Noninvasive Mechanical Ventilation in Children

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Noninvasive Mechanical Ventilation

- Provide support without artificial airways
- Negative-pressure ventilation
- Iron lung used in 1950s during polio epidemic
Iron lung

- Useful in neuromuscular dz, chest wall deformity, central hypoventilation
- Not useful in acute resp. failure
- Poor patients’ acceptance
- Awkward size
- Create upper airway obstruction
Noninvasive Mechanical Ventilation

- Use of mask or nasal prongs
- Provide support through nose and/or mouth
- Absence of artificial airways eg ETT, trach
Advantages

- Avoid intubation and/or tracheostomy
- Prevent injury to vocal cords
- Decreased risk of nosocomial pneumonia
- Decreased sedation requirement
- Preserve swallowing, feeding, speech
- Ambulate more easily
- Can be used at home
Limitations

- Nasal-mask (interface) intolerance
- Discomfort
- Asynchrony
- Serious air leaks
- Gastric distension
- Eye irritation, conjunctivitis
- Epistaxis, nasal irritation, rhinorrhea, dry nose&throat
- Facial skin breakdown or necrosis esp. at the nose bridge
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- Facial skin breakdown or necrosis esp. at the nose bridge --
- Abnormal facial growth esp. in pre-pubertal children
Selecting patients for noninvasive ventilation

- **Inclusion criteria**
  - Acute or chronic respiratory failure
  - Sleep-related breathing disorder
  - Upper airway obstruction

- **Relative contraindication**
  - Inability to use nasal or face mask
  - High risk of aspiration
  - Life threatening refractory hypoxemia
  - Require ETT for secretion drainage
  - Hemodynamic instability
Acute Hypoxemic Respiratory Failure

**Fig. 1.** - The ratio of the partial pressure of arterial oxygen to the fraction of inspired oxygen ($P_{a,O_2}/F_{I,O_2}$) at baseline and after 1 h of mechanical ventilation in patients with acute respiratory failure in a) the noninvasive ventilation ($n=32$, baseline mean±SD: 116±24, 60 min 230±76, p<0.001); and b) conventional ventilation groups ($n=32$, baseline mean±SD: 124±25, 60 min 211±68, p<0.001). From [5] with permission.
Obstructive sleep apnea
CPAP

- Pneumatic splint to prevent airway collapse
- Increased end expiratory lung volume
- Lethal risk are essentially non-existence
Intermittent noninvasive ventilation

- **Only 4-6 hours per night can improve**
  - Daytime gas exchange and dyspnea

- **May be explained by**
  - Rest fatigued resp. muscles → Improve muscle function
  - Re-expand microatelectasis → Improve lung compliance
  - Prevent blunting hypercapnic drive
Central hypoventilation syndrome
Kyphoscoliosis
Nasal masks
Chin strap
Full face mask (rarely used)
Nasal cannula
Head gear
Modes of noninvasive positive pressure ventilation

- Continuous positive airway pressure (CPAP)
- Bilevel positive airway pressure (BiPAP)
- ICU ventilators
  - Pressure support
  - Pressure control
  - Volume controlled
CPAP vs. BiPAP

- **CPAP** → work as upper airway splint

- **BiPAP** → increase ventilation + upper airway splint
BiPAP vs. ICU ventilators

- As responsive
- As able to meet ventilatory demand
- Better able to compensate for leaks
- Transition to exhalation as well
**BiPAP**

- Lack of monitoring
- Lack of alarms
- CO$_2$ rebreathing due to single inspiration-expiration circuit
- FiO$_2$ accuracy/consistency??
ICU ventilators for NIV

- Few compensate for leaks?
- Nasal / some orofacial masks may be a problem
- Cycling to exhalation a problem
- Most alarms not designed for NIV
- Do monitor patient / ventilator system
- Do alarm problem situations
- Do provide precise FiO₂
Ideally BiPAP for use in ICU

- Able to monitor the patient / ventilator system
  - (pressure, flow, and volume waveforms)
- Appropriately alarmed
- Able to provide accurate, high FiO\textsubscript{2}
- Designed for use in the ICU
Humidification

- High flows result in dried retained secretions
- Use heated (pass over) humidifier
- Adjust to patient comfort