Noninvasive Ventilation in Acute Respiratory Failure

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Question 1

- Noninvasive positive-pressure ventilation was associated with less morbidity (including from intubation), lower mortality, lower adverse events, or lower medical utilization when compared with supportive medical therapy or invasive ventilation in which disease state?

a. In adults with chronic obstructive pulmonary disease and acute respiratory failure?
b. In adults with acute cardiogenic pulmonary edema?
c. In adults with acute respiratory failure due to other causes including pneumonia, asthma, obesity hypoventilation syndrome, and interstitial lung disease?
d. In adults with acute respiratory failure in selective settings, including the postoperative setting and the post-transplant setting?

Williams JW Jr, Cox CE, Hargett CW, et al. AHRQ Comparative Effectiveness Review No. 68. Available at www.effectivehealthcare.ahrq.gov/nppv.cfm.

Question 2

- Intubation has what benefit over noninvasive positive-pressure ventilation (NPPV) :

a. Requires less sedation.
b. Allows the patient to communicate easier.
c. Assists with secretion clearance.
d. Decreases nosocomial pneumonia.

Williams JW Jr, Cox CE, Hargett CW, et al. AHRQ Comparative Effectiveness Review No. 68. Available at www.effectivehealthcare.ahrq.gov/nppv.cfm.
Pierson DJ. Respir Care 2009;54(1):40-52. PMID: 19111105.

Question 3

- CPAP in hypoxemic respiratory failure

a. Decreases functional residual capacity.
b. Improves V/Q mismatch
c. Increases work of breathing.
d. Increases afterload.

Ventilatory and hemodynamic effects of continuous positive airway pressure in left heart failure. Am J Respir Crit Care Med. 1997 Feb;155(2):500-5.

Question 4

- Potential benefits for using NIV in a patient with a CMO status are:

a. Allows travel of family member.
b. Allows the patient to transfer home to die.
c. Allows the patient to finish financial matter.
d. A and B
e. All the above.

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Outline of Material

- Brief review of acute respiratory failure
- Introduction of the role of noninvasive ventilation (NIV) modalities in managing acute respiratory failure of various etiologies
- Results of studies and evidence-based conclusions about the relative benefits and adverse effects of currently available NIV modalities for acute respiratory failure
- Gaps in knowledge and future research needs
- Ethics of noninvasive ventilation

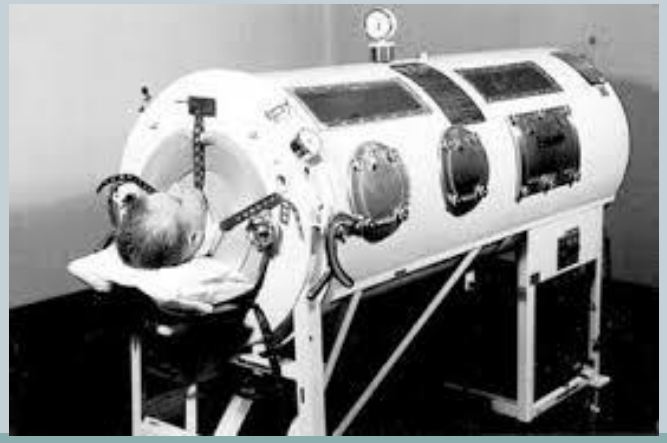
Noninvasive Ventilation (NIV)

- **Delivery of ventilation to the lungs without an invasive airway (endotracheal or tracheostomy)**
- **Avoid the adverse effects of intubation or tracheostomy (early and late)**

"Noninvasive ventilation in acute respiratory failure", Int J Chron Obstruct Pulmon Dis. 2014; 9: 837-852.

Types of Noninvasive Ventilation

- Negative pressure ventilation (iron or tank-chest cuirass)
- Abdominal Displacement(Pneumobelt-Rocking bed)
- Positive pressure ventilation(pressure BIPAP- CPAP,Volume)



Acute Respiratory Failure

- Acute respiratory failure
  - Significant change in a patient's baseline gas-exchange status that occurs relatively suddenly (usually hours to days) and is potentially life threatening but does not require emergent intubation.
- The annual incidence of acute respiratory failure
  - 77.6 to 430 patients per 100,000 in the United States
  - Expected to rise as the population ages.

Williams JW Jr, Cox CE, Hargett CW, et al. AHRQ Comparative Effectiveness Review No. 68. Available at www.effectivehealthcare.ahrq.gov/nppv.cfm.
Behrendt CE. Chest 2000;118(4):1100-5. PMID: 11035684.
Cartin-Ceba R, Kojicic M, Li G, et al. Chest 2011;140(6):1447-55. PMID: 21998258.

