Non-Invasive Ventilation: Overrated

August 24, 2009

Grand Rounds

University of Colorado Denver

Department of Surgery

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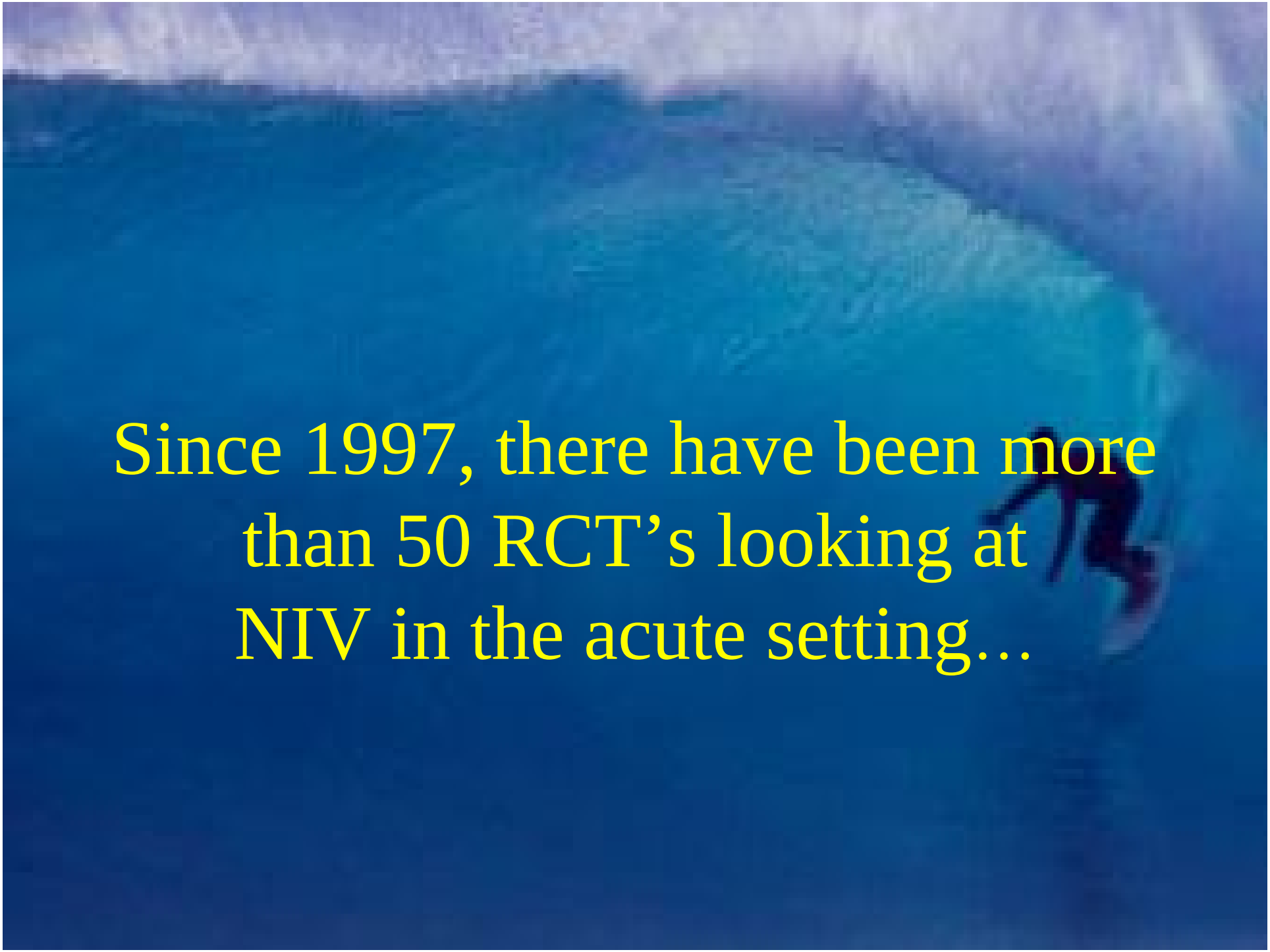
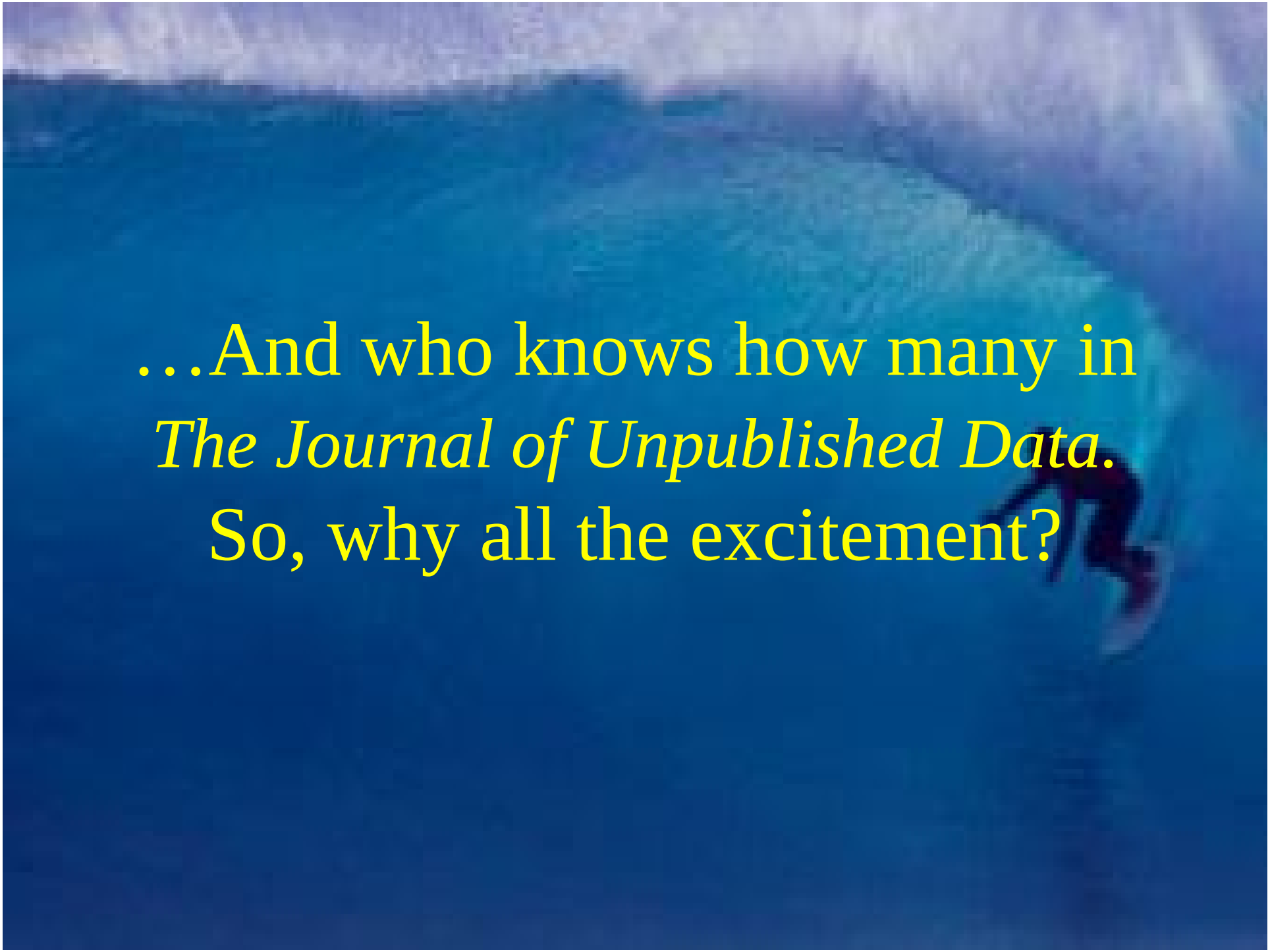
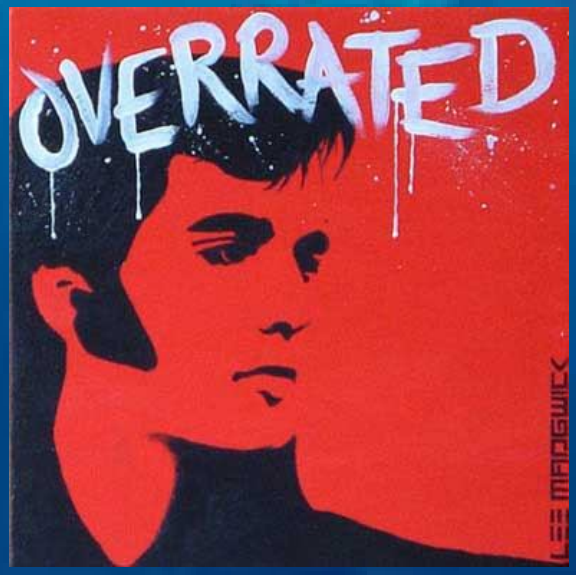

