

## Noninvasive Ventilation: Non-COPD Applications

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## NONINVASIVE MECHANICAL VENTILATION

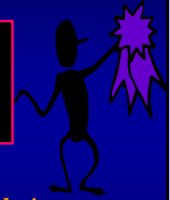
### Why Noninvasive Ventilation?

- ⊙ Avoids ↓
- ⊙ Leaves ↓
- ⊙ More comfortable  
*permits talking, eating, less sedation*
- ∴ Lower morbidity, mortality, cost

**A respiratory system  
protective strategy**

**Caveat:  
Must be used selectively**

*pneumonia, sinusitis*



## Non-COPD Applications of NIV

### Obstructive Diseases

Asthma  
Cystic Fibrosis  
Upper Airway

### Hypoxemic

CHF  
ARDS  
Pneumonia

### Restrictive Diseases

Neuromuscular  
Kyphoscoliosis

### Immunosuppressed

Do-not-intubate  
Post-operative

## RCT of NIV for Asthma

	NIV	Sham
n	17	16
FEV1 (%)	37.3	33.8
↑50% FEV1	80%	20%*
% Δ FEV1	53.5	28.5*
Hospitalized	3 (17.6%)	10 (63.5%)*

Soroksky et al, Chest 2003; 123:1018.

## NPPV FOR STATUS ASTHMATICUS

17 pts; 15 successful; face PSV 18 cm H2O

pH (2h)	7.25 → 7.32
PaCO <sub>2</sub> (2h)	65 → 52
RR/min (2h)	29 → 20
Duration	16 ± 21 h

Meduri et al. Chest '96, 110: 767

## NIV for Asthma

- After failure to respond to several treatments with aerosolized bronchodilator
- Increased work of breathing; tachypneic, tachycardic, increased accessory muscle use
- ? Use early to alleviate dyspnea, airway obstruction
- ? Combine with continuous nebs, heliox

## NIV for other Obstruction

- Cystic Fibrosis
  - Anecdotal data
  - Bridge to transplantation
- Upper Airway Obstruction
  - Anecdotally (Meduri et al, Chest '96), reduces work of breathing in post-extubation stridor, can be combined with heliox

## NIV for Restrictive Processes

- Neuromuscular Disease – acute deterioration
  - 24/7 NIV
  - Cough assist as much as needed
- If hospitalization necessary, place in ICU or step-down unit, monitor closely
- If secretions excessive, may need intubation and wean to NIV

## NIV for Restrictive Processes

- Pulmonary Fibrosis – acute deterioration
  - Success rate low
  - Not recommended application

Al Hameed Can Respir J 2004
- Obesity Hypoventilation
  - BiPAP often successful
  - May require relatively high pressures
  - May be switched to CPAP when stabilized

Piper et al Chest '94

## Acute Hypoxemic Respiratory Failure

- If PaO<sub>2</sub>/FIO<sub>2</sub> < 200
  - 3 Resp Distress, RR > 30-35
  - 1 Non-COPD dx
    - Cardiogenic Pulm Edema
    - Pneumonia (incl immunosuppr)
    - ARDS
    - Trauma
  - Age > 40
- 1.01  
1.72

Antonelli et al, Int Care Med 2001 27:1718

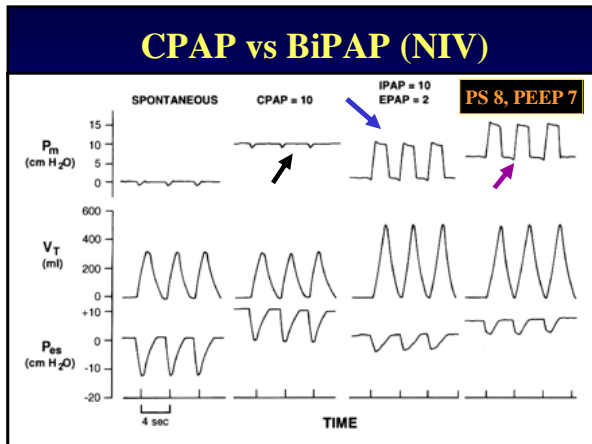
## NIV for Acute Cardiogenic Pulmonary Edema (ACPE)

- Rationale:
  - Increased intrathoracic pressure:
    - Raises FRC opening flooded alveoli
      - Improved oxygenation
      - Increased compliance
  - Preload and afterload reducing effect