Acute Respiratory Failure

- Acute respiratory failure can stem from various causes, including:
  - Chronic obstructive pulmonary disease
  - Acute cardiogenic pulmonary edema
  - Pneumonia
  - Acute respiratory distress syndrome
  - Asthma
  - Obesity hypoventilation syndrome
  - Interstitial lung disease

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Invasive Ventilation for the Management of Acute Respiratory Failure

- Strategies for managing acute respiratory failure depend on the underlying etiology and severity and include emergent ventilation, medications, or respiratory support.
- In severe cases, acute respiratory failure requires respiratory support with invasive mechanical ventilation.
- Despite the benefits of invasive ventilation in treating respiratory failure, up to 40 percent of patients die in the hospital.
  - Some of these deaths are directly attributable to the complications of invasive ventilation.
- Patients might require prolonged invasive ventilation
  - Can lead to an adverse impact on quality of life and functional independence.

Williams JW Jr, Cox CE, Hargett CW, et al. AHRQ Comparative Effectiveness Review No. 68. Available at www.effectivehealthcare.ahrq.gov/nppv.cfm.
Cartin-Ceba R, Kojicic M, Li G, et al. Chest 2011;140(6):1447-55. PMID: 21998258.
Esteban A, Anzueto A, Frutos F, et al. JAMA 2002;287(3):345-55. PMID: 11790214.

Noninvasive Positive-Pressure Ventilation (NPPV) for Managing Acute Respiratory Failure

- An increasingly recognized option for managing certain cases of acute respiratory failure
- NPPV uses positive pressure to deliver a mixture of air and oxygen throughout the respiratory tree.
- Patient interfaces for NPPV include a face mask, a nasal mask, or nasal pillows.
- The two most commonly used modes of NPPV are:
  - Continuous positive airway pressure (CPAP)
  - Bilevel positive airway pressure (BPAP)

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Pierson DJ. Respir Care 2009;54(1):40-52. PMID: 19111105.

ADVANTAGES OF NIV

- Preservation of airway defense mechanism
- Early ventilatory support
- Intermittent ventilation possible
- Patient can eat, drink and communicate
- Ease of application and removal
- Patient can cooperate with physiotherapy
- Improved patient comfort
- Reduced need for sedation
- Reduces need for invasive monitoring

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Pierson DJ. Respir Care 2009;54(1):40-52. PMID: 19111105.

ADVANTAGES OF NIV

- Can be initated and discontinued as needed.
- Avoidance of complications of endotracheal intubation
  - upper airway trauma, sinusitis, otitis, nosocomial (ventilator associated) pneumonia
- Reduces risk of ventilator induced lung injury associated with high ventilating pressures
- Ventilation outside hospital possible
- Correction of hypoxemia without worsening hypercarbia
- Less cost

Williams JW Jr, Cox CE, Hargett CW, et al. AHRQ Comparative Effectiveness Review No. 68. Available at www.effectivehealthcare.ahrq.gov/nppv.cfm.
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Noninvasive Ventilation Disadvantages

- It is a resource-intensive modality
  - Requires a significant amount of physician and nursing time.
- Substantial training and experience are needed for its implementation.
- Mask uncomfortable or claustrophobic
- It is not appropriate for some patients
  - Shock, facial trauma, cardiopulmonary arrest, severely impaired consciousness, or high aspiration risk, unable to cooperate, protect the airway, or clear secretions.

Williams JW Jr, Cox CE, Hargett CW, et al. AHRQ Comparative Effectiveness Review No. 68. Available at www.effectivehealthcare.ahrq.gov/nppv.cfm.
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Uncertainties Related to the Use of NPPV in Managing Acute Respiratory Failure

- Noninvasive positive-pressure ventilation (NPPV) has been assessed in several trials; clinically important benefits for this modality have been demonstrated in some of these trials.
- However, the use of NPPV remains highly variable. Challenges related to the use of NPPV include:
  - Lack of physician knowledge
  - Low rates of perceived efficacy
  - Limited information on the effects of NPPV in patients with respiratory failure caused by conditions other than COPD and ACPE

Williams JW Jr, Cox CE, Hargett CW, et al. AHRQ Comparative Effectiveness Review No. 68. Available at www.effectivehealthcare.ahrq.gov/nppv.cfm.

Goals of NIV

Short term (acute)

- ✓ **Relieve symptoms**
- ✓ **Reduce work of breathing**
- ✓ **Improve or stabilize gas exchange**
- ✓ **Good patient-ventilator synchrony**
- ✓ **Optimize patient comfort**
- ✓ **Avoid intubation**
- ✓ **Minimize risk**

"Noninvasive Ventilation", Proceedings of the Amer Thoracic Soc, Vol. 6, No. 4 (2009), p 367-370.

Why the interest in NIV

The desire to avoid complications of invasive ventilation

- **Complications related to the process of intubation and mechanical ventilation**
  - **Aspiration**
  - **Trauma**
  - **Arrythmias and hypotension**
  - **Barotrauma**
- **Complications caused by loss of airway defense mechanisms**
  - **Direct conduit to lower airway → chronic bacterial colonization**

"Noninvasive ventilation in acute respiratory failure", Int J Chron Obstruct Pulmon Dis. 2014; 9: 837-852.