Since 1997, there have been more
than 50 RCT's looking at
NIV in the acute setting…


…And who knows how many in
The Journal of Unpublished Data.
So, why all the excitement?

“Non-invasive ventilation:
BiPAP or Buy Crap?”
-Jim Haenel, RRT, Ventilator Guru.



What is non-invasive positive pressure ventilation (NIV, NPPV)?

NIV (NPPV) is mechanical ventilation using techniques that do not require an endotracheal airway.

- CPAP=PEEP
- BiPAP=CPAP + PSV
- Bilevel (bilevel CPAP) = ARPV w/ spontaneous breathing

CPAP vs BIPAP

CPAP does not actively assist inspiration

"They tried to switch me to BIPAP but I couldn't tolerate the warm humidified component of the apparatus...made me feel like I was drowning." Katie Bakes, MD

Hill N. Lancet 2009; 374: 250–59

Why Low Lung Volumes are Bad

- The Functional Residual Capacity (FRC) is the lung's physiologic reserve
- Loss of chest wall or lung compliance causes reduced FRC.

What is the Closing Volume?

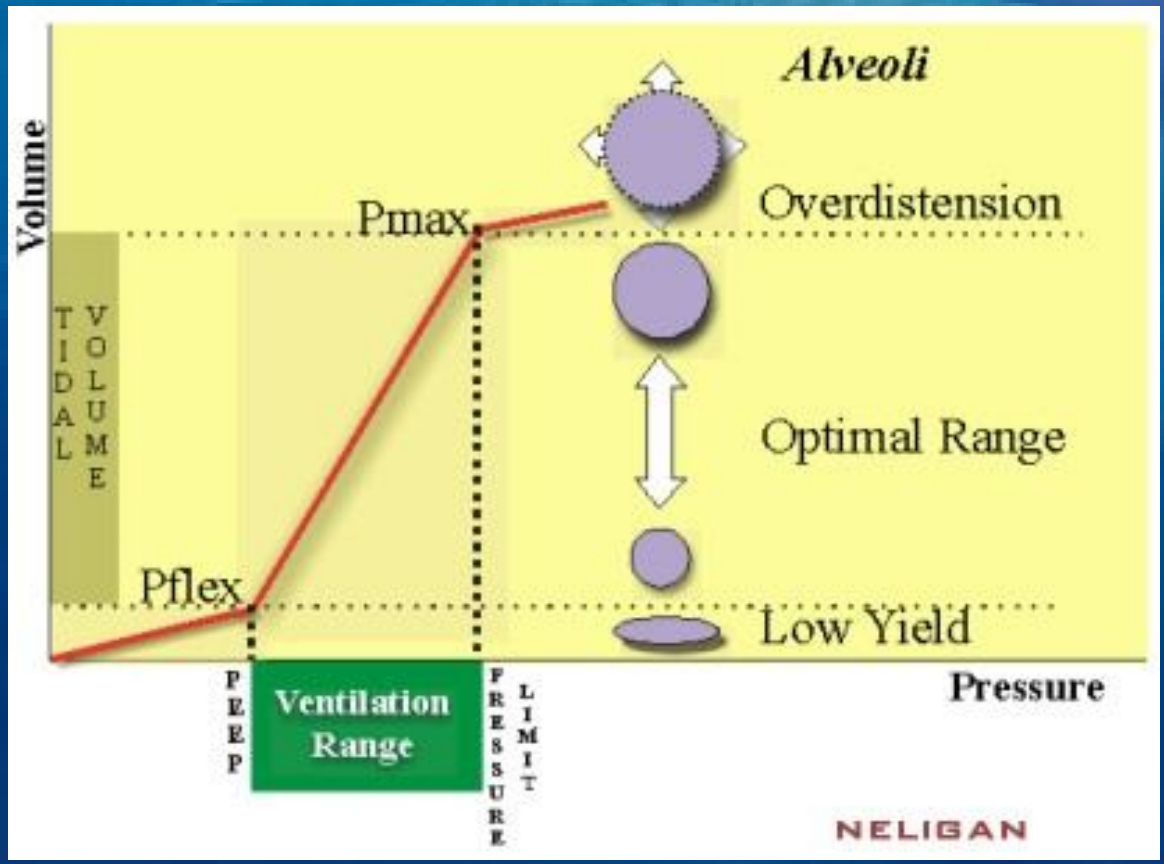
- **The closing volume (CV) is the point at which dynamic compression of the airways begins.**

