HFNC
Washout of Dead-space

Continuous high flow oxygen washes out the upper airways

Reservoir of oxygen in upper airway (pharynx) available for gas exchange

Avoids rebreathing of CO2 and therefore decreases anatomic dead space



- Achieving sufficiently high flows is critical to maximize CO2 washout.
- Increasing flows from 15 to 45 L/min tripled the reduction in anatomic dead space, from 20 to 60 mL.
- **Patients with hypercarbia in addition to hypoxemia a**ppear to gain the greatest benefit from the combination of upper airway CO2 clearance and decreased CO2 production from reduced metabolic demand

Hiệu quả sinh lý của HFNC **Lighter: dung nạp và dễ chịu hơn**

- Cho phép Bn giao tiếp, giảm lo lắng, giảm cảm giác ngộp thở so với NIV, cảm giác dễ chịu (dòng khí ấm và ẩm)
- Khả năng ho, khạc đàm→ làm sạch đường thở
- **Nói chuyện, khả năng ăn uống và vận động sớm**

HFNC: chỉ định lâm sàng

- **Acute Hypoxemic Respiratory Failure**
- **Preventing Reintubations**
- **Post-Operative Respiratory Failure**
- **HFNC during Bronchoscopy/ Invasive Procedure**
- **Other Indications**
  - ✓ Acute heart failure
  - ✓ Pre-Oxygenation and Apneic Oxygenation for Intubation
  - ✓ Facilitating weaning in tracheostomized patients
  - ✓ Obstructive sleep apnea syndrome
  - ✓ Patients with a do-not-intubate order…

HFNC
Acute Hypoxemic Respiratory Failure

- Primary reason for instituting HFNC therapy
- RCT: the effect of HFNC on intubation rates and mortality

Table 2. Prospective Trials Evaluating High Flow Nasal Cannula Oxygenation in Medical Patients