MECHANISM OF ACTION

- Improvement in pulmonary mechanics and oxygenation
  - COPD - oxygen therapy can worsen hypercarbia and respiratory acidosis.
  - NIV augments alveolar ventilation and allows oxygenation without raising $PaCO_2$
- Partial unloading of respiratory muscles
  - NIV increases tidal volume, decrease in respiratory rate and increase in minute ventilation.

"Noninvasive ventilation in acute respiratory failure", Int J Chron Obstruct Pulmon Dis. 2014; 9: 837-852.

PREREQUISITIES

- Patient is able to cooperate
- Patient can control airway and secretions
- Adequate cough reflex
- Patient is able to coordinate breathing with ventilator
- Patient can breathe unaided for several minutes
- Hemodynamically stable
- Improvement in gas exchange, heart rate and respiratory rate within first two hours
- Normal functioning gastrointestinal tract

INDICATIONS OF NIV

- **Acute Respiratory Failure**
  - Hypercapnic acute respiratory failure
    - Obstructive and restrictive disease
  - Hypoxic acute respiratory failure
    - Acute pulmonary edema
    - Acute pneumonia
    - ARDS
    - Trauma
  - Acute exacerbation of COPD
  - Status asthmaticus

"Noninvasive ventilation in acute respiratory failure", Int J Chron Obstruct Pulmon Dis. 2014; 9: 837-852.

INDICATIONS OF NIV

- **Acute Respiratory Failure**
  - Post surgical respiratory failure
  - Post extubation
    - ✓ Avoid reintubation if RF develops
    - ✓ Improve gas exchange and pulmona
  - Weaning difficulties
    - Before extubation criteria met
  - Cystic fibrosis
  - Acute respiratory failure in obesity hypoventilation Syndrome

"Noninvasive ventilation in acute respiratory failure", Int J Chron Obstruct Pulmon Dis. 2014; 9: 837-852.

INDICATIONS OF NIV

- Chronic Respiratory Failure
- Immunocompromised Patients
  - Avoid ETT→ ↓infectious and hemorrhagic complications
- Do Not Intubate Patients
  - ETT is contraindicated
  - Pt. refuses

"Noninvasive ventilation in acute respiratory failure", Int J Chron Obstruct Pulmon Dis. 2014; 9: 837-852.

Selection Criteria

- Acute Respiratory Failure (At least two of the following criteria should be present)
  - Respiratory distress with dyspnea
  - Use of accessory muscles of respiration
  - Abdominal paradox
  - Respiratory rate >25/min
  - ABG shows pH <7.35 or $PaCO_2$ >45mmHg or PaO_2/FiO_2 <200

"Noninvasive ventilation in acute respiratory failure", Int J Chron Obstruct Pulmon Dis. 2014; 9: 837-852.

Selection Criteria

Indications	Signs and Symptoms	Selection Criteria
✓Acute exacerbation of chronic obstructive pulmonary disease(COPD) ✓Acute asthma ✓Hypoxemic respiratory failure ✓Community – acquired pneumonia ✓Cardiogenic pulmonary edema ✓Immunocompromised patients ✓Postoperative patients ✓Postextubation (weaning) status ✓"Do not intubate"status	Moderate to severe dyspnea ■ RR > 24 breaths/min ■ Use of accessory muscles ■ Paradoxical breathing	$PaCO_2$ > 45 torr , PH < 7.35 or $PaCO_2$ / F_1 O_2<200

"Noninvasive ventilation in acute respiratory failure", Int J Chron Obstruct Pulmon Dis. 2014; 9: 837-852.

Selection Criteria in COPD

- Chronic Respiratory Failure (Obstructive lung disease)
  - Fatigue, hypersomnolence, dyspnea
  - ABG shows pH <7.35, $PaCO_2$ >55 mmHg
  - Oxygen saturation <88% for >10% of monitoring time despite O_2 supplementation

"Noninvasive ventilation in acute respiratory failure", Int J Chron Obstruct Pulmon Dis. 2014; 9: 837-852.

Selection Criteria

- <u>Thoracic Restrictive/ Cerebral Hypoventilation Diseases</u>
  - Fatigue, morning headache, hypersomnolance, nightmares, enuresis, dyspnea
  - ABG shows $PaCO_2$ >45mmHg
  - Nocturnal SaO_2 <90% for more than 5 minutes sustained or 10% of total monitoring time

"Noninvasive ventilation in acute respiratory failure", Int J Chron Obstruct Pulmon Dis. 2014; 9: 837-852.

Potential indicators of success in NPPV use

Younger age
Lower acuity of illness (APACHE score)
Able to cooperate, better neurologic score
Less air leaking
Moderate hypercarbia (PaCO2 >45 mmHG, <92 mmHG)
Moderate acidemia (pH <7.35, >7.10)
Improvements in gas exchange and heart respiratory rates within first 2 hours

"Noninvasive ventilation in acute respiratory failure", Int J Chron Obstruct Pulmon Dis. 2014; 9: 837-852.
Failed noninvasive poistive-pressure ventilation is associated with an increased risk of intubation-related complications. Ann Intensive Care 2015; 5:4.

