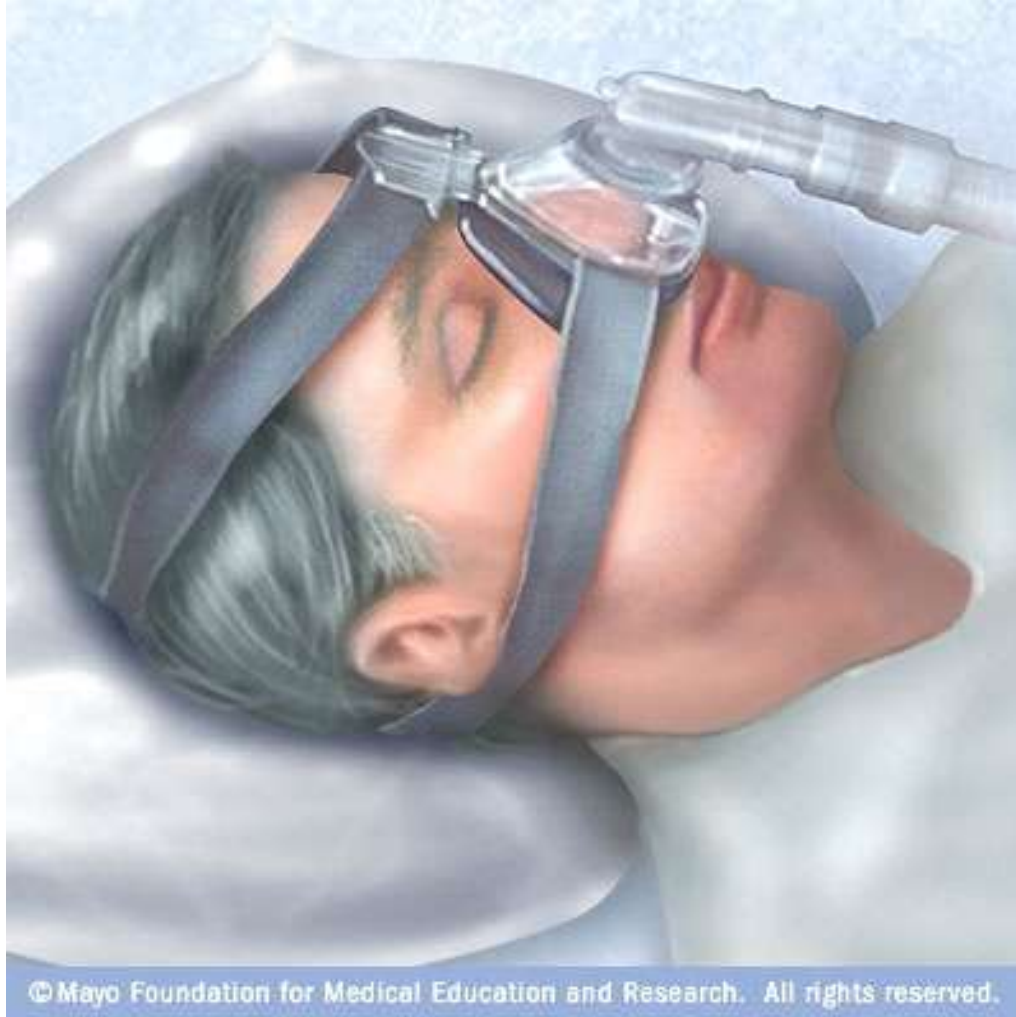


# Non Invasive Ventilation



# Introduction to CPAP

CPAP, initially used for the treatment of acute pulmonary edema, became popular in the 1980s for management of obstructive sleep apnea



# Noninvasive ventilation (NIV):

A form of ventilatory support that avoids airway invasion

→ improved outcomes in certain types of acute respiratory failure

The successful application of NIV requires the training & collaboration of an experienced ICU team, including intensivists, nurses, and respiratory therapists

# Non Invasive Ventilation

- **CPAP** = Continuous Positive Airway Pressure
  - ▣ constant, positive, end–expiratory airway pressure
- **NIPPV = BiPAP** = Bilevel Positive Airway Pressure
  - ▣ same constant positive end–expiratory pressure, with added positive pressure at the onset of inspiration
- **Mechanisms of Action**
  - ▣ Improves alveolar ventilation by increasing Tidal Volume
  - ▣ Improves oxygenation
    - Recruits atelectatic alveoli & decreases intrapulmonary shunting
  - ▣ Decreases work of breathing
  - ▣ Improves cardiac output