- **The CV increases with age, smoking, lung disease, and body position (supine>erect).**

What does NIV do?

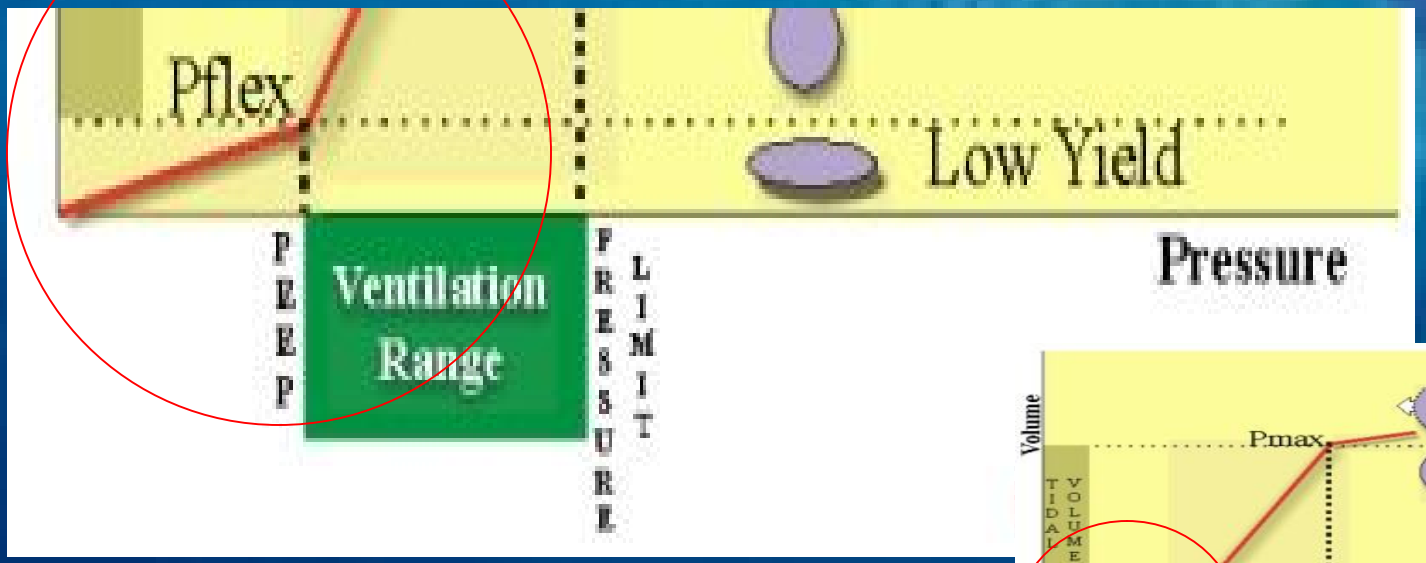
- Decreases work of breathing
- Recruits alveoli to improve FRC
- Increases closing volume
- Optimizes lung compliance
- Assists with ventilation, poor device for oxygenation