Absolute Contraindications to NPPV

Cardiac or respiratory arrest
Nonrespiratory organ failure
Severe encephalopathy (eg, GCS <10)
Severe upper gastrointestinal bleeding
Hemodynamic instability or unstable cardiac arrhythmia
Facial or neurological surgery, trauma, or deformity
Upper airway obstruction

"Noninvasive ventilation in acute respiratory failure", Int J Chron Obstruct Pulmon Dis. 2014; 9: 837-852.

Relative Contraindications to NPPV

Medically unstable (hypotensive shock, uncontrolled cardiac ischemia, or arrhythmia)
Agitated, uncooperative
Swallowing impairment
Multiple organ failure (two or more)
Recurrent upper airway or GI surgery
Progressive respiratory failure
Pregnancy
Inability to protect airway
Inability to clear secretions
High risk for aspiration

"Noninvasive ventilation in acute respiratory failure", Int J Chron Obstruct Pulmon Dis. 2014; 9: 837-852.

Clinical Benefits of Noninvasive Positive Pressure Ventilation

- **ACUTE CARE**
- Reduces need for intubation
- Reduces incidence of nosocomial pneumonia
- Shortens stay in intensive care unit
- Shortens hospital stay
- Reduces mortality
- Preserves airway defenses
- Improves patient comfort
- Reduces need for sedation

CHRONIC CARE

- Alleviates symptoms of chronic hypoventilation
- Improves duration and quality of sleep
- Improves functional capacity
- Prolongs survival

Nasal Mask

- Advantages
  - **Less risk of aspiration**
  - **Enhanced secretion clearance**
  - **Less claustrophobia**
  - **Easier speech**
  - **Less dead space**

- Disadvantages
  - **Mouth leak**
  - **Less effectiveness with nasal obstruction**
  - **Nasal irritation and rhinorrhea**
  - **Mouth dryness**

Nasal Interface

Oronasal (full face mask)

- Preferred
  - In acute settings
  - For patients with copious air leaking through the mouth
  - For edentulous patients
- Interferes with speech, eating and expectoration
- Increase risk of aspiration, rebreathing
- Increase likelihood of claustrophobic reaction

"Noninvasive ventilation in acute respiratory failure", Int J Chron Obstruct Pulmon Dis. 2014; 9: 837-852.

Nasal vs. Full-face Masks

Variables	Nasal	Oronasal
Comfort	+++	++
Claustrophobia	+	++
Rebreathing	+	++
Lowers CO_2	+	++
Permits expectoration	++	+
Permits speech	++	+
Permits eating	+	-
Function if nose obstructed	-	+

Helmet

- A helmet covers the whole head and part of the neck.
- Advantages
  - Well tolerated
  - Allows interaction with the environment
  - Can be used in edentulous patients and with facial trauma
  - Do not cause skin lesions.
  - Can speak, read, eat.
- Disadvantages
  - Noise can be annoying.

"Noninvasive ventilation in acute respiratory failure", Int J Chron Obstruct Pulmon Dis. 2014; 9: 837-852.

Helmet

CPAP

- Not a true ventilator mode as it does not actively assist inspiration.
  - Delivers constant pressure during both inspiration and expiration
- Increase functional residual capacity
  - Improve lung compliance
  - Open collapsed alveoli
  - Improve oxygenation
  - Decrease work of breathing

Thorax 2002;57:192-211.

Mask CPAP in Hypoxemic Failure

- **Recruits lung units**
  - improved V/Q matching > rapid correction of PaO_2 & $PaCO_2$[1]
  - increased functional residual capacity
  - decreased respiratory rate and work of breathing
- **Reduces airway resistance**
- **Improves hemodynamics in pulmonary edema**
  - decreases venous return
  - decreases afterload and increases cardiac index (in 50%)
  - decreases heart rate
- **Average requirement: 10cmH_2O**

Ventilatory and hemodynamic effects of continuous positive airway pressure in left heart failure. Am J Respir Crit Care Med. 1997 Feb;155(2):500-5.

BIPAP (Bilevel positive airway pressure)

- Pressure target ventilation
- Cycle between adjustable inspiratory & expiratory (IPAP & EPAP)
- Improve ventilation depends to difference of IPAP & EPAP

Initial BIPAP Settings

- EPAP 4–5 cm H_2O
- IPAP12–15 cm H_2O (to be increased as tolerated to 20 cm H_2O)
- Triggers -Maximum sensitivity
- Back up rate 15 breaths/min
- Back up I:E ratio1:3

Thorax 2002;57:192-211.

Adverse effects and complications of NIV

- Mask related
  - Nasal pain
  - Air leak
  - Nasal bridge erythema and ulceration
- Ventilator air flow or pressure complications
  - Conjunctival irritation
  - Sinus or ear pain
  - Nasal or oral dryness
  - Nasal congestion or discharge
  - Gastric insufflation
  - Failure to ventilate

"Noninvasive ventilation in acute respiratory failure", Int J Chron Obstruct Pulmon Dis. 2014; 9: 837-852.

