Noninvasive Ventilation

Arthur Jones, EdD, RRT

http://rc-edconsultant.com/

Learning Objectives:
- Explain the rationale for noninvasive ventilation.
- Describe the effects, indications, advantages, disadvantages, and complications associated with negative pressure ventilation.
- Describe the operation of specific negative pressure ventilators.
- Describe the modes, effects, complications, indications, and contraindications associated with noninvasive positive-pressure ventilation (NPPV).
- Describe the evidence basis for NPPV for selected conditions.
- Compare the interfaces used in NPPV with respect to their indications, advantages, and limitations.
- Describe the issues pertaining to types of NPPV circuits and humidification systems.

Negative Pressure Ventilation

Definitions
- Noninvasive ventilation - mechanical ventilation without tracheal tube.
- Noninvasive positive pressure ventilation (NPPV) - ventilation without tracheal tube and with positive airway pressure.
- Negative pressure ventilation - ventilation with negative pressure applied to thorax.

Rationale for NIV
- Ventilate patients, while avoiding the complications associated with tracheal tubes:
  - ventilator associated pneumonia
  - airway trauma
  - psychological trauma, due to aphonia, restraint
**NPV physiologic effects**
- Subambient pressure surrounds thorax to inflate lungs

**Physiologic effects**
- Decreased work of breathing (WOB)
- Increased distribution of ventilation
- Subambient pressure inflates lungs
  - intermittent, with passive deflation
  - continuous negative expiratory pressure (CNEP) - maintain FRC
- Increased pulmonary blood flow
- Increased ventricular filling - increased cardiac output (cuirass)

**Indications**
- Unable to fit or tolerate mask for NPPV
- Neuromuscular disease
- Neurological trauma
- Intolerance of increased mean airway pressure; e.g., PEEP
- COPD - chronic state and acute exacerbations

**Indications**
- Post congenital heart surgery
  - tetralogy of Fallot correction
  - tricuspid atresia correction (Fontan)
  - phrenic nerve injury
- Neonatal respiratory distress
- Bronchopulmonary dysplasia

FYI- Click to download article on negative pressure ventilation and acute respiratory failure (interesting). [http://www.erj.ersjournals.com/cgi/content/abstract/9/7/1531](http://www.erj.ersjournals.com/cgi/content/abstract/9/7/1531)

**Indications**
- Post emphysematous lung resection
- During microlaryngeal surgery
- Cystic fibrosis
- Weaning from PPV
- Flail chest (CNEP)
- Meconium aspiration??
- Bronchopleural fistula??

**Benefits**
- Avoidance of tracheal tube complications
- Avoidance of facial trauma from mask
- Reduced sedation requirements
- No ventilator - induced lung injury
**Benefits**
- Patient can talk
- Patient can cough
- Improved enteral nutrition - patient may be able to eat

**Disadvantages**
- Lack of airway protection
- Large, non-portable equipment (tanks)
- Decreased patient access (tanks)
- Cumbersome to apply to some patients (tanks, wraps)
- Difficult to maintain seal
- Difficult to monitor volumes
- Patient intolerance (varies with type)

**Disadvantages**
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**Complications**
- Peripheral venous pooling (tank shock)
- Gastrointestinal bleeding
- Dynamic upper airway collapse
- Irritation at neck seal (tanks)
- Back pain

**Contraindications**
- Obstructive sleep apnea
- Morbid obesity
- Severe kyphoscoliosis
- Recent abdominal surgery

**Negative pressure ventilators**
- Drinker-Shaw iron lung
- Emerson iron lung
- Porta-Lung™ (tank, only)
- Coppa iron lung and cuirass
  - microprocessor-based
  - not available in the US

Click to see Emerson Iron Lung
http://farm3.static.flickr.com/2260/2319904866_3f168e4633.jpg?v=0
Click to see Porta-Lung™
http://portalung.com/Products.htm
Click to see Coppa microprocessor iron lung and cuirass
http://www.coppabiella.it/interno.asp?pagina=elettromedicali.htm