# BIPAP /NIV delivery devices

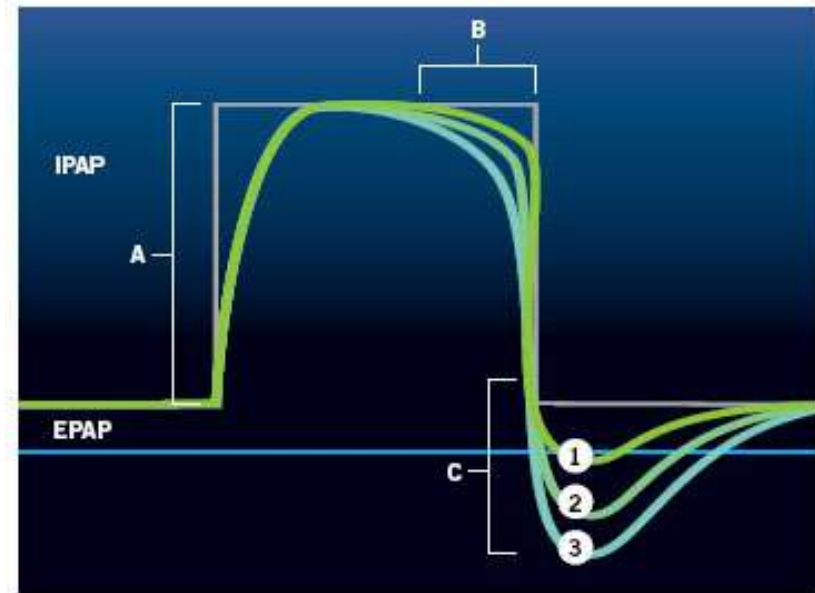
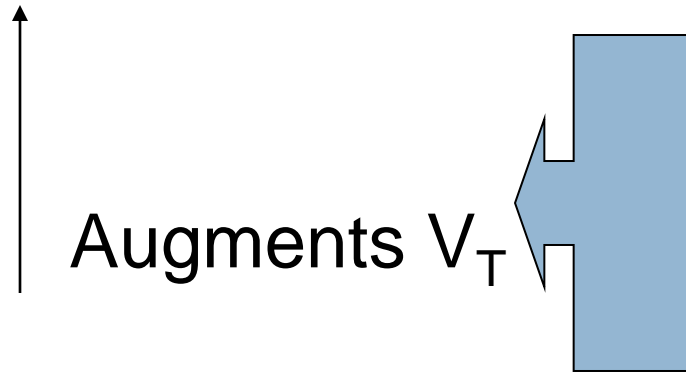


# Interfaces



# Set two pressures...IPAP and EPAP

Reduce PaCO<sub>2</sub>



IPAP equals Pressure support  
CPAP equals PEEP

# Who benefits from NIV?

- Hypercapneic respiratory failure
  - ▣ COPD exacerbations
  - ▣ Neuromuscular disorders
  - ▣ Chest wall deformities eg kyphoscoliosis
- Hypoxemic respiratory failure
  - ▣ Cardiogenic pulmonary edema
- Post extubation to avoid re-intubation
- Palliative care for DNR patients

# NIV and COPD is it effective?

- ▣ Improved quality of life
- ▣ Reduced intubation rate
- ▣ Reduction in hospital days
- ▣ Reduced mortality



Diaz et al E. Resp J 2002, 20: 1490  
Clini et al E. Resp J 2002: 20: 529  
Tuggery et al Thorax 2003: 58: 867  
Keenan et al Ann Int Med 2003

# NIV – bridge to extubation in COPD

- Failed weaning trial
- Extubate to NIV compared with continued intubation:
  - ▣ Increased weaning rate at 28 days
  - ▣ Reduced
    - Rate of MV
    - ICU LOS
    - Incidence of nosocomial pneumonia
    - 60 day mortality
    - Less need for tracheostomy
  - ▣ But be careful with patient selection
    - Avoid if difficult airway
    - Need IPAP of ~ 15 cm water

Nava et al Ann Int Med 1998

Ferrer Am et al J Resp Crit care Med 2003

# Asthma and NIV?

- Weak evidence
  - ▣ Improved gas exchange
  - ▣ Reduced intubation rate
  - ▣ ? Improved peak flow
  - ▣ ? Reduced hospitalization
- Monitor – low threshold to intubate