Complications Associated with Mask CPAP/NPPV Therapy

complications	Corrective Action
Mask discomfort Excessive leaks around mask Pressure sores	• Check mask for correct size and fit. • Minimize headgear tension. • Use spacers or change to another style of mask. • Use wound care dressing over nasal bridge.
Nasal and oral dryness or nasal congestion	• Add or increase humidification. • Irrigate nasal passages with saline. • Apply topical decongestants. • Use chin strap to keep mouth closed. • Change to full face mask.
Aerophagia , gastric distention	• Use lowest effective pressures for adequate tidal volume delivery. • Use simethicone agents.
Aspiration Mucous plugging	• Make sure patients are able to protect the airway. • Ensure adequate patient hydration. • Ensure adequate humidification.

Failure of NIV

- Mask intolerance
- Failure to improve ventilation
- Claustrophobia
- Sensation of excessive air pressure
- Patient-ventilator asynchrony

Monitoring

- Subjective responses
  - Bed side observation
  - Ask about discomfort related to the mask or airflow
- Physiologic response
  - ↓ RR, ↓ HR
  - Patient breath in synchrony with the ventilator
  - ↓ accessory muscle activity and abdominal paradox
  - Monitor air leaks and V_t
- Gas exchange
  - Continuous oximetry
  - Occasional ABG

Criteria for Terminating Noninvasive Positive Pressure Ventilation and Switching to Invasive Mechanical Ventilation

- **Worsening pH and arterial partial pressure of carbon dioxide ($PaCO_2$)**
- **Tachypnea (over 30 breaths/min)**
- **Hemodynamic instability**
- **Oxygen saturation by pulse oximeter (SpO_2) less than 90%**
- **Decreased level of consciousnees**
- **Inability to clear secretions**
- **Inability to tolerate interface**

Failed noninvasive poistive-pressure ventilation is associated with an increased risk of intubation-related complications. Ann Intensive Care 2015; 5:4.

Rating the Strength of Evidence From the Comparative Effectiveness Review

- The strength of evidence was classified into four broad categories:

High	Further research is very unlikely to change the confidence in the estimate of effect.
Moderate	Further research may change the confidence in the estimate of effect and may change the estimate.
Low	Further research is likely to change the confidence in the estimate of effect and is likely to change the estimate.
Insufficient	Evidence either is unavailable or does not permit estimation of an effect.

Williams JW Jr, Cox CE, Hargett CW, et al. AHRQ Comparative Effectiveness Review No. 68. Available at www.effectivehealthcare.ahrq.gov/nppv.cfm.

Overview of the Findings for NPPV Versus Supportive Medical Therapy in Patients With Acute Respiratory Failure

	Mortality	Endotracheal Intubation Rate	Hospital-Acquired Pneumonia	Incident Myocardial Infarction Rates
NPPV + Supportive Medical Therapy Versus Supportive Medical Therapy Only	Decreased with NPPV. Evidence was strongest in patients with COPD or ACPE. (OR = 0.56; 95% CI, 0.44 to 0.72) ***SOE: High***	Decreased with NPPV. Evidence was strongest in patients with COPD or ACPE. (OR = 0.31; 95% CI, 0.24 to 0.41) ***SOE: High***	Decreased with NPPV. Evidence was strongest in patients with COPD. (OR = 0.27; 95% CI, 0.15 to 0.49) ***SOE: Moderate***	No difference between groups. Evidence was strongest in patients with COPD or ACPE. (OR = 1.11; 95% CI, 0.85 to 1.44). ***SOE: Moderate***

95% CI = 95-percent confidence interval; ACPE = acute cardiogenic pulmonary edema; COPD = chronic obstructive pulmonary disease; NPPV = noninvasive positive-pressure ventilation; OR = odds ratio; SOE = strength of evidence

Williams JW Jr, Cox CE, Hargett CW, et al. AHRQ Comparative Effectiveness Review No. 68. Available at www.effectivehealthcare.ahrq.gov/nppv.cfm.

Overview of the Findings for NPPV With BPAP Versus CPAP in Patients With ACPE

	Mortality	Endotracheal Intubation Rate	Hospital-Acquired Pneumonia	Incident Myocardial Infarction Rates
NPPV With BPAP Versus NPPV With CPAP in Patients With ACPE	No difference between groups. (OR = 0.89; 95% CI, 0.58 to 1.35) ***SOE: Moderate***	No difference between groups. (OR = 0.84; 95% CI, 0.51 to 1.38). ***SOE: Moderate***	Not reported	No difference between groups. (OR = 0.69; 95% CI, 0.34 to 1.40) ***SOE: Low***

95% CI = 95-percent confidence interval; ACPE = acute cardiogenic pulmonary edema; BPAP = bilevel positive airway pressure; COPD = chronic obstructive pulmonary disease; CPAP = continuous positive airway pressure; NPPV = noninvasive positive-pressure ventilation; OR = odds ratio; SOE = strength of evidence

Williams JW Jr, Cox CE, Hargett CW, et al. AHRQ Comparative Effectiveness Review No. 68. Available at www.effectivehealthcare.ahrq.gov/nppv.cfm.