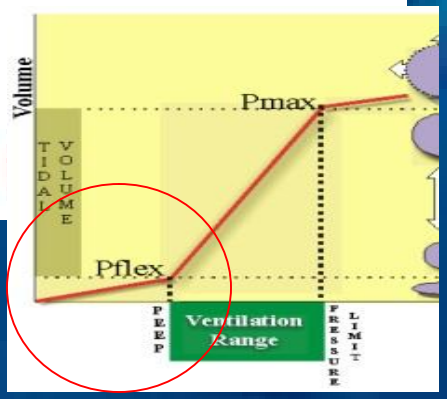
How does NIV work?



www.icmtutorials.com

Positive pressure: optimizing ventilation





Pressure-volume curve

Indications for NIV

- COPD and CHF exacerbations
- Pulmonary infiltrates in immunocompromised patients
- Weaning of previously intubated stable patients with chronic obstructive pulmonary disease.
- To palliate symptoms in terminally ill patients

Hill N. Lancet 2009; 374: 250–59

Benefits of NIV

- Decreased work of breathing in select patients
- Improved gas exchange in select patients
- Avoid complications of intubation; decreased risk of VAP

Hill N. Lancet 2009; 374: 250–59

Pieracci FM. Am Surg 2007; 73:419-432

NIV: Absolute Contraindications

- Unable to fit mask
- Respiratory arrest
- Untrained staff

Hill N. Lancet 2009; 374: 250–59

NIV: Contraindications

- Patient unable to protect airway
- Swallowing Impairment
- Hemodynamic Instability (Systolic BP < 90 mmHg)
- Severe Acidemia (pH < 7.25)
- Copious Secretions
- Agitation
- Recent UGI Surgery
- MOF

Hill N. Lancet 2009; 374: 250–59

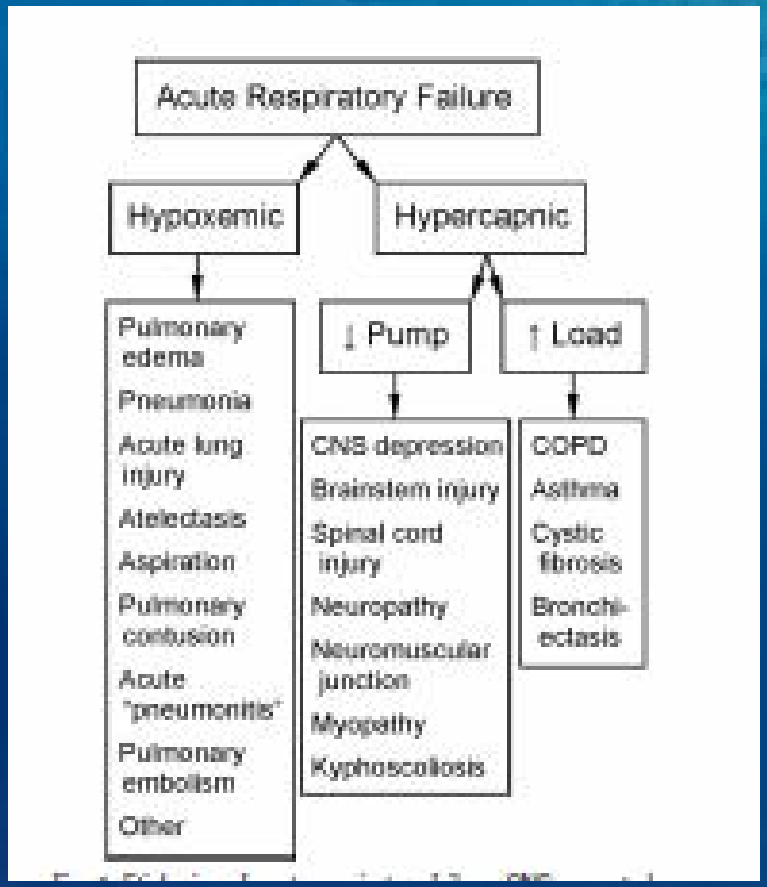
NIV: Contraindications

- Epistaxis
- Barotrauma (Pneumothorax)
- Facial and Skull Trauma (Pneumocephalus)
- Obtunded Patient

Crummy M. Naughton T. Internal Medicine Journal. 2007; 112–118.