Meduri et al Chest 1996  
Sorosky et al Chest 2003

# Cardiogenic pulmonary edema

## Role for NIV?

- Increased functional residual capacity
  - ▣ Re-expand alveoli - improve oxygenation
- Improved lung compliance
- Improved cardiac output
- NIV better than CPAP



# Pneumonia & NIV – not routine

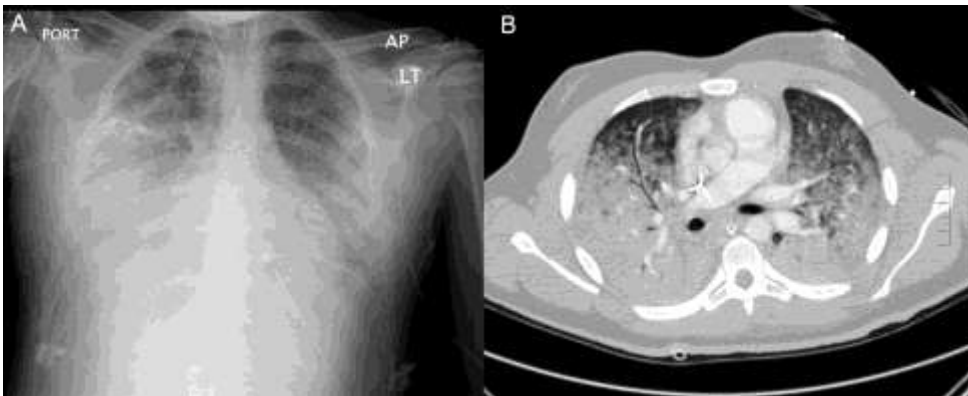
- Conflicting data on NIV efficacy
- Effective in subgroup of subjects with COPD
  - ▣ Careful patient selection



Confalonieri et al Am J Resp Crit Care Med 1999  
Jolliet P Int Care Med 2001  
Hill et al CCM 2007

# NIV and ALI/ARDS

- Failure rate  $> 50\%$  especially in
  - ▣ Hypoxemia, shock, metabolic acidosis
  - ▣ SAPS score  $> 34$
  - ▣  $\text{PaO}_2/\text{FiO}_2 < 175$



Antonelli et al CCM 2007

# NIV and extubation failure

- Not indicated for most subjects
- ? Helpful in
  - ▣ COPD
  - ▣ Cardiogenic pulmonary edema
  - ▣ Hypercapnic respiratory failure
- Monitor closely
  - ▣ Low threshold to intubate

Keenan SP et al JAMA 2002  
Esteban A NEJM 2004  
Nava CCM 2005

# Respiratory Failure in Immunocompromised Patients



The data support NIV as the preferred initial ventilatory modality for these patients, to avoid intubation and its associated risks (reduced infectious complications)

Table 1. Noninvasive ventilation for various types of acute respiratory failure (ARF): Evidence for efficacy and strength of recommendation

Type of ARF	Level of Evidence <sup>a</sup>	Strength of Recommendation <sup>b</sup>
Hypercapnic respiratory failure		
COPD exacerbation	A	Recommended
Asthma	C	Option
Facilitation of extubation (COPD)	A	Guideline
Hypoxemic respiratory failure		
Cardiogenic pulmonary edema	A	Recommended
Pneumonia	C	Option
ALI/ARDS	C	Option
Immunocompromised	A	Recommended
Postoperative respiratory failure	B	Guideline
Extubation failure	C	Guideline
Do not intubate status	C	Guideline
Preintubation oxygenation	B	Option
Facilitation of bronchoscopy	B	Guideline

**A, multiple RCTs & meta-analyses**

**B, more than one RCT, case control series, or cohort studies**

**C, case series or conflicting data**

When in doubt, a brief, cautious trial of NIV can be attempted, with plans to intubate if the patient fails to improve sufficiently

# Patient selection for NIV



- Need for ventilatory assistance
- No contraindications for NIV

# Patient Selection

## Criteria for selecting patients for NIPPV:

1. Alert & cooperative.
2. Hemodynamic stability.
3. No need for endotracheal intubation: to protect airways or to remove excessive secretions.
4. No acute facial trauma.
5. Properly fitted mask.
6. No multiorgan dysfunction.