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Negative pressure ventilators

Drinker-Shaw iron lung

Ventilators
- Emerson U-Cyclit™ (not available)
- LifeCare NEV 100™ (not available)
- Pegaso V™
- Hayek RTX™
- Hayek MRTX™ - portable
- Hayek MRITX™ - MRI compatible

Click for information on the Pegaso V™ ventilator
http://portalung.com/PEGASO_V2.htm
Click to see infant negative pressure ventilator

Body wraps
- Nu-Mo suit™
- Pulmo Wrap™
- Poncho Wrap™

Click to see Pulmo Wrap
Click to see a vintage cuirass
http://www.frca.co.uk/images/cuirass.jpg

Hayek RTX™ cuirass ventilator
- Biphasic cuirass ventilation - inspiratory and expiratory pressure
- Easy to apply
- Modes:
  - High-frequency chest oscillation
  - Secretions mode - oscillations, cough
  - Continuous negative expiratory pressure
  - Control mode
  - Respiratory triggered
  - Respiratory synchronized

FYI - Click for more information on the Hayek RTX™
http://www.unitedhayek.com/clinicians#modes

Hayek RTX™ cuirass ventilator
- Specifications
  - 6-1200 cycles per minute
  - I:E Ratio: 1:6 - 6:1
  - Maximum inspiratory pressure: -50 cm H2O
  - Maximum expiratory pressure: +50 cm H2O
  - Power unit weight: 9 kg
  - Four adult size cuirasses
  - Seven pediatric size cuirasses
Ventilator operation

Settings
- Peak inspiratory pressure - adjusts tidal volume
- Peak expiratory pressure - active exhalation, cough assistance
- Continuous negative expiratory pressure
  - maintains FRC
  - balances intrinsic PEEP for patient triggering

Rate
I:E ratio
Trigger sensitivity
- sensed at nares
- sensed in cuirass (Hayek)
FIO2 - mask or nasal cannula

Monitoring

Blood gases
- baseline and PRN arterial sampling
- pulse oximetry
- end-tidal CO2 monitoring

Volumes
- spirometry with mask??
- respiratory inductive plethysmography??

Patient transport

Portable positive pressure ventilation
- mouthpiece
- mask
Iron lung - can be manually operated
Battery-powered negative pressure ventilators, like Hayek MRTX™

Sites for NPV

Intensive care units
Intermediate care units
Long-term care facilities
Homes

Summary & Review

Rationale for NIV - ventilate without intubate
Physiologic effects of NPV vs. PPV - cardiovascular
NPV indications
- mask intolerance
- need to increase pulmonary perfusion
**Summary & Review**

- NPV benefits - no ventilator-induced lung injury
- Complications - tank shock
- Contraindications - upper airway obstruction
- NPV enclosure types
  - tank
  - cuirass
  - wrap

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**Summary & Review**

- Ventilator operation
  - pressure controlled ventilation with supplemental mask or nasal O2
  - limited monitoring capabilities

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**Noninvasive Positive Pressure Ventilation (NPPV)**

**Attributes**

- Noninvasive positive pressure ventilation - PPV without tracheal tube
- Important attribute of NPPV - existence of a mask leak - that affects
  - volume delivered (volume control)
  - ventilator triggering to inspiration
  - ventilator cycling to expiration

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**Modes**

- continuous positive airway pressure
- bilevel positive airway pressure
- pressure support
- pressure control
- volume control
- proportional assist

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**Physiologic effects**

- Decreased WOB
- Increased dynamic lung compliance
- Increased tidal volume
- Increased inspiratory capacity (CPAP and COPD patients)
### Physiologic effects
- Improved blood gases
  - Oxygenation increased by end-expiratory pressure
  - Hypercapnea decreased with inspiratory pressure
- Cardiac output
  - Normal and COPD patients - decreased
  - Some CHF patients - increased

### Benefits
- Prevention of ETT complications
- Reduction in sedation requirements
- Prevention of tracheotomy
- Reduction in ICU length-of stay (LOS)