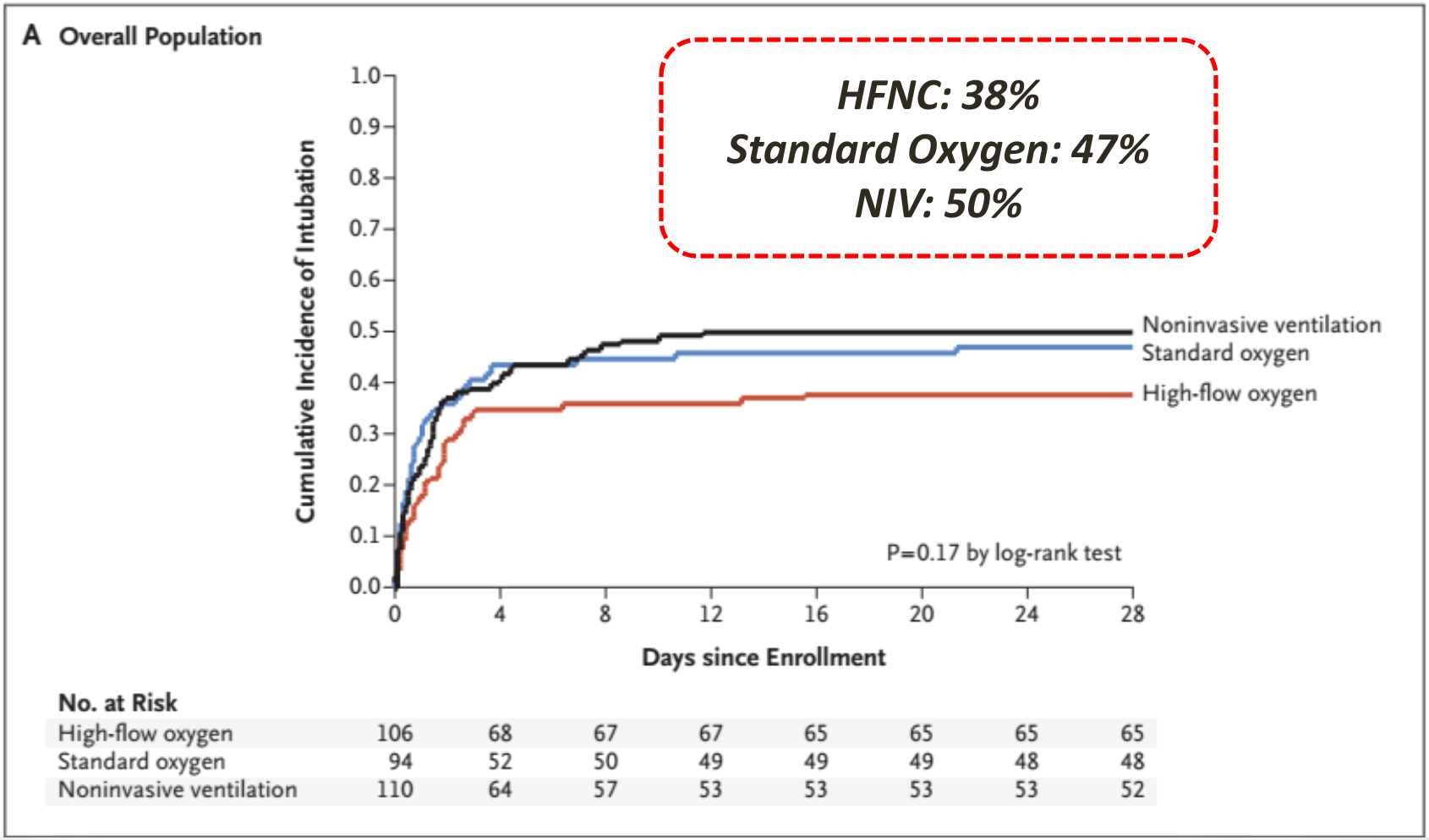
Study	Design/n	Patients	Comparison	Outcomes
Acute Hypoxemic Respiratory Failure				
FLORALI Frat et al., 2015 (19)	RCT 310	$PaO_2/FiO_2 \leq 300$	HFNC 50 L/min vs. COT or NIV	Fewer intubations with HFNC (38%) vs. COT (47%) and NIV (50%). Lower 90 day mortality with HFNC.
HOT-ER Jones et al., 2016 (20)	RCT 303	$SpO_2 \leq 92\%$ and RR ≥ 22 Admitted to ED	HFNC 40 L/min vs. COT	5.5% of HFNC vs. 11.6% of COT intubated within 24 hrs. (p=0.053). No difference in 90 day mortality.

Acute Hypoxemic Respiratory Failure
FLORALI trial

- Comparing HFNC vs. conventional low flow oxygen and NIV.
- Patients: Adults ,no prior history of lung disease.
- ARF: Respiratory rate > 25 bpm, a PaO_2/FiO_2 ratio < 300 on 10 L/min or more of oxygen, and a $PaCO_2$ < 45 mmHg.
- ¾ patients had pneumonia
- Intervention:
  - ✓ HFNC therapy (50 L/min with FiO_2 titrated to SpO_2 > 92%)
  - ✓ Oxygen via a non-rebreather face mask (10 L/min or greater for SpO_2 >92%)
  - ✓ NIV (inspiratory pressure titrated to 7-10 ml/kg tidal volumes, expiratory pressure 2-10 cm H_2O and FiO_2 titrated for SpO_2 > 92%)