## Acute Pulmonary Edema: CPAP (10-12.5 cm H<sub>2</sub>O) works better than O<sub>2</sub> by mask

- Decreases dyspnea more rapidly
- Lowers respiratory rate, breathing effort
- Improves oxygenation, cardiac performance
  - Reduces intubation rate (50% to 20%)
  - Decreases ICU length of stay (Bersten et al)
  - Decreases mortality, morbidity

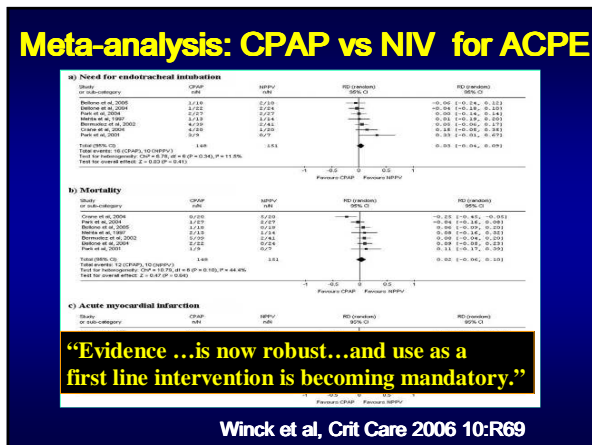
Pooled results of 4 controlled trials



### Acute Pulmonary Edema: NIV (PS+PEEP) works better than O<sub>2</sub> by mask

- Decreases dyspnea more rapidly
- Lowers respiratory rate, breathing effort
- Improves oxygenation, cardiac performance
- Reduces intubation rate (? Just hypercapnics\*)
- No adverse effect on MI rate
- Decreases morbidity

Pooled results of controlled trials \*Nava et al



### Multicenter RCT of ACPE “3CPO”

26 ctrs, RR>20, pH<7.35, excl if “need for intervention”

	NIV or CPAP	ST
n	702	367
Death 7 days (%)	9.5	9.8
Intubation (%)	2.9	2.8
MI (%)	27	24.9
Dyspnea (1 hr)	-4.6	-3.9*
pH (1 hr)	+0.11	+0.08*
RR (1 hr)	-7.2	-7.3

\* P < 0.05      Gray et al, NEJM 2008

### Multicenter RCT of ACPE

**Weaknesses:**

- Inclusion RR > 20/ min (mild)
- 3% intubation in ctrs very low – hard to improve on that - no mention of DNI status
- Mortality rate 10% at 1 week - no mention of cause or timing

Gray et al, NEJM 2008

### When to use Noninvasive Techniques for ACPE?

Gray - As “adjunctive therapy” to effect “earlier improvement” in pts with severe dyspnea or not responsive to pharmacologic Rx

- Start with CPAP (or BiPAP)
- If persisting dyspnea or hypercapnia with CPAP alone, add pressure support

## NIV FOR SEVERE COMMUNITY ACQUIRED PNEUMONIA

56 pts, RR 37, PaCO<sub>2</sub> 49, P/F ratio 175

	NIV	CONV
n	28	28
Tubed	6	14*
ICU study (d)	1.8	6*
Deaths	6	6
COPD deaths (2 mos)	1 (11%)	5 (63%)

Confalonieri et al, AJRCCM 160: 1585, '99 \*P<0.05

? SARS

## NIV for ARF in Immunocompromised

CXR abnl, T > 38.3, RR > 30, PaO<sub>2</sub>/FIO<sub>2</sub> < 200

	NPPV	STD
n	26	26
Heme malign (%)	15 (58%)	15 (58%)
Intubations (%)	12 (46%)	20 (77%)
Vent dur (d)	6	6
ICU stay (d)	7	10
Hosp death (%)	13 (50%)	21 (81%)*

Hilbert et al NEJM 2001; 344: 481 \*P < 0.05

## NIV for Immunocompromised:

Rationale: Lowers risk of Nosocomial Pneumonia

761 pts followed prospectively, 129 NPPV, 607 ETI

Hazard ratio NPPV:ETI  
(Adjusted for SAPS II)