NPPV Versus Supportive Medical Therapy in Patients With Acute Respiratory Failure (1 of 2)

- Mortality and endotracheal intubation rates decreased with NPPV versus supportive care (OR for mortality = 0.56, 95% CI 0.44 to 0.72; OR for intubation rate = 0.31, 95% CI 0.24 to 0.41).
  - **Supportive care was medical therapy.**
  - **Evidence was strongest for patients with chronic obstructive pulmonary disease and acute cardiogenic pulmonary edema; limited evidence supported an effect in postoperative and post-transplantation settings.** Strength of Evidence: High

Williams JW Jr, Cox CE, Hargett CW, et al. AHRQ Comparative Effectiveness Review No. 68. Available at www.effectivehealthcare.ahrq.gov/nppv.cfm.

NPPV Versus Supportive Medical Therapy in Patients With Acute Respiratory Failure (2 of 2)

- The rate of hospital-acquired pneumonia decreased with NPPV versus supportive care (OR = 0.27; 95% CI, 0.15 to 0.49); evidence was strongest for patients with chronic obstructive pulmonary disease (COPD).
  Strength of Evidence: Moderate
- No differences in myocardial infarction rates were observed (OR = 1.11; 95% CI, 0.85 to 1.44); evidence was strongest in patients with COPD and acute cardiogenic pulmonary edema.

  Strength of Evidence: Moderate

Williams JW Jr, Cox CE, Hargett CW, et al. AHRQ Comparative Effectiveness Review No. 68. Available at www.effectivehealthcare.ahrq.gov/nppv.cfm.

Noninvasive Positive-Pressure Ventilation With BPAP Versus CPAP in Patients With ACPE

- Mortality and endotracheal intubation rates did not differ significantly when providing NPPV with BPAP versus CPAP (OR for mortality = 0.89, 95% CI 0.58 to 1.35; OR for intubation rate = 0.84, 95% CI 0.51 to 1.38).

  Strength of Evidence: Moderate
- Myocardial infarction did not differ significantly when providing NPPV with BPAP versus CPAP (OR = 0.69, 95% CI 0.34 to 1.40).

  Strength of Evidence: Low

Williams JW Jr, Cox CE, Hargett CW, et al. AHRQ Comparative Effectiveness Review No. 68. Available at www.effectivehealthcare.ahrq.gov/nppv.cfm.

Other Key Findings of the Comparative Effectiveness Review (1 of 2)

- Evidence from a limited number of patients (n = 405) suggested that NPPV, when compared with invasive ventilation, decreased rates of hospital-acquired pneumonia. This evidence was highest in patients with chronic obstructive pulmonary disease.

  Strength of evidence: High
- Evidence from a limited number of patients also suggested that rates of mortality did not differ between NPPV and invasive ventilation groups.

  Strength of evidence: Low

Williams JW Jr, Cox CE, Hargett CW, et al. AHRQ Comparative Effectiveness Review No. 68. Available at www.effectivehealthcare.ahrq.gov/nppv.cfm.

Other Key Findings of the Comparative Effectiveness Review (2 of 2)

- Limited evidence suggested potential benefits of noninvasive positive-pressure ventilation (NPPV) in preventing recurrent respiratory failure after extubation in high-risk patients.

  Strength of Evidence: Low

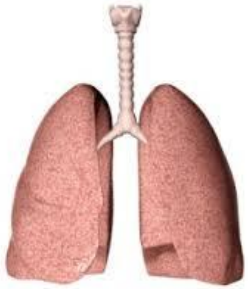
- Limited evidence also suggested some benefits when NPPV was used to facilitate extubation in patients with chronic obstructive pulmonary disease who were intubated for acute respiratory failure.

  Strength of Evidence: Low

Williams JW Jr, Cox CE, Hargett CW, et al. AHRQ Comparative Effectiveness Review No. 68. Available at www.effectivehealthcare.ahrq.gov/nppv.cfm.

Conclusions (1 of 2)

- For patients with acute respiratory failure due to severe exacerbations of COPD or ACPE, NPPV, when compared with supportive medical therapy alone, improved the:
  - Rate of mortality
  - Rate of endotracheal intubation
  - Rate of hospital-acquired pneumonia
- In a limited number of patients, the reduction in the rate of hospital-acquired pneumonia was seen with NPPV when compared with invasive ventilation.



Williams JW Jr, Cox CE, Hargett CW, et al. AHRQ Comparative Effectiveness Review No. 68. Available at www.effectivehealthcare.ahrq.gov/nppv.cfm.