### Complications
- Delayed intubation
- Patient intolerance, anxiety
- Facial ulcers
- Ear, sinus pain
- Increased WOB - patient-ventilator dyssynchrony, due to inappropriate device and/or control settings

### Complications
- Pneumothorax
- Gastric insufflation - high pressures
- Aspiration
- Mucus plugging
- Hemodynamic compromise

### Contraindications
- Unable to fit or tolerate interface
- Facial trauma or surgery
- Active vomiting
- Acute abdominal process - risk for vomiting, aspiration

### Contraindications
- Apnea
- Cardiovascular instability
- Excessive and/or viscous secretions
- Recent gastro-oesophageal surgery
- Severely impaired mental status
<table>
<thead>
<tr>
<th>Indications</th>
<th>Questionable indications</th>
</tr>
</thead>
<tbody>
<tr>
<td>▶ COPD</td>
<td>▶ ARDS/ALI - may harm by delaying intubation</td>
</tr>
<tr>
<td>▶ Acute cardiogenic pulmonary edema (ACCPE)</td>
<td>▶ Pneumonia - no evidence of benefit</td>
</tr>
<tr>
<td>▶ Blunt thoracic trauma</td>
<td>▶ Asthma - no evidence of benefit</td>
</tr>
<tr>
<td>▶ Postoperative respiratory failure</td>
<td></td>
</tr>
<tr>
<td>▶ Weaning from invasive ventilation</td>
<td></td>
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<tr>
<td>▶ Miscellaneous conditions</td>
<td></td>
</tr>
<tr>
<td>▶ Neuromuscular conditions - separate lesson</td>
<td></td>
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<tr>
<td>▶ Obstructive sleep apnea - separate lesson</td>
<td></td>
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</table>

"NPPV should be tried very cautiously or not at all in patients with ALI who have shock, metabolic acidosis or profound hypoxemia."

<table>
<thead>
<tr>
<th>NPPV &amp; COPD Exacerbations</th>
<th>NPPV &amp; Stable COPD</th>
</tr>
</thead>
<tbody>
<tr>
<td>▶ First line treatment for exacerbations</td>
<td>▶ Many COPD patients also have sleep apnea (overlap), with greater risk for hypercapnic failure</td>
</tr>
<tr>
<td>▶ Strong evidence for efficacy in hypercapnic failure</td>
<td></td>
</tr>
<tr>
<td>▶ Effects</td>
<td>▶ Effects</td>
</tr>
<tr>
<td>◆ decreased WOB</td>
<td>◆ Decreased air trapping (TLC)</td>
</tr>
<tr>
<td>◆ reversal of ventilatory muscle fatigue</td>
<td>◆ Increased CO2 response</td>
</tr>
<tr>
<td>◆ decreased PaCO2</td>
<td>◆ Stabilizes heart rhythm by reducing vagal activity</td>
</tr>
<tr>
<td>◆ decreased risk for intubation</td>
<td></td>
</tr>
<tr>
<td>◆ decreased mortality</td>
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</table>

<table>
<thead>
<tr>
<th>NPPV &amp; Stable COPD</th>
<th>NPPV for ACCPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>▶ Situations</td>
<td>▶ First line treatment - strong evidence</td>
</tr>
<tr>
<td>◆ home - longer survival for adherent patients (Budweiser)</td>
<td></td>
</tr>
<tr>
<td>◆ rehabilitation - may increase exercise tolerance, except for backpack study</td>
<td>◆ increased FRC</td>
</tr>
<tr>
<td>◆ therapy ceiling for end-stage</td>
<td>◆ increased lung compliance</td>
</tr>
</tbody>
</table>

| NPPV for ACCPE | |
|----------------| |
| ▶ Effects - CPAP and bilevel NPPV equally: | |
| ◆ increased FRC | ◆ decreased WOB |
| ◆ increased lung compliance | ◆ decreased dyspnea & respiratory rate |
NPPV for ACCPE
✓ Effects - CPAP and bilevel NPPV equally:
  ◆ decreased intrapulmonary shunt
  ◆ decreased heart rate
  ◆ increased cardiac output
  ◆ decreased intubation rate
  ◆ may decrease mortality (meta-analysis)
✓ Bilevel NPPV may not be more effective than CPAP (statistical analysis)