Acute Hypoxemic Respiratory Failure
FLORALI trial

Primary outcome

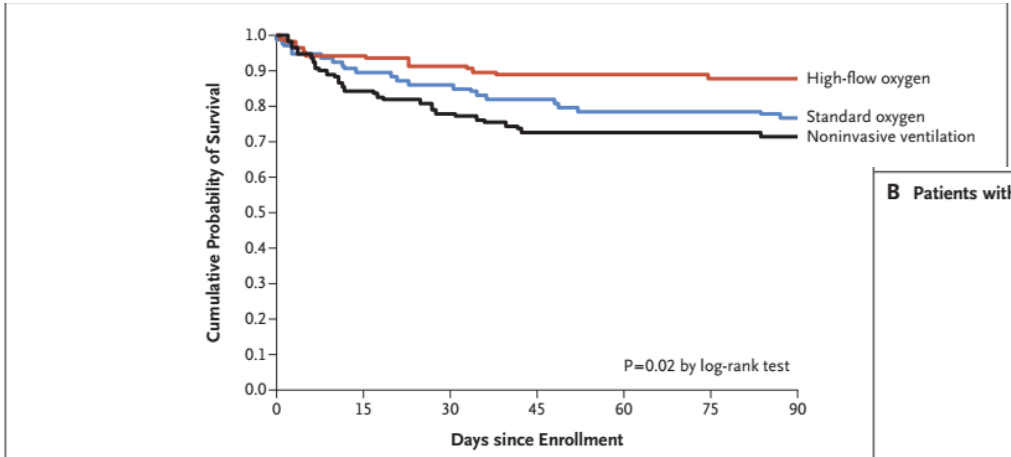


Acute Hypoxemic Respiratory Failure
FLORALI trial

Secondary outcome:

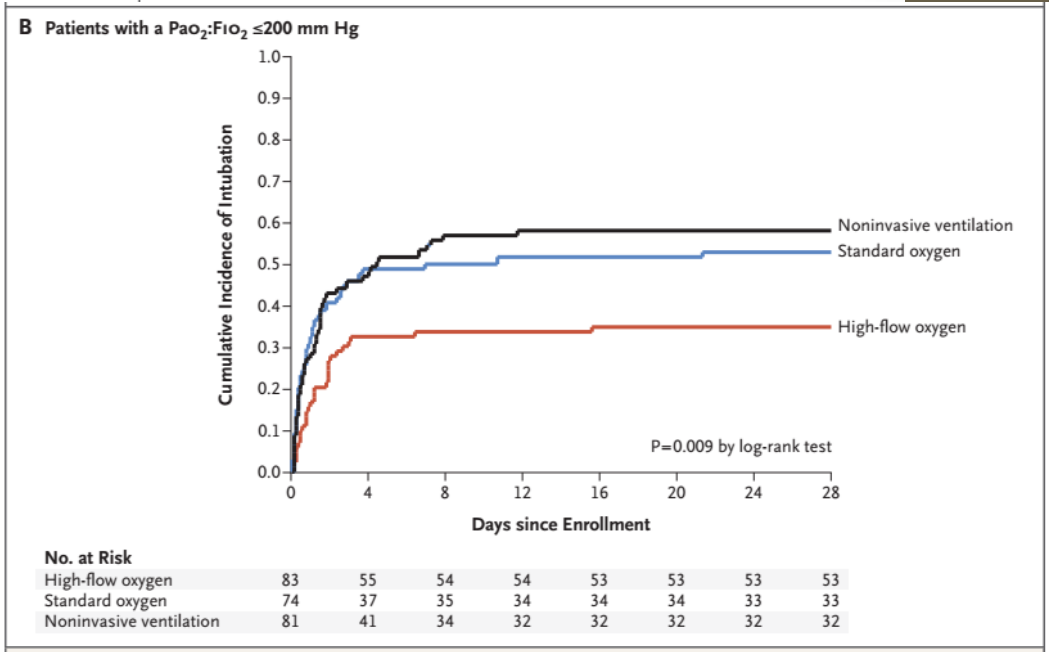
Ventilator-free days at day 28:

- HFNC 24±8 days vs. Standard Oxygen 22±10 in vs. 19±12 in NIV (P=0.02)



No. at Risk							
High-flow oxygen	106	100	97	94	94	93	93
Standard oxygen	94	84	81	77	74	73	72
Noninvasive ventilation	110	93	86	80	79	78	77

Figure 3. Kaplan–Meier Plot of the Probability of Survival from Randomization to Day 90.