Respiratory Distress

Failure to ventilate or failure to oxygenate?



Keenan SP, Mehta S. Respiratory Care. 2009; 54: 116-26.

Respiratory Failure
Disorders of Oxygenation

- Acute Respiratory Distress Syndrome/ ALI
- Pulmonary contusion
- Pneumothorax
- Pulmonary embolism
- Aspiration
- Pneumonia
- Pulmonary Edema
  - Congestive heart failure
  - Iatrogenic fluid overload

Respiratory Failure
Disorders of Ventilation

- Obstructive
  - COPD
  - Mucus plugging
- Altered mental status/ CNS injury
- Pain
  - Rib fractures
  - Abdominal/Thoracic surgery
- Chest wall trauma

Benefits and risks of noninvasive ventilation

A prospective observational study in 70 ICUs

1076 patients requiring ventilatory support.

•Failure associated with

increased mortality

for de novo (non-CHF, non-COPD) patients.

•Nosocomial pneumonia rates were not statistically different in the NIV and ETI groups

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Level of Evidence	Grading Criteria	Grade of Recommendation
1a	Systematic review of RCTs including meta-analysis	A
1b	Individual RCT with narrow confidence interval	A
1c	All and none studies	B
2a	Systematic review of cohort studies	B
2b	Individual cohort study and low quality RCT	B
2c	Outcome research study	C
3a	Systematic review of case-control studies	C
3b	Individual case-control study	C
4	Case-series, poor quality cohort and case-control studies	C
5	Expert opinion	D

Demoule A, Girou E, Richard JC, et al.

Intensive Care Med 2006; 32: 1756–65.

Complications of Noninvasive Ventilation in Acute Care

Systematic Review of RCT's from 1989-2007 grouped by etiology of respiratory failure

•Conclusion:

If NIV is inappropriately

applied for too long,

the consequences may lead to death,

presumably due to

excessive delay of intubation.

Medscape® www.medscape.com

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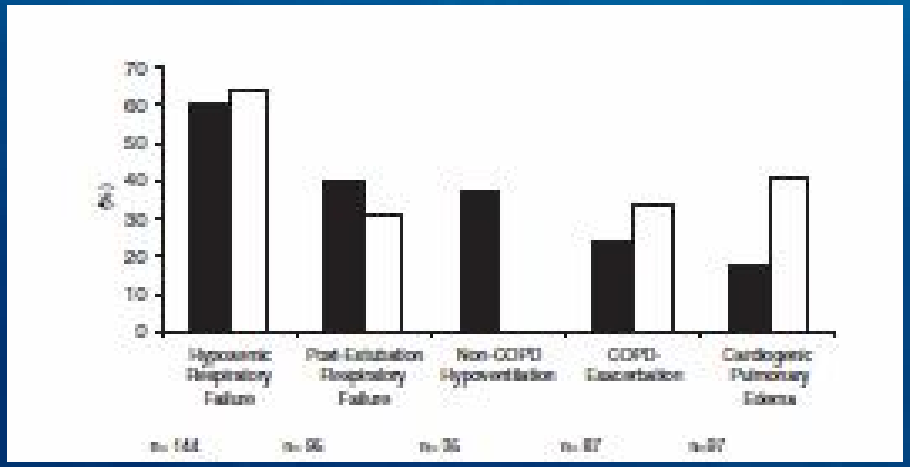
Gay P. Respiratory Care. 2009;54(2):246–257

NIV in acute respiratory failure outside clinical trials: Experience at the Massachusetts General Hospital.

Prospective observational study consisting of 449 patients over the course of one year.



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60% intubation rate with an associated 64% mortality.

Schettino G, Altobelli N, Kacmarek RM. Crit Care Med. 2008; 36, 441-47.

NIV for Acute Respiratory Failure: The Randomized Controlled Trials

Systematic Review of RCT's from 1989-2007 grouped by etiology of respiratory failure

- Conclusion: NIV for ARF is supported by strong evidence in COPD.
- For patients with pneumonia or ALI RCT-level evidence is lacking or does not suggest benefit.