NPPV & blunt thoracic trauma (flail)
✓ CPAP and bilevel NPPV studied - weak evidence
✓ excluded patients
  ◆ emergent intubations
  ◆ injuries to head, face or neck
✓ effects
  ◆ decreased rate of pneumonia
  ◆ decreased mortality
✓ more trials needed

NPPV & postop respiratory failure
✓ CPAP and bilevel NPPV studied - weak evidence
✓ Postoperative upper abdominal & thoracic surgical patients studied
✓ Effects:
  ◆ decreased intubation, reintubation rate
  ◆ decreased pneumonia, sepsis
  ◆ decreased mortality
  ◆ decreased length of hospitalization
✓ CPAP and bilevel NPPV may be equally effective

NPPV & ventilator weaning
✓ Rationales
  ◆ shorten intubation time
    ▶ decreased sedation
    ▶ decrease infection
    ▶ decrease ICU & hospital length-of-stay (LOS)
  ◆ prevent reintubation
  ◆ prevent tracheotomy

NPPV & ventilator weaning
✓ Supportive evidence is moderate, when applied to selected patients, who:
  ◆ meet criteria to initiate spontaneous breathing trial
  ◆ meet criteria for extubation:
    ▶ do not have excessive secretions
    ▶ have an effective cough
    ▶ have acceptable mental status
    ▶ are not a difficult intubation

NPPV & ventilator weaning
✓ Supportive evidence is moderate, when applied to selected patients, who:
  ◆ have no impediments for interface
  ◆ tolerate short term spontaneous breathing for mask adjustments, etc.
NPPV & post-extubation failure
- Evidence does not support efficacy of NPPV in treating post-extubation respiratory failure
- Evidence supports that NPPV may be effective in preventing post-extubation respiratory failure where high-risk patients are identified in advance
- NPPV not recommended as a routine intervention for post-extubation situations.

NPPV - miscellaneous indications
- During bronchoscopy to offset increased WOB and hypoxemia
- Severe bronchiolitis
- Cystic fibrosis - adults with hypercapnic exacerbations
- Immunocompromised patients - prevents ventilator-associated pneumonia
- Pandemic respiratory infections; e.g., SARS - to prevent infection of caregivers during intubations

Summary & Review
- NPPV physiologic effects - may increase cardiac output in CHF
- NPPV benefits - prevent intubation
- NPPV complications - delayed intubation
- NPPV contraindications - mask intolerance
- NPPV indications - cautious application to hypoxemic failure

NPPV Interfaces & Humidification

Issues with interfaces
- Comfort
- Allowance for patient movement
- Weight
- Allergenicity
- Pressure applied to tissues ==> skin ulceration

Issues with interfaces
- Internal volume
  - dead space (V_{Drb}) - rebreathed volume
  - gas compression, decompression volume
- Leaks - mask seal = 2 cm ==> negligible leaks
- Multiple sizes available

Click to hear possible mask leak
Play CPAP mask leak
Click to see Respironics leak chart
http://sleepapnea.respironics.com/PDF/LeakRate.pdf
Issues with interfaces
- Securing system (headgear)
  - comfort
  - stability
  - ease of use
  - washable for home use
  - disposable for hospital use

Interfaces
- Mouthpiece
- Nasal mask
- Nasal pillows
- Oronasal mask
- Total face mask
- Helmet

Click to see various brands of headgear, with prices

Mouthpiece interface
- primarily for daytime use for patients with:
  - neuromuscular disease
  - COPD
  - cystic fibrosis

Nasal interfaces
- Indications
  - primary interface for obstructive sleep apnea
  - good starting interface in mild acute respiratory failure, with limitations
  - postoperative atelectasis (see lung clearance lesson)

