Noninvasive Ventilation for Acute Respiratory Failure- Physiology and Evidence

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Disclosures

- Research Grants/Med Advisory Boards
  - Respironics, Inc
  - Fisher Paykel
  - Breas, Inc

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Outline

- Acute Applications of NIV
  - Physiologic Basis
  - Evidence Base
  - Guidelines
  - Epidemiology

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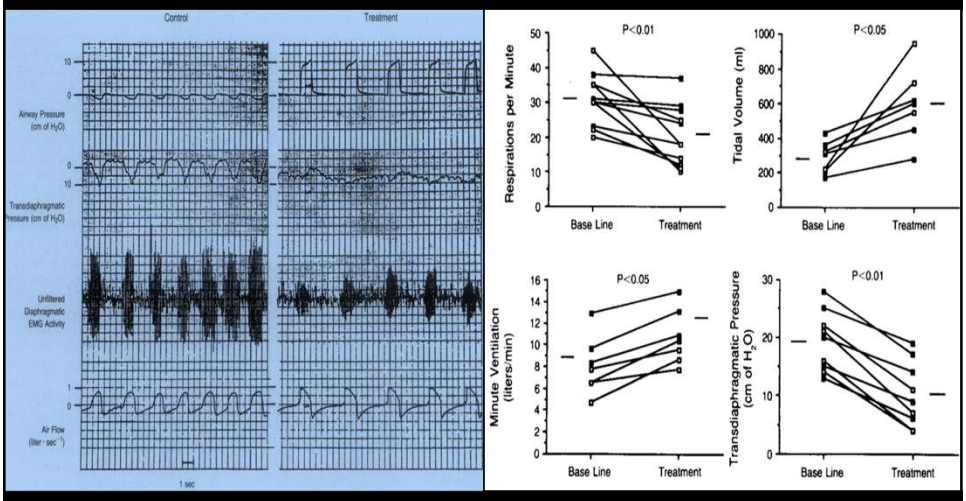
Physiologic Mechanisms of NIV in COPD



Brochard et al, NEJM 1991

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Physiologic Rationale for NIV in COPD: Effect of Pressure Support plus PEEP

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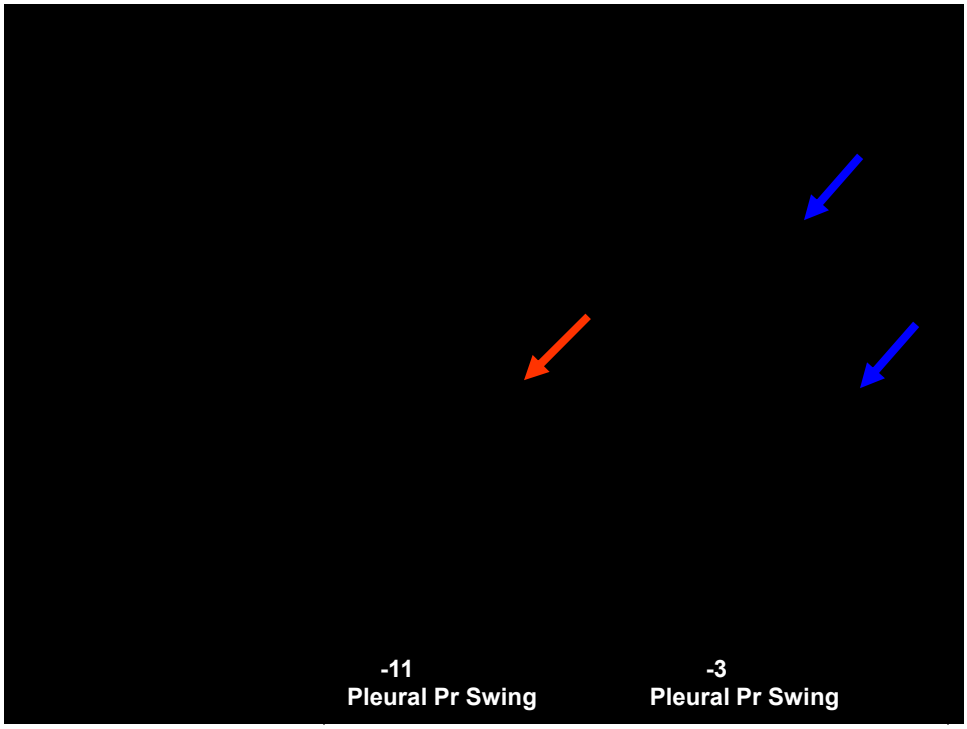

