Noninvasive Ventilation

Arthur Jones, EdD, RRT

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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.

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Learning Objectives:

- 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.
- Compare the ventilator types and modes applied to NPPV with respect to their advantages and disadvantages.
- Describe techniques for ventilator control adjustments for NPPV.
- Discuss clinical issues pertaining to NPPV, including aerosol delivery, heliox, clinical sites and end-of-life care.

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Negative Pressure Ventilation

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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.

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Rationale for NIV

- Ventilate patients, while avoiding the complications associated with tracheal tubes:
  - ventilator associated pneumonia
  - airway trauma
  - psychological trauma, due to aphonia, restraint

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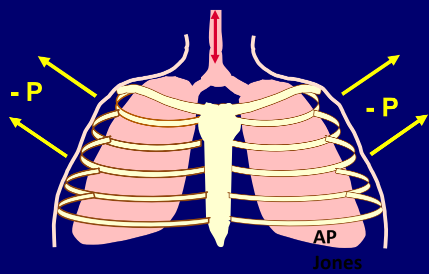
NPV physiologic effects

- Subambient pressure surrounds thorax to inflate lungs



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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)

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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

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Indications

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

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Indications

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

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Benefits

- Avoidance of tracheal tube complications
- Avoidance of facial trauma from mask
- Reduced sedation requirements
- No ventilator - induced lung injury

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Benefits

- Patient can talk
- Patient can cough
- Improved enteral nutrition - patient may be able to eat

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Disadvantages

- Lack of airway protection
- Large, non-portable equipment (tanks)
- Decreased patient access (tanks)
- Cumbersome to apply to some patients (tanks, wraps)

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Disadvantages

- Difficult to maintain seal
- Difficult to monitor volumes
- Patient intolerance (varies with type)

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Complications

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

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Contraindications

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

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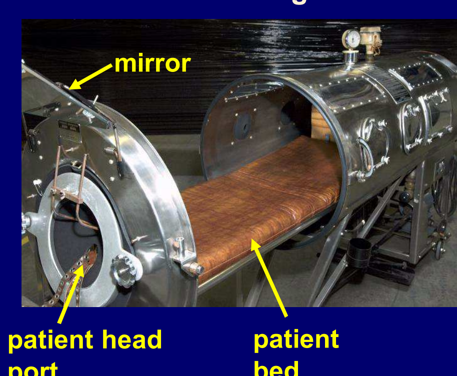
Negative pressure ventilators

- Drinker-Shaw iron lung



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Negative pressure ventilators

- Emerson iron lung

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Negative pressure ventilators

- Porta-Lung™ (tank, only)

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Negative pressure ventilators

- Coppa iron lung and cuirass
  - microprocessor-based
  - not available in the US

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Negative pressure ventilators

- Hayek RTX™

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Negative pressure ventilators

- Pulmo wrap

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Negative pressure ventilators

- Vintage cuirass

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Negative pressure ventilators

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

Click for video on Hayek ventilator (2.5 min)
https://www.youtube.com/watch?v=t_5EwDP48Pk&t=80s

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Negative pressure ventilators

- Hayek RTX™ cuirass ventilator
  - Modes:
    - High-frequency chest oscillation
    - Secretions mode - oscillations, cough
    - Continuous negative expiratory pressure
    - Control mode
    - Patient trigger
    - Patient synchronized

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Negative pressure ventilators

- Hayek RTX™ cuirass ventilator
  - Specifications
    - 6-1200 cycles per minute
    - I:E Ratio: 1:6 - 6:1
    - Maximum inspiratory pressure: -50 cm H20

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Negative pressure ventilators

- Hayek RTX™ cuirass ventilator
  - Specifications
    - 6-1200 cycles per minute
    - I:E Ratio: 1:6 - 6:1
    - Maximum inspiratory pressure: -50 cm H20
    - Maximum expiratory pressure: +50 cm H20
    - Power unit weight: 9 kg
    - Four adult size cuirasses
    - Seven pediatric size cuirasses

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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

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Ventilator operation

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

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Monitoring

- Blood gases
  - baseline and PRN arterial sampling
  - pulse oximetry
  - end-tidal CO2 monitoring
- Volumes
  - spirometry with mask??
  - respiratory inductive plethysmography??

