Basic Concepts of Noninvasive Positive Pressure Ventilation

Chapter 19

Noninvasive Ventilation

- Does not require an endotracheal tube
- Use of NPPV has the potential:
  - to avoid complications of intubation
  - decrease mortality rates
  - decrease length of stay

Noninvasive Techniques

Negative Pressure

- Iron lung
- Chest cuirass

Abdominal displacement

- Rocking bed
- Intermittent abdominal pressure ventilator - pneumobelt

Noninvasive Techniques

- Positive Pressure Ventilation
  - Bag mask ventilation
  - IPPV – pressure targeted ventilator and mask
  - IPPB
  - CPAP
  - NPPV

Goals and Indications

- Clinical research
- Evidence based medicine
- Variety of disorders, diseases, and clinical settings (acute, chronic, home)

Acute Respiratory Failure

- Avoid intubation
- Decreases mortality
- Reduces the duration of ventilation
- Shortens hospital stay/ICU days
- Reduces nosocomial infections
- Preserves airway defenses
- Improves patient comfort
- Reduces need for sedation

Physiologic Goal for Acute Care:

- Improve gas exchange
- Increase alveolar ventilation

Patient Selection

- Patient diagnosis
- Clinical characteristics
- Risks of failure
- Establish the need for ventilatory assistance
- Exclude patients are high risk of failure or complications
- Disease reversibility

Exclusion Criteria

- Respiratory arrest
- Hemodynamic instability
- Inability to protect the airway
- Excessive secretions
- Agitated or confused patients
- Facial deformities
- Uncooperative, unmotivated patients
- Brain injury

NPPV Successfully Used in:

- COPD Exacerbation
- Asthma
- Hypoxemic Respiratory Failure
- CAP
- Cardiogenic Pulmonary Edema

Chronic Care Benefits

- Supportive therapy
- Alleviates symptoms of chronic hypoventilation, nocturnal desaturation, respiratory muscle fatigue, poor sleep quality
- Improves duration and quality of sleep
- Improves functional capacity
- Prolongs survival
- Improves quality of life

Patient Selection

- ABG criteria can vary
- Symptoms of nocturnal hypoventilation
- Medically stable
- Able to protect airway
- Patient motivation

NPPV successfully used in:

- Restrictive thoracic disorders
- Chronic stable COPD
- Cystic fibrosis
- Nocturnal hypoventilation

Also indicated for:

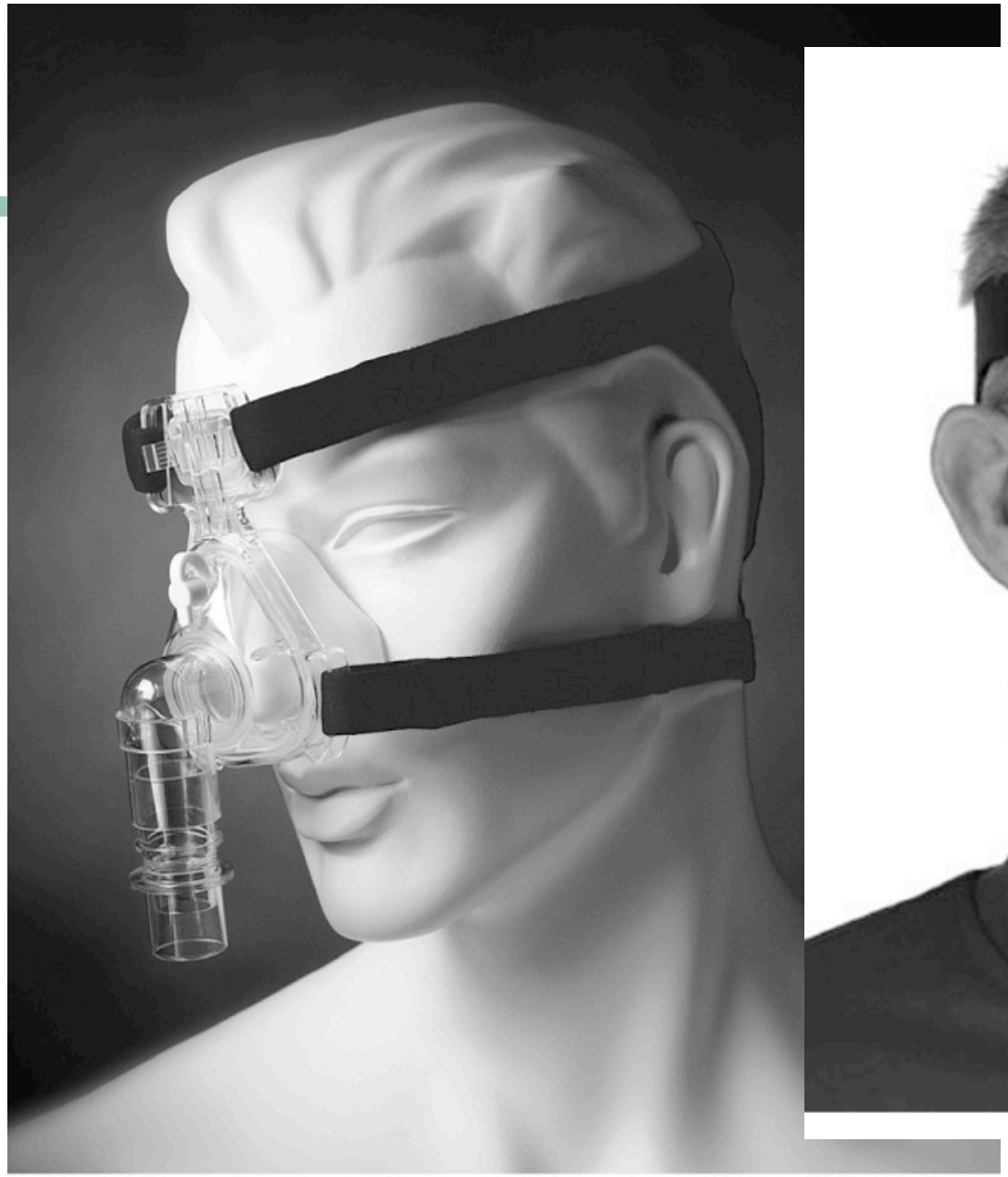
- Facilitation of weaning from invasive ventilation
- “DNI”