Nasal interfaces
- Advantages:
  - enables speech, eating, coughing
  - less risk for aspiration, gastric distension
  - less claustrophobia

Nasal interfaces
- Limitations
  - erroneous monitoring of exhaled TV
  - nasal resistance limits effectiveness
  - mouth breathing limits effectiveness and patients with ARF tend to mouth-breathe
  - lesser pressure can be administered
Nasal interfaces

**Types**

- **masks**
- **pillows**

Nasal masks include:
- Respironics Curve™ nasal mask (courtesy Respironics)
- Respironics ComfortGel™ mask (courtesy Respironics)
- Respironics Total Face Mask™ (courtesy Respironics)
- Respironics Performax™ (courtesy Respironics)


Oronasal (full face) mask

- Most common for bilevel NPPV
- **Advantages**
  - less leakage
  - more stable pressures
  - less patient cooperation
- **Limitations**
  - claustrophobia
  - aspiration

Oronasal (full face) mask

- Respironics ComfortGel™ mask (courtesy Respironics)

Click to see various brands of full face masks, with prices: [http://www.cpap.com/simple-find-cpap-products/cpap-masks/cpap-masks/full-face.html](http://www.cpap.com/simple-find-cpap-products/cpap-masks/cpap-masks/full-face.html)

Total face mask

- Most effective NPPV interface for acute respiratory failure.
- **Advantages**
  - minimal leaks - accommodates greatest pressure
  - less discomfort
  - Less pressure injury - larger area of contact
- **Limitations**
  - does not increase $V_{Drb}$
  - May increase claustrophobia

Total face mask

- Respironics Total Face Mask™ (courtesy Respironics)
- Respironics Performax™ (courtesy Respironics)

Click to see all Respironics masks, etc. [http://masks.respironics.com/](http://masks.respironics.com/)

Helmet

- **Advantages**
  - overcomes mask-fit problems
  - more comfortable
  - no facial pressure injury
  - less need for patient cooperation
  - allows speaking, coughing
Helmet

- disadvantages
  - not currently FDA-approved
  - may decrease cerebral blood flow in infants
  - impedes patient triggering - decompression volume
  - no capability for volume monitoring
  - humidification may fog the helmet

Click to see neonatal CPAP helmet
http://farm1.static.flickr.com/80/247064940_0236c3543_m.jpg
Click to see adult CPAP helmet

Designer CPAP helmet

Click to hear helmet voice distortion
(Play darkside wma)

Ventilator circuit

- Single-limbed
  - original BiPAP circuit
  - incorporates variable flow leak port
  - requires EPAP > 4 cm H2O to minimize rebreathing

Ventilator circuit

- Double-limbed
  - ICU ventilators and recent bilevel ventilators
  - eliminates rebreathing
  - The circuit and interface must be used for the specified ventilator

Humidification

- None - OK for short-term ventilation
  - humidification ability of mucosa can be overwhelmed
  - desiccated mucosa releases inflammatory mediators
  - possible mucus plugging
  - absence of humidification can impede adherence to therapy

Humidification

- Heat and moisture exchanger
  - can increase resistance
  - increase $V_{Drb} \Rightarrow$
    - hypercapnea
    - increased minute ventilation
    - increased WOB
Humidification
- Heat and moisture exchanger
  - increase $V_{Drb}$
  - can increase resistance
- Heated humidification
  - no effect on $V_{Drb}$
  - no effect on resistance
- Ambient temperature passive humidification increases comfort for some patients

Summary & Review
- Issues with NPPV interfaces - comfort, pressure injury, leaks
- Specific interfaces:
  - mouthpiece
  - nasal mask, pillow
  - oronasal mask
  - total face mask
  - helmet - not FDA-approved

Summary & Review
- NPPV circuits - single, vs. double-limbed
- Humidification - HMEs and $V_{Drb}$