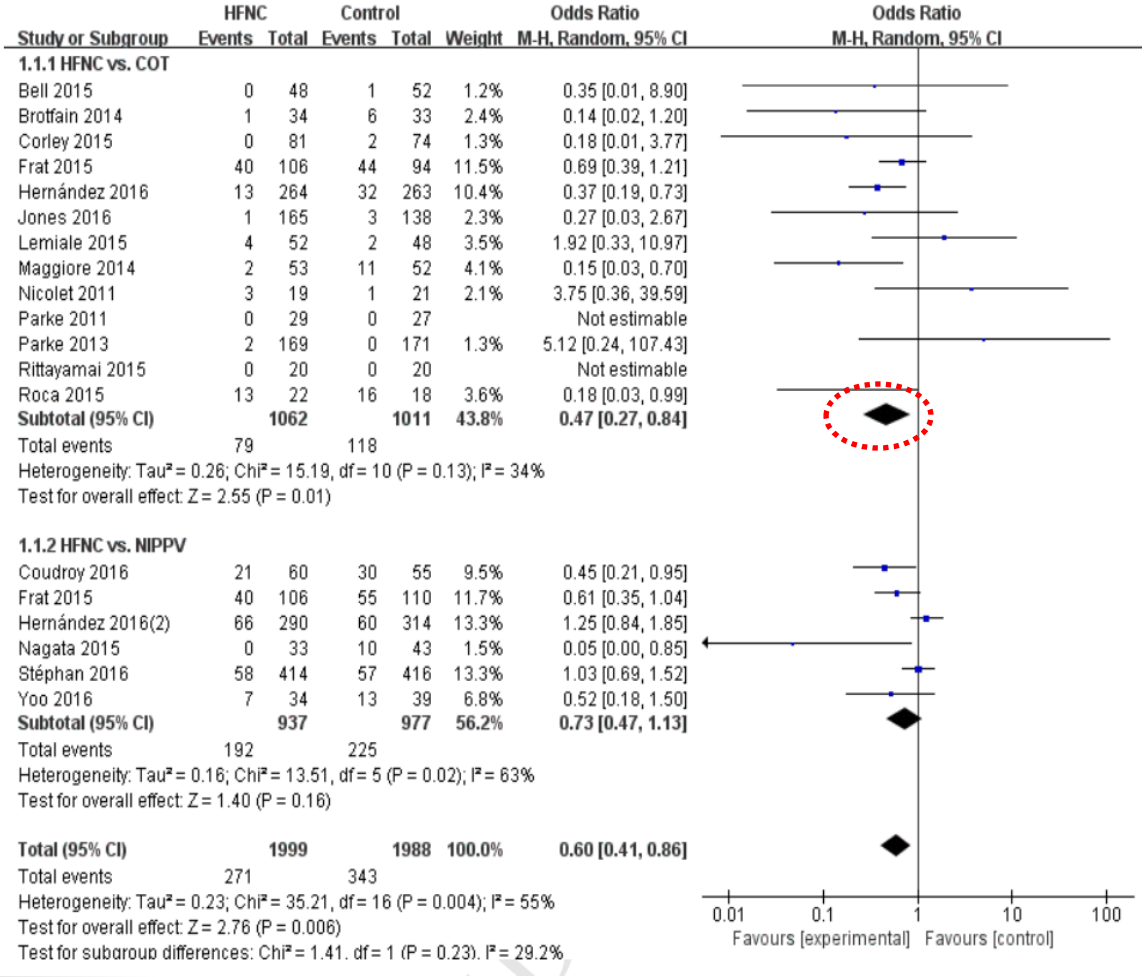


No. at Risk								
High-flow oxygen	83	55	54	54	53	53	53	53
Standard oxygen	74	37	35	34	34	34	33	33
Noninvasive ventilation	81	41	34	32	32	32	32	32

Figure 2. Kaplan–Meier Plots of the Cumulative Incidence of Intubation from Randomization to Day 28.