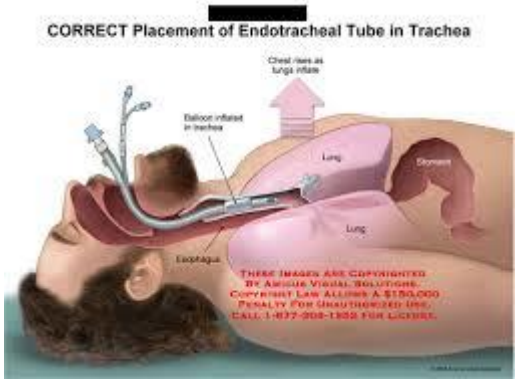
Conclusions (2 of 2)

- Direct comparisons of NPPV with CPAP and BPAP showed similar efficacy in patients with acute cardiogenic pulmonary edema.
- Limited evidence suggested the possibility of a lower benefit with NPPV in studies conducted in clinical practice settings when compared with clinical trials.
  - However, evidence was insufficient to assess the impact of clinician experience, system resources, and patient characteristics on the effects of NPPV.

Williams JW Jr, Cox CE, Hargett CW, et al. AHRQ Comparative Effectiveness Review No. 68. Available at www.effectivehealthcare.ahrq.gov/nppv.cfm.

DNR and DNI

- DNI stands for Do Not Intubate.
- DNI orders and DNR orders are two different things.
  - While a DNR order applies ***only*** in situations where the patient has no pulse, a DNI order applies only in situations where the patient ***still*** has a pulse.
  - DNR can still intubate if no DNI with acute respiratory failure
  - A DNI order means that the patient does not want to have his or her life prolonged through intubation and mechanical ventilation.
    - May still want treatment of arrythmias



http://www.ethics.va.gov/docs/net/net_topic_20050628_what_does_dnr_mean.doc

National Ethics Teleconference
What Does 'DNR' Really Mean?
June 28, 2005

NIV in DNI or CMO Patient

- Is it a comfort measure?
  - Delay death
    - May allow family member travel time
    - May allow transfer to home
    - May allow patient to complete financial matter
  - Ultimately patient's decision and not clinicians for acute respiratory failure.
- DNI and use of NIV in DNI patient frequently not discussed.
  - Physicians reluctant to discuss advance directive
  - More likely discussed when managed patient before hospitalization.

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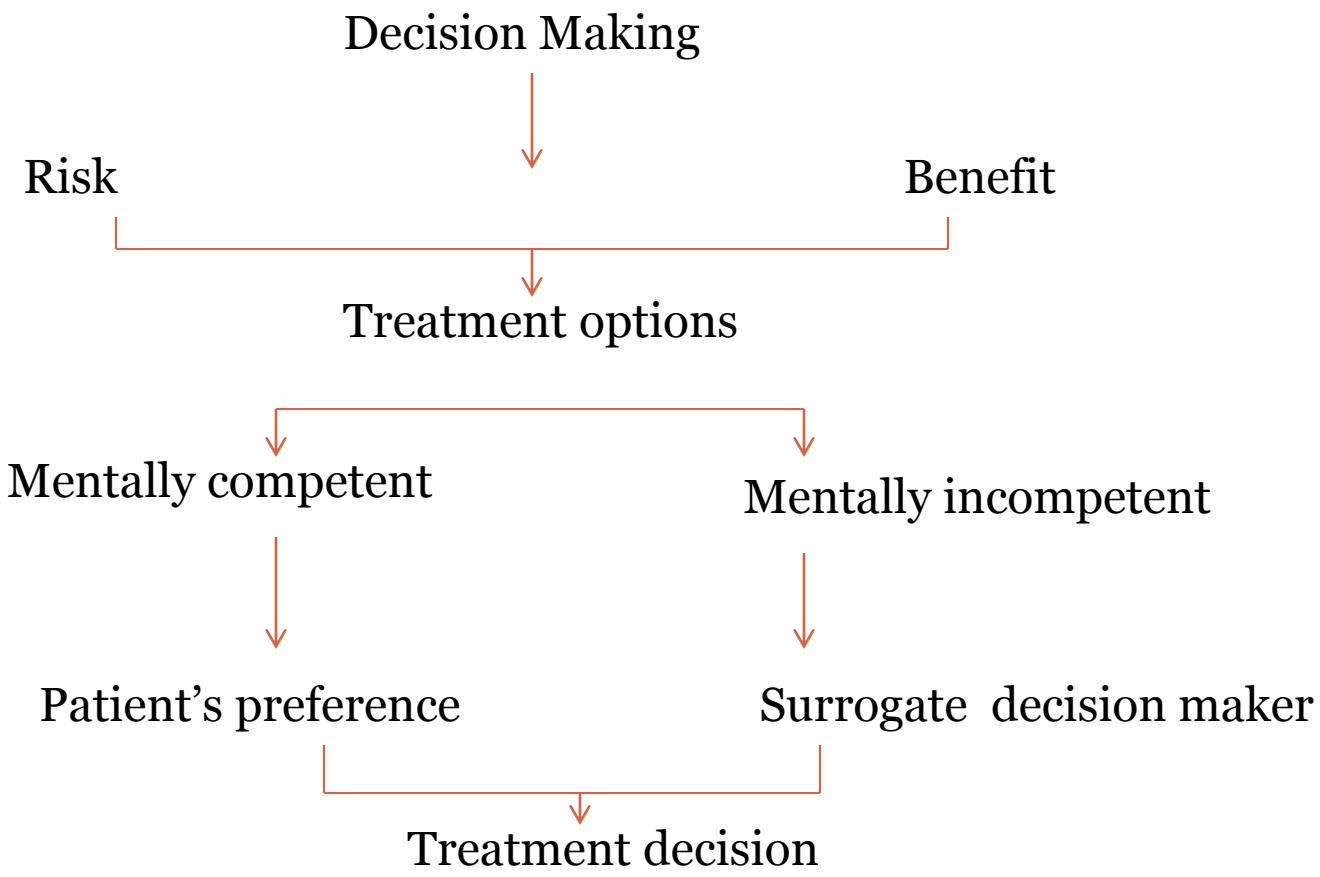
Ethical Approach to Decision Making Process