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Sites for NPV

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

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Patient transport

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

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Summary & Review

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

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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 capabilies

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Noninvasive Positive Pressure Ventilation (NPPV)

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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
- neurally adjusted ventilatory assist (NAVA)

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Physiologic effects

- Decreased WOB
- Increased dynamic lung compliance
- Increased tidal volume
- Increased inspiratory capacity (CPAP and COPD patients)

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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

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Benefits

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

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Complications

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

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Complications

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

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Contraindications

- unable to fit or tolerate interface
- facial trauma or surgery
- active vomiting
- acute abdominal process - risk for vomiting, aspiration

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Contraindications

- apnea
- cardiovascular instability
- excessive and/or viscous secretions
- recent gastro-oesophageal surgery
- severely impaired mental status

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Indications

- COPD
- Acute cardiogenic pulmonary edema (ACPE)
- Blunt thoracic trauma
- Postoperative respiratory failure
- Weaning from invasive ventilation

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Indications

- COPD
- Acute cardiogenic pulmonary edema (ACPE)
- Blunt thoracic trauma
- Postoperative respiratory failure
- Weaning from invasive ventilation
- Miscellaneous conditions
- Neuromuscular conditions - separate lesson
- Obstructive sleep apnea - separate lesson

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Questionable indications

- ARDS/ALI - may harm by delaying intubation
- Pneumonia - no evidence of benefit
- Asthma - no evidence of benefit

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NPPV & COPD Exacerbations

- First line treatment for exacerbations
- Strong evidence for efficacy in hypercapneic failure
- Effects
  - decreased WOB
  - reversal of ventilatory muscle fatigue
  - decreased $PaCO_2$
  - decreased risk for intubation
  - decreased mortality

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NPPV & Stable COPD

- Many COPD patients also have sleep apnea (overlap), with greater risk for hypercapneic failure
- Effects
  - Decreased air trapping (TLC)
  - Increased CO_2 response
  - Stabilizes heart rhythm by reducing vagal activity

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NPPV & Stable COPD

- Situations
  - home - longer survival for adherent patients
  - rehabilitation - may increase exercise tolerance, except for backpack study
  - therapy ceiling for end-stage

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NPPV for acute cardiogenic pulmonary edema (ACPE)

- First line treatment - strong evidence
- Effects - CPAP and bilevel NPPV equally:
  - increased FRC
  - increased lung compliance
  - decreased WOB
  - decreased dyspnea & respiratory rate

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NPPV for ACPE

- 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

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NPPV & blunt thoracic trauma (flail)

- CPAP and bilevel NPPV studied - fair evidence
  - case studies
  - small RCT was stopped due to efficacy of NPPV

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NPPV & blunt thoracic trauma (flail)

- excluded patients
  - emergent intubations
  - injuries to head, face or neck
- effects
  - decreased rate of pneumonia
  - decreased mortality

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NPPV & postop respiratory failure

- CPAP and bilevel NPPV studied
- 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 (need more trials)

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NPPV & ventilator weaning

- Rationales
  - shorten intubation time
    - decreased sedation
    - decrease infection
    - decrease ICU & hospital length-of-stay (LOS)
  - prevent reintubation
  - prevent tracheotomy

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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

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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.

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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.

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NPPV - miscellaneous indications

- During bronchoscopy to offset increased WOB and hypoxemia
- Severe bronchiolitis
- Cystic fibrosis - adults with hypercapneic exacerbations

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NPPV - miscellaneous indications

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

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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

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Intermission

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NPPV Interfaces & Humidification

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Issues with interfaces

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

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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

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Issues with interfaces

- Securing system (headgear)
  - comfort
  - stability
  - ease of use
  - washable for home use
  - disposable for hospital use

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Interfaces

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

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Mouthpiece interface

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

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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)

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Nasal interfaces

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

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Nasal interfaces

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

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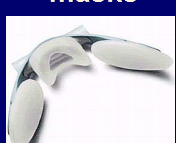
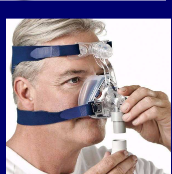
Nasal interfaces

- masks



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Nasal interfaces

- pillows




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Oronasal (full face) mask

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

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Oronasal (full face) mask




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Total face mask

- Most effective NPPV interface for acute respiratory failure.
- Minimal leaks - accommodates greatest pressure
- Less discomfort
- Less pressure injury - larger area of contact
- Does not increase V_{Drb}
- May increase claustrophobia

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Total face mask

Respironics Total Face Mask™ (courtesy Respironics)

Respironics Performax™ (courtesy Respironics)

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Helmet

- Advantages
  - researchers compared noninvasive oxygen delivery methods—a helmet versus a face mask—for patients with acute respiratory distress syndrome.
  - the trial was stopped early because the helmets proved more effective than the face masks for treating this condition.

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Helmet

- advantages
  - best interface for COVID infection
  - overcomes mask-fit problems
  - more comfortable
  - no facial pressure injury
  - less need for patient cooperation
  - allows speaking, coughing

Click for video on helmet NPPV (2.5 min)
https://www.youtube.com/watch?v=kuTqecGcwTw

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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

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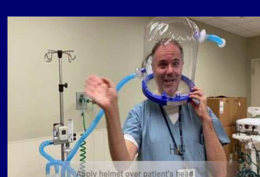
Helmet



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Helmet

Designer CPAP helmet

Click to hear helmet voice distortion

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Ventilator circuit

- Single-limbed
  - original BiPAP circuit
  - incorporates variable flow leak port
  - requires EPAP > 4 cm H_2O to minimize rebreathing

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Ventilator circuit

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

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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