Acute Hypoxemic Respiratory Failure

Can high-flow nasal cannula reduce the rate of endotracheal intubation in adult patients with acute respiratory failure compared with conventional oxygen therapy and noninvasive positive pressure ventilation? A systematic review and meta-analysis



HFNC reduced the need for endotracheal intubation compared to conventional oxygen and NIV (OR 0.60 [0.41 0.86]) and should be considered as first-line therapy for patients with acute hypoxemic respiratory failure.

Acute Hypoxemic Respiratory Failure in Immunosuppressed Patients

Immunosuppressed				
Coudroy et al., 2016 (37)	Obs. cohort 115	$PaO_2/FiO_2 \leq 300$ RR $\geq$ 25	HFNC 50 L/min vs. NIV	Fewer intubations with HFNC than NIV (35 vs. 55%). Lower 28 day mortality with HFNC (20 vs 40%).
Frat et al., 2016 (35)	Post-hoc of RCT 82	$PaO_2/FiO_2 \leq 300$	HFNC 50 L/min vs. COT or NIV	31% of HFNC, 43% of COT and 65% of NIV were intubated by 28 days. Age and NIV use as first-line therapy were independently associated with need for intubation.
Lemiale et al., 2015 (82)	RCT 100	> 6 L/min COT or symptoms of respiratory distress	HFNC 40-50 L/min vs. Venturi mask with 60% FiO_2	No difference in intubations or comfort. HFNC only applied for 2 hours.
Lemiale et al., 2017 (38)	Post-hoc of RCT 353	PaO_2 < 60 mmHg RR > 30 or respiratory distress	Propensity-matched analysis of HFNC 40 L/min [10-50] vs. COT	No difference in intubations. No difference in 28 day mortality.

HFNC
Preventing Reintubations

- HFNC improved secretion clearance, prevented hypoxemia, and lowered respiratory rates, $PaCO_2$ and dyspnea scores
- Maggiore et al., 2014

  RCT 105 pts $PaO_2/FiO_2 < 300$ at time of extubation HFNC 50 L/min vs. Venturi mask

  → **HFNC reduced desaturations, reintubations and NIV**

  → **Improved comfort with HFNC.**

HFNC

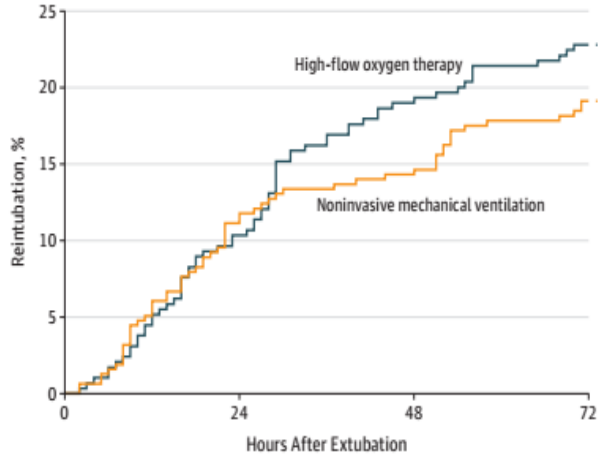
Preventing Reintubations

JAMA | Original Investigation | CARING FOR THE CRITICALLY ILL PATIENT

Effect of Postextubation High-Flow Nasal Cannula vs Noninvasive Ventilation on Reintubation and Postextubation Respiratory Failure in High-Risk Patients
A Randomized Clinical Trial