HKSPM Newsletter 2007. Dec Issue 3 pg. 8.

Gaps in Knowledge (1 of 2)

- Evidence on the effects of noninvasive positive-pressure ventilation (NPPV) versus supportive care is limited in patients with:
  - Asthma
  - Interstitial lung disease
  - Pneumonia
  - Acute respiratory distress syndrome/acute lung injury
  - Obesity hypoventilation syndrome
  - Postoperative respiratory failure
  - Post-transplantation respiratory failure
- The benefits of NPPV to assist weaning or to prevent recurrent acute respiratory failure postextubation remain uncertain.

Williams JW Jr, Cox CE, Hargett CW, et al. AHRQ Comparative Effectiveness Review No. 68. Available at www.effectivehealthcare.ahrq.gov/nppv.cfm.

Gaps in Knowledge (2 of 2)

- It is unclear if the effects of noninvasive positive-pressure ventilation (NPPV) vary by patient characteristics such as body mass index, mental status, or overall disease burden.
- The impact of NPPV versus supportive care on outcomes such as patient psychological status, quality of life, and functional status and on resource utilization require more extensive characterization.
- There is uncertainty about the effects of training, staffing composition/ratios, and the use of algorithms on NPPV effectiveness.

Williams JW Jr, Cox CE, Hargett CW, et al. AHRQ Comparative Effectiveness Review No. 68. Available at www.effectivehealthcare.ahrq.gov/nppv.cfm.

Question 1

- Noninvasive positive-pressure ventilation was associated with less morbidity (including from intubation), lower mortality, lower adverse events, or lower medical utilization when compared with supportive medical therapy or invasive ventilation in which disease state?

a. In adults with chronic obstructive pulmonary disease and acute respiratory failure.
b. In adults with acute cardiogenic pulmonary edema.
c. In adults with acute respiratory failure due to other causes including pneumonia, asthma, obesity hypoventilation syndrome, and interstitial lung disease.
d. In adults with acute respiratory failure in selective settings, including the postoperative setting and the post-transplant setting.

Williams JW Jr, Cox CE, Hargett CW, et al. AHRQ Comparative Effectiveness Review No. 68. Available at www.effectivehealthcare.ahrq.gov/nppv.cfm.

Answer

- A. In adults with chronic obstructive pulmonary disease and acute respiratory failure.

Question 2

- Intubation has what benefit over noninvasive positive-pressure ventilation (NPPV) :

a. Requires less sedation.
b. Allows the patient to communicate easier.
c. Assists with secretion clearance.
d. Decreases nosocomial pneumonia.

Williams JW Jr, Cox CE, Hargett CW, et al. AHRQ Comparative Effectiveness Review No. 68. Available at www.effectivehealthcare.ahrq.gov/nppv.cfm.
Pierson DJ. Respir Care 2009;54(1):40-52. PMID: 19111105.

Answer

- C. Assists with secretion clearance.

Question 3

- CPAP in hypoxemic respiratory failure

a. Decreases functional residual capacity.
b. Improves V/Q mismatch.
c. Increases work of breathing.
d. Increases afterload.

Ventilatory and hemodynamic effects of continuous positive airway pressure in left heart failure. Am J Respir Crit Care Med. 1997 Feb;155(2):500-5.

Answer

- B. Improves V/Q mismatch

Mask CPAP in Hypoxemic Failure

- **Recruits lung units**
  - improved V/Q matching > rapid correction of PaO_2 & $PaCO_2$[1]
  - increased functional residual capacity
  - decreased respiratory rate and work of breathing
- **Reduces airway resistance**
- **Improves hemodynamics in pulmonary edema**
  - decreases venous return
  - decreases afterload and increases cardiac index (in 50%)
  - decreases heart rate
- **Average requirement: 10cmH_2O**

Ventilatory and hemodynamic effects of continuous positive airway pressure in left heart failure. Am J Respir Crit Care Med. 1997 Feb;155(2):500-5.

Question 4

- Potential benefits for using NIV in a patient with a CMO status are:

a. Allows travel of family member.
b. Allows the patient to transfer home to die.
c. Allows the patient to finish financial matter.
d. A and B
e. All the above.

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Answer

- E. All the above.

Questions