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Benefits of NIV in Acute COPD compared to Conventional Rx*

- More rapidly improves dyspnea
- More rapid ↓ RR, HR, breathing effort
- More rapid ↓ PaCO2, ↑ O2
- Lowers intubation rate (50%➔20% ↓65%)
- Lowers mortality (↓55%), morbidity rate
- Less time in hospital (↓1.9d)

*Meta-analysis Quon et al,Chest'08

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NIV for COPD associated with:

- Difficult weaning (to facilitate extubation)
- Pneumonia
- Extubation failure
- Do-not-intubate status
- Post-operative Respiratory Failure

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NIV for Acute Pulmonary Edema: Physiologic Rationale

- CPAP:
  - Increased FRC
  - Re-expands flooded alveoli
  - Improved oxygenation
  - Increased compliance
  - Afterload reduction - ↑ cardiac function
- Pressure Support:
  - Further reduction in work

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Acute Cardiogenic Pulmonary Edema

- Multiple RCTs have shown that either CPAP (10-12.5 cm H20) or BiPAP (12-15/4-5 cm H20) benefit patients compared to oxygen supplementaion alone.
- But which is better?

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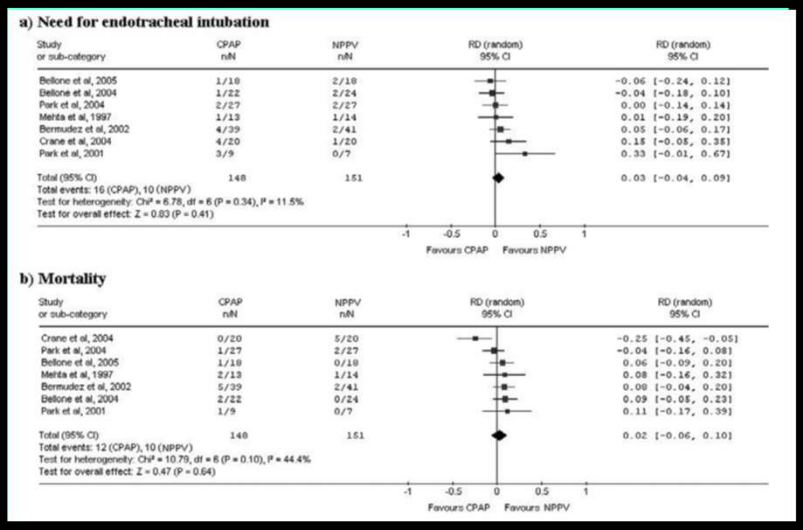
Meta-analysis: CPAP vs NIV for CPE