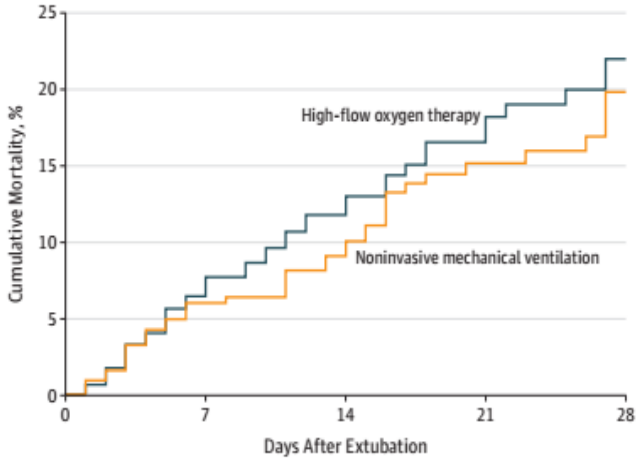
Gonzalo Hernández, MD, PhD; Concepción Vaquero, MD; Laura Colinas, MD; Rafael Cuena, MD; Paloma González, MD; Alfonso Canabal, MD, PhD; Susana Sanchez, MD; Maria Luisa Rodriguez, MD; Ana Villasclaras, MD; Rafael Fernández, MD, PhD

Figure 2. Kaplan-Meier Analysis of Time From Extubation to Reintubation



No. at risk				
High-flow oxygen therapy	290	260	234	223
Noninvasive mechanical ventilation	314	279	269	253

Figure 3. Kaplan-Meier Analysis of Time From Extubation to Death



No. at risk					
High-flow oxygen therapy	282	223	144	101	78
Noninvasive mechanical ventilation	309	261	187	112	79

Preventing Reintubations

- **Patients at high risk for reintubation: age greater than 65 years old and at least one of the following:**

  1) heart failure as the primary indication for intubation,

  2) moderate-to-severe chronic obstructive pulmonary disease,

  3) APACHE II score > 12,

  4) BMI > 30,

  5) limited airway patency,

  6) inability to manage secretions,

  7) > 2 comorbidities, or

  8) mechanical ventilation > 7 days.

- HFNC delivered at 50 L/min after extubation had similar efficacy to NIV (titrated for respiratory rate < 25, pH > 7.35 and SpO2 > 92%)
- **After 72 hours, 22.8% of patients in the HFNC group were reintubated versus 19.1% in NIV**
- Improved secretion clearance, and **was better tolerated than NIV** (NIV was only tolerated for an average of 14 hours, with 42% experiencing adverse events)

→ **HFNC is beneficial, particularly when secretion clearance is a priority or in the case of NIV mask intolerance**.