Ventilator-assoc Pneumonia 0.25

Nosocomial infection 0.51

Nourdine et al, Int Care Med 25: 567, '99

## NIV as "First Line" Therapy in ARDS

- 147 pts eligible of 479 (332 intubated), had dyspnea, RR > 30 and ≤ 2 new organ failures
- 54% avoided intubation –  
VAP rate 2 vs 20%, mortality 6 vs 53%
- Success more likely if SAPS II ≤ 34 and PaO<sub>2</sub>/FIO<sub>2</sub> > 175 p 1<sup>st</sup> hr of NIV therapy

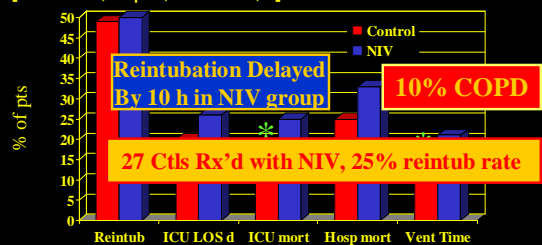
Antonelli et al, CCM, 2006

## Who gets NIV for Severe PNA or ALI/ARDS?

- Not routine – Only at skilled centers - Careful selection!
- Excellent candidate for NIV – single organ system disease, cooperative, no excessive secretions – SAPS ≤ 34
- Can oxygenate adequately (FIO<sub>2</sub> to 60% - 70%) FIO<sub>2</sub>/PaO<sub>2</sub> improves 1<sup>st</sup> hr
- Monitor very closely

## Application of NIV with Early Signs of Extubation Failure

RCT on 223 pts from 38 ICUs worldwide with  
↑PaCO<sub>2</sub>, ↓pH, ↓PaO<sub>2</sub>, ↑RR after extubation



Esteban et al, NEJM 2004; 350:2452

## NIV in Patients at Risk for Extubation Failure

Risks: Age > 65, CHF, APACHE >12

Hypercapnia 25%

	NIV	CTL	NIV	CTL
n	79	83	27	22
Chr Resp	52%	49%	100%	95%
CHF	33%	33%		
Resp Fail	16%	33%*	15%	41%* ←
Reintub	11%	22%	11%	27%* ←
ICU Mor	3%	14%*	0%	18%*
Hosp Mor	16%	23%	4%	41%* ←

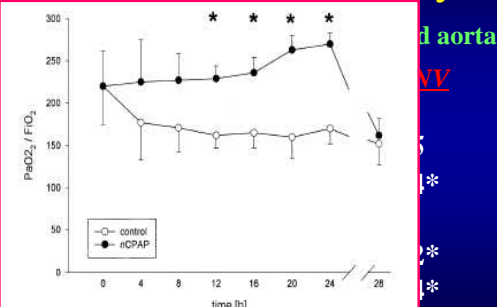
(Ferrer et al, AJRCCM, 2005)

## Lessons of extubation failure trials:

- Hard to predict good candidates for NIV early
- Select patients at high risk for failure with indications for NIV
- NIV works for hypercapnic pts (COPD and CHF)
- Don't delay needed intubation

## CPAP for Prophylaxis after Major Thoracoabdominal Surgery

S/P  
n  
↓  
com  
(↓  
ICU  
Hosp



Kindgren-Milles et al, Chest 128:821, 2006

\*P<0.05

## RCTs of Noninvasive Techniques for Postoperative Patients

### For Prophylaxis:

- Thoracoabdominal vacular (CPAP)
  - Kindgren-Milles et al, Chest '06
- Bariatric surgery (NIV)
  - Joris Chest '97
- Major abd surgery (CPAP)
  - Squadrone JAMA '05
- For Resp Failure:
  - Lung resection (NIV)
    - Auriant et al, AJRCCM '01

## NIV for Do Not Intubate Patients: Factors Predicting Hospital Mortality

Factor	Odds ratio	CI
CHF	0.14	0.03-0.75

### Use of NIV in DNI pts:

- Mainly for pts with reversible problems
- Pt and/or family should be clear on goals  
Life support vs palliation
- May be used to alleviate dyspnea or "buy time" in a terminal pt

Levy et al, Crit Care Med 2004; 32:2002

## Summary: Non-COPD Applications of NIV

- Although COPD is best application of NIV in acute setting, NIV has many others
- ACE and immunosuppressed are best supported by evidence
- Other obstructive, restrictive, and hypoxemic forms of ARF are appropriate, as are categories of ARF such as extubation failure, postop and do-not-intubate
- Proper selection, monitoring and management by a skilled team are keys to success