# NIV contraindications


1. Respiratory arrest–Intubate!
2. Cardiovascular instability (hypo tension, arrhythmias, myocardial infarction).
3. Somnolence impaired mental status, uncooperative patient.
4. High aspiration risk; unable to protect airway, Viscous or copious secretions.
5. Recent facial or gastro–esophageal surgery.
6. Cranio–facial trauma, fixed naso–pharyngeal abnormalities.
7. Burns.
8. Extreme obesity ( $>200\%$  of ideal body wt).

# Advantages of NIV

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- **Better tolerance.**
- **No need for sedation.**
- **Patient can talk, eat, ...**

# Drawbacks of NIPPV:

- Air leaks.
- Facial skin necrosis
- Gastric distension
- Eye irritation.
- Claustrophobia.
- If delays intubation increased  mortality is increased

# Selection of ventilator and ventilator settings

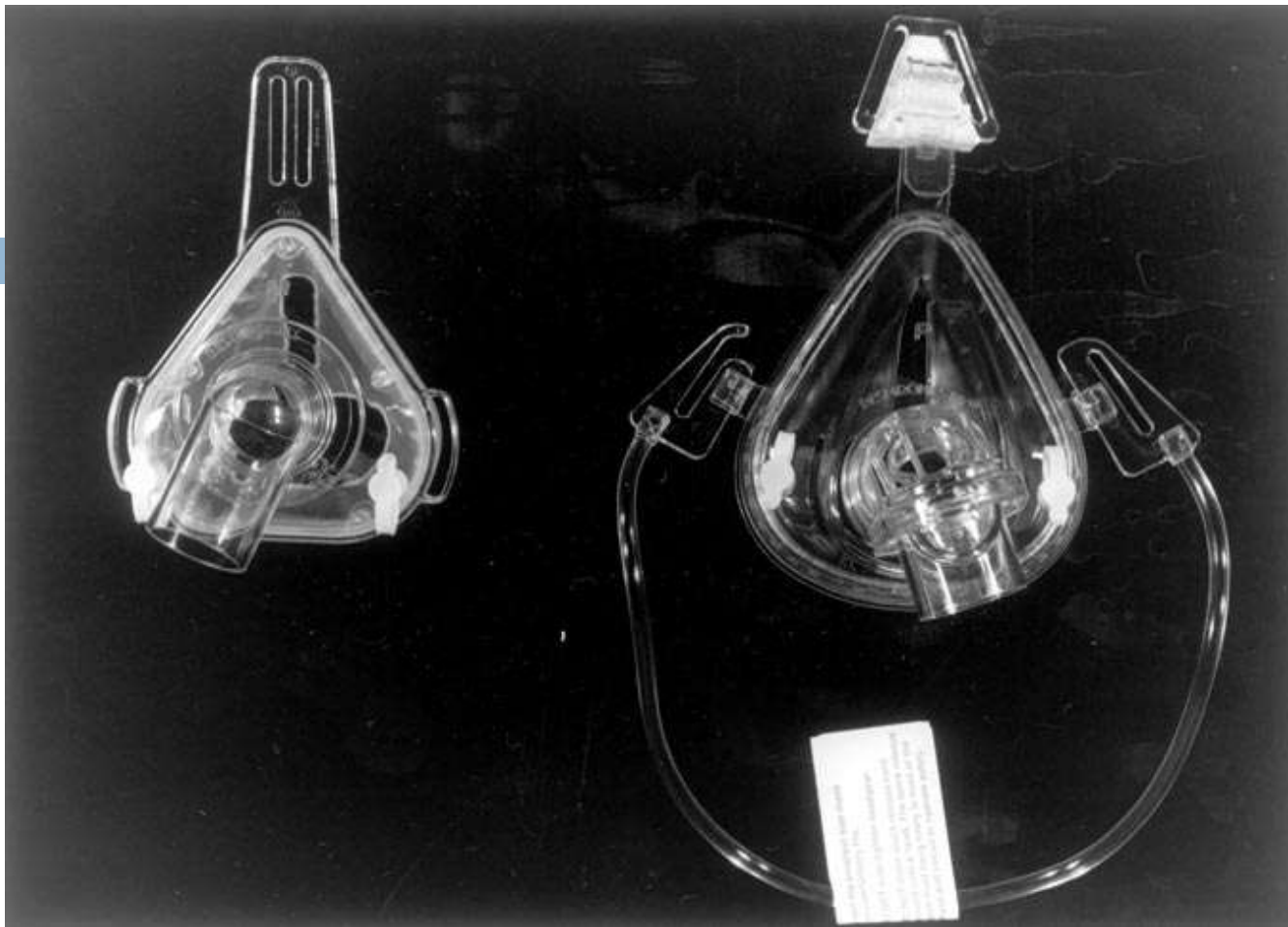
A process of balancing the ability to reduce work of breathing by providing an adequate level of pressure support (usually starting at 8–10 cm H<sub>2</sub>O) against the discomfort & greater air leak imposed by higher pressures