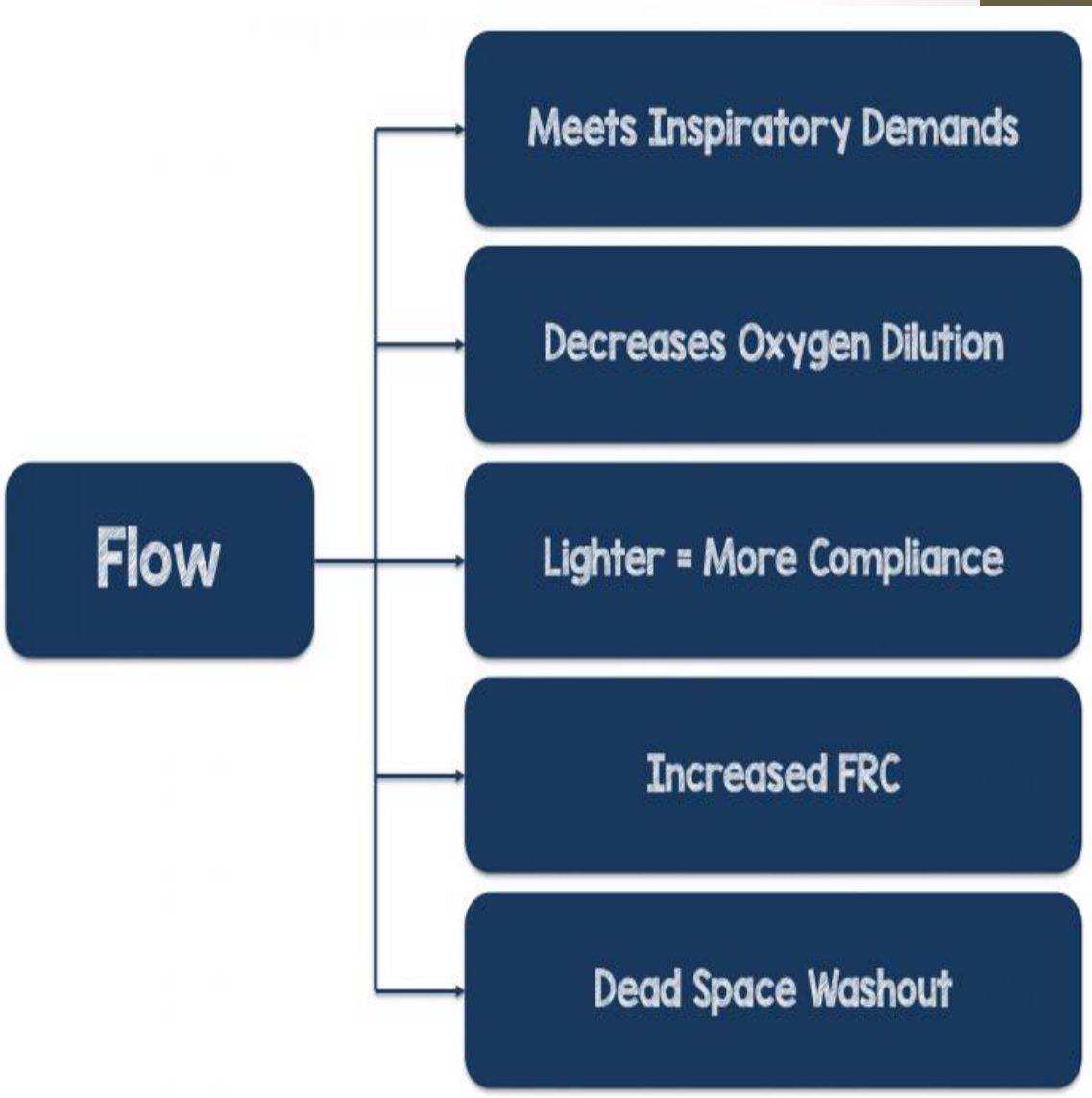
Clinical Applications
Practical Tips

- HFNC therapy should be started as early as possible.
- start with an FIO2 of 1 with the maximum tolerated flow up to 50 L/min
- FIO2 titrated according to a target SpO2
- The flow delivered will try to satisfy the inspiratory demand, minimizing the entrainment of room air
- HFNC weaning: decrease the FIO2 first and then, when the FIO2 is <0.5, start to decrease flow. When FIO2 is <0.5 and the flow rate is <20 L/min, HFNC can be replaced conventional oxygen.
- Patients with HFNC must be strictly monitored→ **Important not to delay intubation in patients who fail**
- Remember NIV: first-line treatment hypercapnic respiratory failure during COPD exacerbations or ACPE ?

Clinical Applications Practical Tips

OPTIMIZE THE FLOW TO START

- Most of the benefits are **from the high flow rates**
- Adult devices max out at 50-60 L/min and the dose for pediatric patient's is 2L/Kg/min



So sánh NIV vs. HFNC

Chỉ định	NIV	HFNC
Đợt cấp COPD	++	-
Phù phổi cấp do tim	++	-
Suy hô hấp sau phẫu thuật	+	+
Suy hô hấp cấp giảm Oxy máu: viêm phổi	-	+
BN suy giảm miễn dịch: ghép tạng	+/-	+
Rút NKQ sớm	++	_
Sau rút NKQ/ BN nguy cơ cao	++	+
Sau rút NKQ/ BN nguy cơ thấp	_	+


Thank you