Winck et al, Crit Care 2006 10:R69

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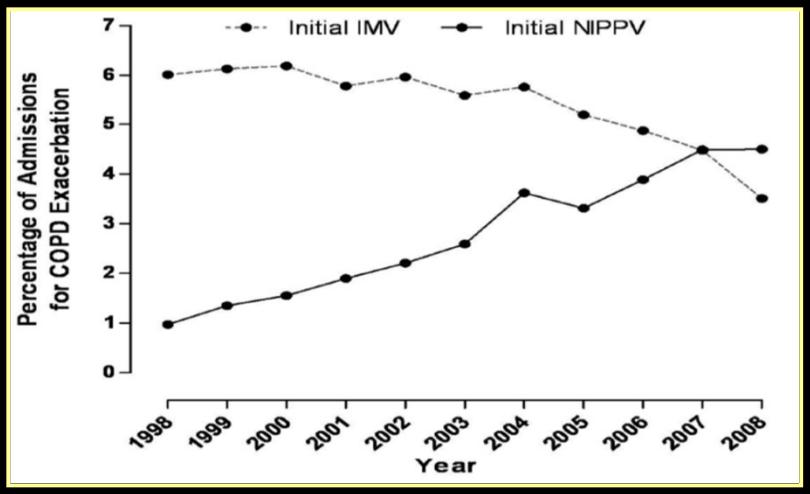
Increasing Use of NIV for COPD in US (> $7X10^6$ admissions)



Chandra D et al, AJRCCM 2012

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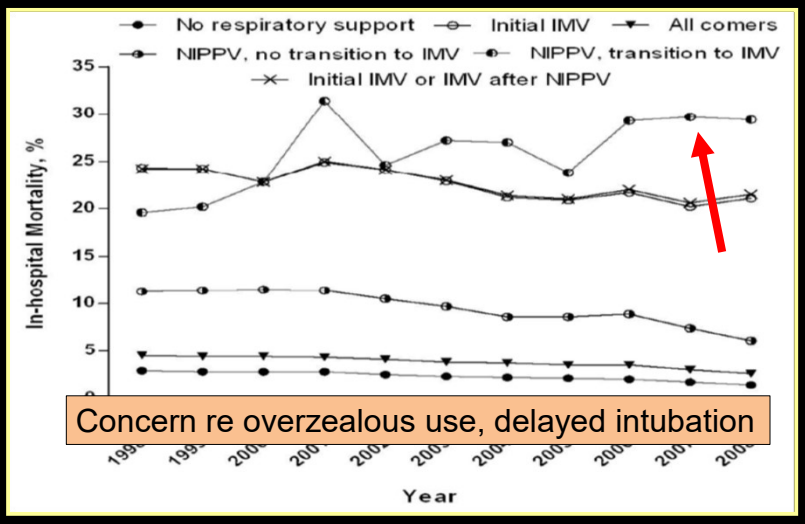
Diminishing Mortality Overall



Concern re overzealous use, delayed intubation

Chandra D et al, AJRCCM 2012

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ERS/ATS CLINICAL PRACTICE GUIDELINE – NIV FOR ACUTE RESP FAILURE

NIV: Summary of Recommendations

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.

ROCHWERG ET AL, ERJ 2017

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NIV Outcomes from LUNG SAFE

- Large observational multinational ARDS study
- 506 of 2813 (18%) ARDS pts treated with NIV
- NIV failure in 22% mild, 42% mod and 47% severe (Overall NIV Failure rate 38%)
- NIV success 16% died, NIV failure 45% died
- If PaO2/FIO2<150, mortal NIV 36% IMV 25%

Bellani G et al. AJRCCM 2016

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Why is NIV so challenging for ARDS/Severe Hypoxemic RF?

- Severe O2 defect – more PEEP, more leak, desaturation if mask "falls" off
- Stiff lungs – Higher insp pressure, more leak, less comfort
- High minute volumes, tachypnea – harder to meet demands, synchronize
- Sick patients – sepsis, secretions, MODS, deteriorating
- Prolonged respiratory failure

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High Flow Nasal O2 (HFNO) v NIV

Role in Moderate ARDS?
Role of interface in NIV?