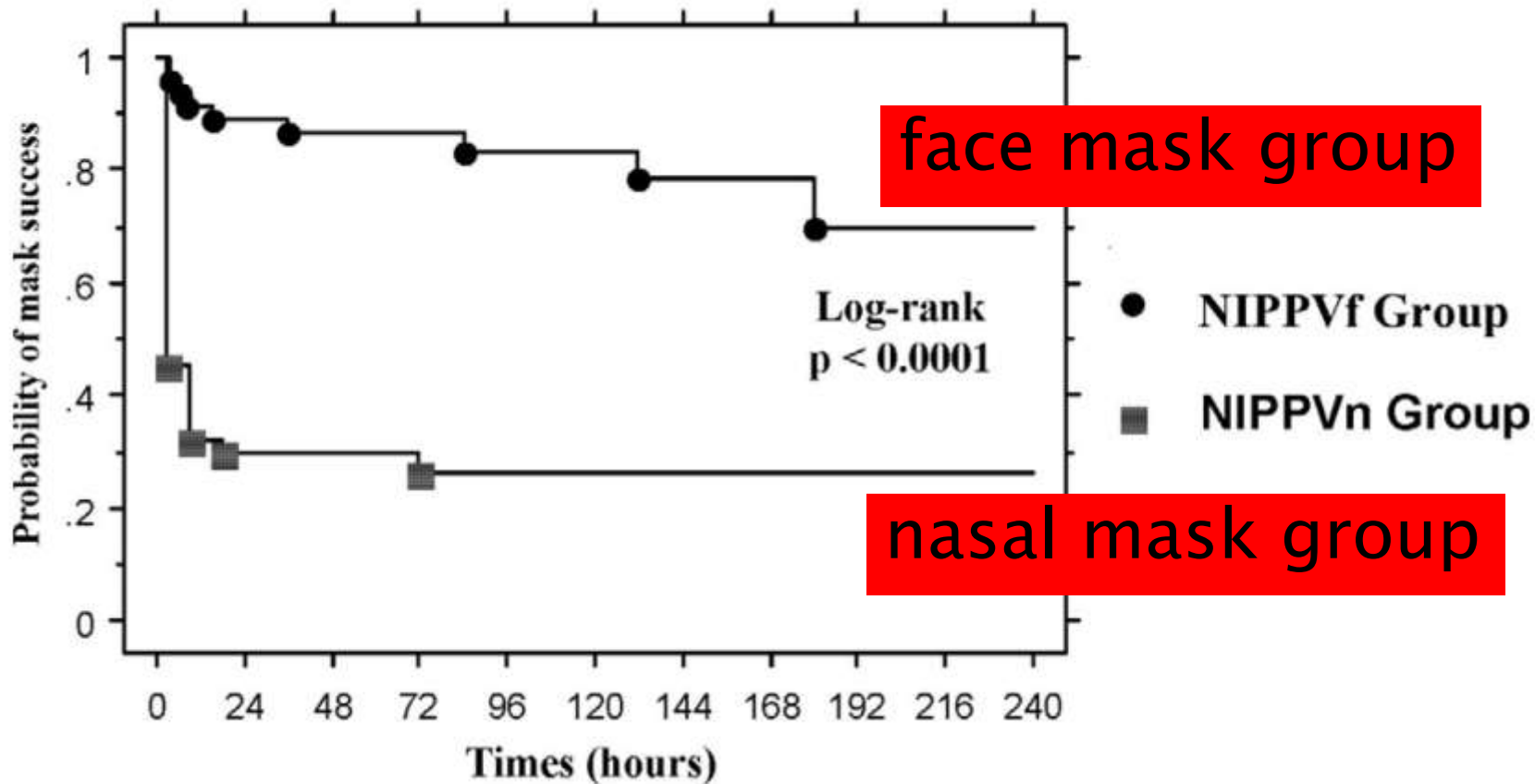
# NIV TECHNIQUES

# Selection of an Interface

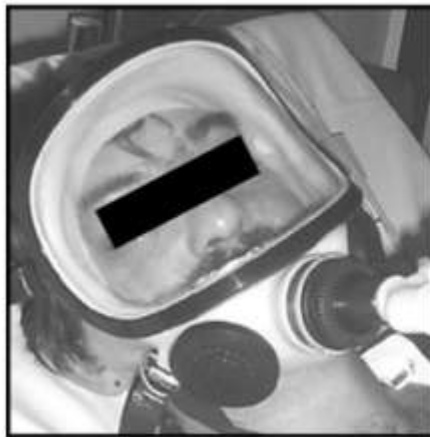
**Selection of a properly fit  
& comfortable interface is  
critical to NIV success**



***Conclusion:* Although both masks performed similarly with regard to improving vital signs and gas exchange and avoiding intubation, the nasal mask was less well tolerated than the oronasal mask in patients with acute respiratory failure. (Crit Care Med 2003; 31:468–473)**



**Conclusions:** A face mask should be the first-line strategy in the initial management of hypercapnic acute respiratory failure with NIPPV. However, if NIPPV has to be prolonged, switching to a nasal mask may improve comfort by reducing face mask complications. (Crit Care Med 2009; 37:124–131)



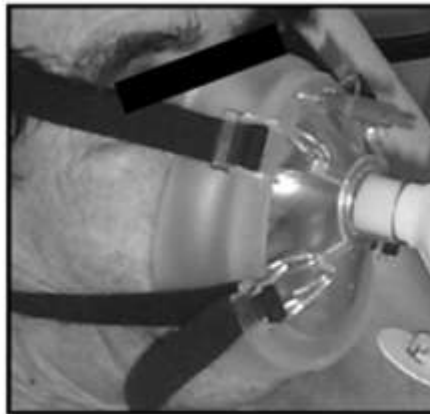
**INSPIR'AID**

Integral mask with the largest internal volume (977 ml)



**FULL FACE**

Large oronasal mask with a large internal volume (163 ml)



**AIRVIE**

Small oronasal mask with a moderate internal volume (84 ml)



**ORACLE**

Mouth piece without internal volume

*Leaks & Asynchrony*

**Conclusion:** The internal volume of the masks had no apparent short-term dead space effect on gas exchange, minute ventilation, or patient's effort, suggesting that, with the exception of mouthpiece, interfaces may be interchangeable in clinical practice provided adjustment of the ventilatory device parameters are performed. (Crit Care Med 2009; 37:939–945)



2



# How long would you try

- One hour !
- If successful then extend as necessary