NPPV Devices & Controls

Institutional bilevel ventilators
- Desirable features
  - built-in blender
  - leak compensation
  - trigger compensation
  - backup rate
  - rise time adjustment
  - graphic display
  - alarms
  - battery power supply

Institutional bilevel ventilators
- Respironics
  - BiPAP S/T$^\text{TM}$ - no blender
  - Focus$^\text{TM}$ - no blender
  - Vision$^\text{TM}$
- Mallinckrodt Onyx$^\text{TM}$
**Institutional bilevel ventilators**

Respironics Vision™ Respironics Focus™

Images courtesy of Respironics

**Institutional bilevel ventilators**

- Respironics Vision™
  - acute care bilevel ventilation
  - blender - adjustable FIO2
  - Auto-Track™ trigger
  - rise time adjustable
  - graphic display
  - alarms
  - no battery backup

**ICU ventilators**

- With NIV mode - provide leak compensation
- Without NIV mode - no leak compensation
  - impedes patient triggering
  - impedes cycling to expiration in PSV mode
  - can be used; but, could lead to problems (injury, litigation)

**Ventilators**

- ICU ventilators with noninvasive modes (examples)
  - Maquet Servo™
  - Drager Evita XL™
  - Newport e360™ and HT50™ (transport)
  - Viasys Vela™ and Avea™
  - Hamilton Raphaël™ & C-2™
  - GE Engstrom Carestation™
  - Puritan-Bennett 840™

**ICU ventilators**

- advantages
  - graphics to show:
    - triggering
    - cycling
    - intrinsic PEEP (PEEPi)
    - work of breathing (WOB)

**Spontaneous WOB**

- spontaneous breaths
- increased WOB
- work of breathing (WOB)
ICU ventilators

- **advantages**
  - graphics
  - exhaled volume monitoring
  - expiratory cycle adjustment
  - rise time adjustment
  - invasive ventilation capability - easier to switch over
- **disadvantage** - expense

Modes applied to NIV

- **volume control**
  - identical success rate, compared to pressure control
  - stable volumes in face of changing lung mechanics
  - higher peak airway pressures that caused flatulence in two patients that sounded like a mask leak
  - common in home NIV (Europe)

- **pressure control ventilation (PCV)**
  - stable volume delivery in face of leaks
  - flow variable with patient demands
  - trial results - PCV may be more effective than PSV for COPD exacerbations

- **pressure support**
  - most common mode for NIV
  - some ventilators do not include backup rate - apnea adjustment is important

- **proportional assist ventilation (PAV)**
  - delivers flow proportional to patient's inspiratory effort
  - terminates flow in response to cessation of inspiratory effort

- **pressure support**
  - appropriate expiratory cycle adjustment is important
  - appropriate rise time adjustment is important
  - observe inspiratory time and I:E ratio - may require inspiratory time limit adjustment
Modes applied to NIV

- proportional assist ventilation (PAV)
  - clinical trials conclude that it is better tolerated than PSV; but, PSV was delivered with PB 7200ae?
  - Respironics Vision - PAV mode not available in U.S.
  - Puritan-Bennett 840 - company does not support use of PAV with NIV

Ventilation modes and NIV

- Pressure support with volume guarantee (VSV)??
  - no NIV with VSV trials located
  - problem with VSV - patient distress and hyperpnea causes ventilator to decrease support

Ventilation modes and NIV

- Neurally adjusted ventilatory assist (Maquet NAVA™)
  - flow delivery in response to diaphragmatic electrical activity
  - eliminates leaks as a triggering and cycling factor
  - need human trials on NAVA and NIV
  - it works on rabbits

Ventilation settings

- Expiratory flow cycling adjustment:
  - patient comfort
  - ventilator graphics
  - inspiratory time, I:E ratio
  - to eliminate PEEPi

Ventilation settings

- PEEP 3 < 10 (ideally)
- PSV, IPAP - exhaled tidal volume > 5 ml/kg IBW
- Reasonable starting pressures - PEEP = 5; PSV = 10
- FIO2 for desired SPO2