- **Pre-pandemic**

- **RCT of High Flow v Stnd O2 vs NIV in PNA/ARDS: ↓ intub rate ↓ O2, decr 90d mortal Frat et al NEJM 2014**
- **Helmet for ARDS/PNA – 83 pt RCT at U of Chicago compared Helmet vs Stnd Full Face mask; intub rate 18% vs 62% and 90d mortal rate 34% v 56%.**
- Patel B et al, JAMA 2016

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Helmet

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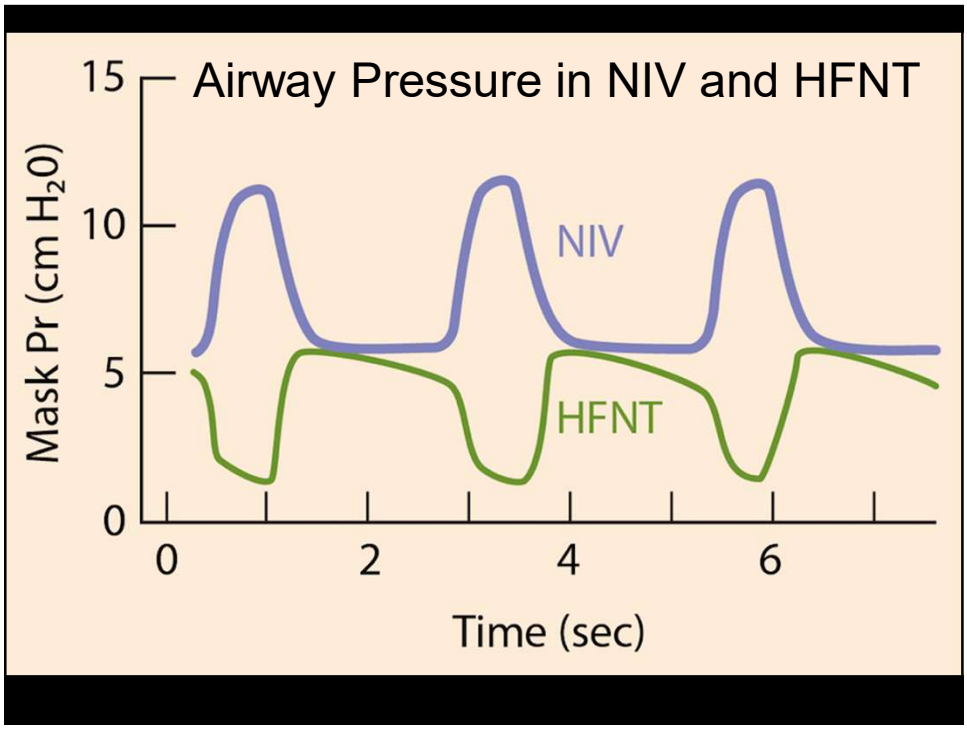

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Comparison of NRS studies

Study222	Type	n	Results	Intubation	Mortality
Pre-COVID					
FLORALI	RCT	310	HFNC >> NIV = Stnd O2	Yes*	Yes
Helmet	RCT	83	Helmet NIV >> Mask NIV	Yes	Yes
Ferreryo JAMA	Metaanalysis	3804	Helmet or Mask NIV/ HFNC	Yes/Yes	Yes/No
COVID					
Italy Non-ICU	Observation	670	HFNC = Helmet CPAP = Mask NIV	No	No
Paris ICU	Retrospect	379	HFNC > non-HFNC	Yes	No
Grieco	RCT	199	Helmet CPAP > HFNC	Yes	No
Perkins	Adaptive RCT	1272	Mask CPAP > SO, HFNC = Stnd O2	Yes	No
Ospina Tascon	RCT	199	HFNO > Stnd O2	Yes	No
Crimi	RCT	362	HFNO = Stnd O2	No	No
Arabi	RCT	320	Helmet - Usual	No	No

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Summary: NIV for Acute Resp Failure

- Strong physiologic and clinical evidence to support use of NIV for hypercapnic RF and cardiogenic pulm edema
- Other indications: Post-op, Post-extubation, Trauma, palliative
- Hypoxemic RF still controversial
- Use increased during “decade of NIV”
- HFNC may have advantages for AHRF

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