# Successful application of NIV

- Decreased work of breathing (decreased respiratory rate, less use of accessory muscles..)
- Improved gas exchange (CO<sub>2</sub>, PO<sub>2</sub>)
- Patient feels better

# Keys to success

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1. Consideration the etiology of the ARF & evidence for efficacy
2. Good candidates for NIV ? & no contraindications
3. Consideration of predictors of success & failure
4. Selection of an Interface & ventilator settings
5. Experience of caregivers

## Subjective

Mask comfort

Tolerance of ventilator settings

Respiratory distress

## Physical findings

Respiratory rate

Other vital signs

Accessory muscle use

Abdominal paradox

## Ventilator parameters

Air leaking

Adequacy of pressure support

Adequacy of PEEP

Tidal volume (5–7 mL/kg)

Patient-ventilator synchrony

## Gas exchange

Continuous oximetry (until stable)

ABGs, baseline and 1–2 hrs, then as indicated

## Location

Usually ICU or respiratory care unit to start

General ward may be OK if patient stable

Depends on monitoring needs of patients and  
monitoring capabilities of unit

# Monitoring of NIV for ARF

# Predictors of failure: Noninvasive ventilation (NIV) for acute respiratory failure

## COPD

Air leaking

APACHE II  $\geq 29^b$

Asynchrony

Copious secretions ★

Glasgow Coma Score  $\leq 11^b$

Lack of “compliance” or “tolerance”

pH  $< 7.25^b$

Respiratory rate  $\geq 35$  breaths/min<sup>b</sup>

## Hypoxemic respiratory failure

ALI/ARDS

SAPS II  $\geq 35$  ★

Metabolic acidosis

PaO<sub>2</sub>/FIO<sub>2</sub>  $\leq 146$  (or  $\leq 175$  for ARDS) after 1

hr of NIV ★

Pneumonia

Severe hypoxemia

Shock