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Humidification

- Heat and moisture exchanger
  - can increase resistance
  - increase V_{Drb} ==>
    - hypercapnea
    - increased minute ventilation
    - increased WOB

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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

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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

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Summary & Review

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

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NPPV Devices & Controls

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Institutional bilevel ventilators

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

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Institutional bilevel ventilators

- Respironics
  - BiPAP S/T™ - no blender
  - Focus™ - no blender
  - Vision™
  - V60

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Institutional bilevel ventilators

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

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Institutional bilevel ventilators

- Respironics V60™
  - acute care bilevel ventilation
  - average volume-assured pressure support
  - auto-adaptive leak compensation
  - inspiratory triggering
  - expiratory cycling
  - adjustable ramp time
  - built-in blender
  - battery backup- 6 hours

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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)

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Ventilators

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

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Ventilators

- Ventilator Intervention Technology Accessible Locally (VITAL)
  - developed by NASA for pandemic
  - tested in Jet Propulsion Laboratory (JPL)
  - FDA emergency authorization April 30, 2020
  - uses some parts from available ventilators
  - eight U.S. manufacturers licensed for production.

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Ventilators

- Ventilator Intervention Technology Accessible Locally (VITAL)
  - assist-control
  - volume targeted
  - PEEP 5-35 cm H_2O
  - frequency 4-40 BPM
  - TV 150-800 mL

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Ventilators

- Ventilator Intervention Technology Accessible Locally (VITAL)

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ICU ventilators

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

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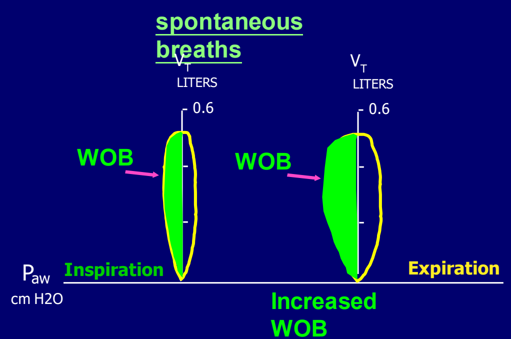
Spontaneous WOB



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ICU ventilators

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

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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)

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Modes applied to NIV

- 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

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Modes applied to NIV

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

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Modes applied to NIV

- 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

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Modes applied to NIV

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

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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

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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

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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
  - evidence favors NAVA over PSV

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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

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Ventilation settings

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

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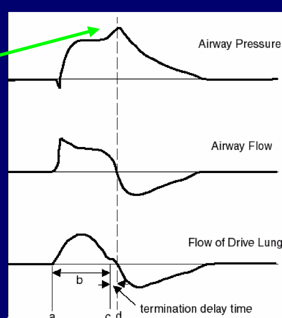
Expiratory flow-cycling (PSV)

Patient expiratory effort

Late termination

Inability to trigger



Courtesy Newport Medical

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Ventilation settings

- Rise time adjustment:
  - patient comfort
  - ventilator graphics

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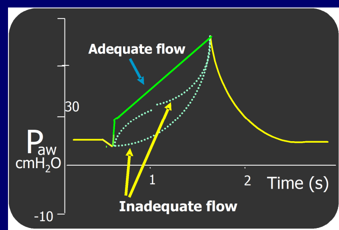
Inspiratory flow/rise- pressure wave

Linear or bowed upward rise in pressure after trigger on the pressure wave

Slow rise in pressure, concave shape of the pressure wave



Courtesy Newport Medical

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Summary & Review

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

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NPPV Clinical Issues

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Clinical indicators of successful NIV

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

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Clinical indicators of successful NIV

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

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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

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Aerosol delivery

- Aerosol delivery devices
  - pneumatic nebulizer
    - place proximal to patient
    - place between patient and leak valve
  - vibrating mesh (Aeroneb Pro™) - does not add flow to circuit
  - MDI & spacer - coordinate with inspiration

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Aerosol delivery

- Total face masks allow medications to enter eyes - especially problematic with ipratropium
- More research is needed to generate specific recommendations
- Regardless of device, it's a good idea to place aerosol generator between the HME and the patient

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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

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Heliox therapy

- Problems:
  - heliox can not be used in hypoxemic patients
  - heliox causes errors in TV and FIO2 measurement and delivery
  - only FDA-approved ventilator is the Viasys Avea
  - heliox is expensive
  - helium causes vocal distortion

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Sites for NPPV administration

- Factors
  - acuity of patient
  - expertise of personnel
  - availability of physical resources
- Monitoring capabilities
  - personnel (skilled)
  - electronic

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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

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Sites for NPPV administration

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

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Sites for NPPV administration

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

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Sites for NPPV administration

- 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

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Sites for NPPV administration

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

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Sites for NPPV administration

- Home
  - chronic conditions
  - end-of-life care
  - requires education of patient & caregivers

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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

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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 - for whom?
    - decrease dyspnea
    - comfort is not provided when a patient is resisting the treatment

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NIPPV and End-of-Life Care

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

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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

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END

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