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Keenan SP, Mehta S. Respiratory Care. 2009; 54: 116-26.

Noninvasive ventilation for respiratory failure after extubation.

Multicenter RCT consisting of 221 patients, trial stopped early.

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•Conclusion: noninvasive positive-pressure ventilation does not prevent reintubation or reduce mortality in unselected patients who have respiratory failure after extubation.

Esteban A, et. al. NEJM. 2004; 350;2452-60.

Treatment of acute hypoxemic respiratory insufficiency with CPAP

RCT examined patients with hypoxemic respiratory failure.

Treatment failed to reduce:

- the intubation rate, hospital mortality or ICU length of stay

- A **higher number of adverse events** occurred with CPAP treatment (18 vs 6; P=0.01) including cardiac arrest

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4	Case-series, poor quality cohort and case-control studies	C
5	Expert opinion	D

Delclaux C, et. al. Treatment of acute hypoxemic nonhypercapnic respiratory insufficiency with CPAP delivered by a face mask: A randomized controlled trial. JAMA 2000; 284:2352–2360.

Continuous positive airway pressure for treatment of postoperative hypoxemia.

RCT: 209 patients with severe hypoxemic respiratory failure after abdominal surgery

- Results: decreased intubation rate and PNA in patients with severe hypoxemia (P:F < 300)

- Conclusion: study not generalizable

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Squadrone V, Coha M, Cerutti E, et al. JAMA. 2005;293:589–595. Fiore J. Annals of Surgery. 2009 249;2:351-352,

Continuous positive airway pressure for treatment of postoperative hypoxemia.

RCT: 209 patients with severe hypoxemic respiratory failure after abdominal surgery

- Finding: Hypoxemic respiratory failure caused by atelectasis.
- Conclusion: did not compare standard medical therapies to CPAP.

Venturi mask at 50% 02 not standard therapy for atelectasis.

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Source: Ann Surg © 2004 Lippincott Williams & Wilkins

Squadrone V, Coha M, Cerutti E, et al. JAMA. 2005;293:589–595. Fiore J. Annals of Surgery. 2009 249;2:351-352,

Indications for NIV: Best Use

Acute or acute on chronic ventilatory failure, $PaCO_2 > 45$ mm Hg, $pH < 7{\cdot}35$

Plant PK, Owen JL, Elliott MW. Lancet 2000; 355: 1931–35.

Is NIV cost-effective?

Table 6. Diagnosis-Related Groups and National Average Payments

Current DRG	Former DRG	Description	Payment* ($)	Type of Ventilation
189	87	Pulmonary edema and respiratory failure	6,780	NIV
190-192	88	Chronic obstructive pulmonary disease	5,528	NIV
208	566	Respiratory system diagnosis: intubation and ventilatory support < 96 h	11,150	Intubation
207	565	Respiratory system diagnosis: ventilatory support ≥ 96 h	25,429	Intubation
004	483	Tracheostomy, except for face, mouth, and neck diagnoses	56,694	Tracheostomy and mechanical ventilation

* Payment assumes a 2008 standardized amount of $4,963.64, a hospital with a wage index of 1.000, and does not include capital payment or any add-on payments for teaching, disproportionate share, et cetera. The amount does not take into account the current blended-payment formula, under which payment is based on both old and new Diagnosis-Related Groups (DRGs).

Gay P. Respiratory Care. 2009;54(2):246–257

NIV: in the field and ED

Katie Bakes, MD with CPAP

"When Littleton Fire Rescue arrived, I had a pulse ox of 55% and HR around 200. They gave me CPAP in the ambulance, and it was the first time I felt like I might actually live."

NIV in the SICU? No thanks!

- NIV requires holding tube feeds due to aspiration risk.
- NIV is not cost-effective.
- Evidence does not support routine use in abdominal surgery patients post-op.
- Evidence advises against use in patient with ALI/ARDS.
- Using NIV to prevent reintubation is not recommended and may even be dangerous.

Take Home Points

1. **For respiratory failure in the SICU**
   treat the patient not the symptom.

2. **CPAP/BIPAP: good for ventilation,**
   poor oxygenation device.

3. **NIV use has potential**
   for harm in patients with ALI/ARDS.

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