Expiratory flow-cycling (PSV)

- Patient expiratory effort
- Late termination
- Inability to trigger

Courtesy Newport Medical
Ventilation settings

- Rise time adjustment:
  - patient comfort
  - ventilator graphics

Inspiratory flow/rise-pressure wave

- Linear or bowed upward rise in pressure after trigger on the pressure wave
- Slow rise in pressure, concave shape of the pressure wave

Summary & Review

- Types of ventilators used for NPPV
- Specific bilevel and ICU ventilators
- ICU ventilator advantages
- NPPV modes
- Ventilation settings

NPPV Clinical Issues

Clinical indicators of successful NIV

- Favorable response in first 2 hours of NPPV
- APACHE II score < 29
- pH > 7.30
- Glasgow coma score ≥ 15

FYI - Click to access APACHE II calculator

Clinical indicators of successful NIV

- Favorable response in first 2 hours of NPPV
- APACHE II score < 29
- pH > 7.30
- Glasgow coma score ≥ 15
- Absence of pneumonia or ARDS
- Minimal interface air leaks
- Patient-ventilator synchrony

FYI - Click to download article on NIV & critical care
http://www.chestjournal.org/content/132/2/711.long
Aerosol delivery
- Remove NIV interface and administer, if safe and feasible
- Aerosol medications are effective with NIV via all types of devices
- Aerosols are effectively delivered via nasal interface
- Increased dosage may be necessary, because of leaks, nasal deposition

Heliox therapy
- Meta-analyses on routine use of heliox for asthma and COPD do not support routine use
- Heliox decreases PEEPi and WOB in ventilated patients with COPD exacerbations

Sites for NPPV administration
- Factors:
  - acuity of patient
  - expertise of personnel
  - availability of physical resources
- Monitoring capabilities:
  - personal (skilled)
  - electronic
### Sites for NPPV administration

**Pre-hospital - EMS**
- for some conditions, the sooner, the better for NPPV
- avoids emergency intubations
- especially applicable to ACCPE & COPD

**Emergency room**
- early initiation of NPPV
- advanced resources, including RTs

**Intensive care**
- best site for sickest patients
- intensive monitoring
- extensive physical resources
- personnel resources
  - respiratory therapists
  - critical care nurses

**Intermediate care (step-down)**
- usually telemetric monitoring
- personnel resources varies:
  - respiratory therapists
  - patient:nurse ratio
- stable patients

**General ward**
- telemetry - maybe
- more patients per nurses, who may be unfamiliar with NPPV
- respiratory therapy coverage varies
- intermittent NPPV, as for:
  - sleep apnea
  - stable COPD
  - stable neuromuscular disease

**Long-term care facilities**
- chronic care
  - COPD
  - failure to wean from ventilation
- monitoring varies by units
- usually have skilled respiratory therapy staff

**Home**
- chronic conditions
- end-of-life care
- requires education of patient & caregivers
NIPPV and End-of-Life Care

Patient choices
- do not intubate (DNI)
- comfort measures only (CMO)

Informed consent of patient and/or family is needed - NIV is life support

Common conditions
- COPD
- cancer
- neuromuscular diseases
- chronic heart failure

NIPPV and End-of-Life Care

Goals of NIV for terminal patients
- delay death
  - to go home
  - to settle personal issues
  - to see a person
- provide comfort - to whom?
  - decrease dyspnea
  - comfort is not provided when a patient is resisting the treatment

Common conditions
- COPD
- cancer
- neuromuscular diseases
- chronic heart failure

Ethical controversy exists over whether NIV ought to be used at end-of-life.
The decision should rest with the patient (author’s opinion)

Summary & Review

Indicators for successful NPPV
- Aerosol delivery - does work with NPPV
- Heliox - may decrease WOB for COPD

Sites for NPPV delivery
- NPPV for end-of-life care

References
### References


### References

- Kacmarek RM. Should noninvasive ventilation be used with the do-not-intubate patient? Respir Care. 2009 Feb;54(2):223-31.
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