Equipment

- Ventilators:
  - Pressure targeted ventilators
  - Portable volume ventilators
- Humidifiers
- Patient Interface

Patient Interfaces

- Nasal
- Full (oronasal)
- Total Face
- Oral interfaces



A

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Set-up and Preparation

- Requires patient cooperation and tolerance
- Selection of appropriate interface
- Starting with low pressure initially
- Allow the patient to hold the mask
- Reassurance
- Requires secure fit, leaks are acceptable

Initial Settings

- CPAP
- BiPAP
  - IPAP
  - EPAP
- FiO2
- Leak

Predictors of NPPV success

- Higher level of consciousness
- Younger age
- Less severe illness
- Less severe gas exchange
- Minimal leakage
- Intact dentition
- Synchronous breathing
- Fewer secretions
- Absence of pneumonia
- Positive response within 1-2 hours

Monitoring

- Achieve exhaled tidal volume 5-7ml/kg
- Patient ventilator synchrony
  - Rise time
  - Inspiratory sensitivity
  - Expiratory flow cycling
  - EPAP to offset autoPEEP
- Oximetry
- Alleviating disease/disorder signs and symptoms

SUCCESS?

- Improvement in patient comfort
  - Decrease in respiratory rate
  - Reduced inspiratory muscle activity
  - Synchronization with the ventilator
- If these are absent:
  - Refit, change interface
  - Encouragement and coaching
  - Adjusting settings

Termination Criteria

- Worsening pH and $PaCO_2$
- Tachypnea (f>30)
- Hemodynamic instability
- Oxygen saturation <90%
- Decreased LOC
- Inability to clear secretions
- Inability to tolerate interface

Clinical Rounds 19-1

A 72 year old woman with a history of COPD is receiving NPPV for ventilatory failure secondary to postoperative pneumonia. The patient is wearing a full face mask but is having difficulty swallowing and coughing. She appears very weak and has become more agitated and confused in the past hour. The respiratory rate is 24, SpO2 is 92% on 5L/min bleed in. What action should be taken at this time?

Oxygenation and respiratory status appear to be acceptable, but close assessment reveals several risk factors that may compromise the patient's safety. The patient's ability to cough and swallow have deteriorated, reflecting her inability to protect the airway adequately. This places her at very high risk for aspiration. The patient also has become more agitated and confused in the past hour, which could indicate worsening hypercarbia.➔ INTUBATE

Clinical Rounds 19-2

A 71 year old man is admitted to the ICU for an acute exacerbation of COPD. On admission he was tachypneic and dyspneic, as evidenced by a RR of 30 and the use of accessory muscles. ABG values on 2L/min are 7.31/56/49. The attending physician ordered NPPV in an attempt to normalize the pH. The RT initiates NPPV with a full face mask at the following settings A/C mode f = 12, IPAP = 10, EPAP = 4 3L/m O2 bleed in.

After one hour the patient complains of some dyspnea and discomfort and has a RR of 26. The average Vt is 310ml. The full face mask appears to fit well and no significant leak is detected. ABG is 7.32/53/59 SaO2- 90%. What changes if any should be made in the current settings to make the patient more comfortable and help normalize the pH?

Clinical Rounds 19-2

The symptoms of dyspnea, agitation, and increased respiratory rate reveal inadequate clinical improvement from NPPV. Two things need to be considered at this time. Currently the patient's average exhaled Vt is only 3-4ml/kg, this contributes to the high f and may promote auto-PEEP. The practitioner should attempt to increase the exhaled Vt to 5-7ml/kg by increasing IPAP. The use of a full face mask may increase the potential for CO2 re-breathing, especially if EPAP levels are not set adequately. Increasing EPAP increases the flow of gas to the mask during exhalation and reduces the potential for re-breathing of CO2. Increasing EPAP increases the flow of gas to the mask during exhalation and reduces the potential for re-breathing of CO2. Increasing EPAP also may reduce WOB. However if EPAP is increased without increasing IPAP, the gradient between IPAP and EPAP (or the pressure support level) will decrease resulting in a lower delivered Vt. Therefore if EPAP is increased IPAP must also be increased to ensure adequate pressure support for greater Vt delivery to the patient.

Clinical Rounds 19-3

A 68 year old man with severe stable COPD and OSA has been receiving NPPV via nasal mask for approximately 3 months. Follow-up ABG analysis and continuous nocturnal oximetry do not show any significant improvement in gas exchange or the frequency of sleep-related events. When questioned about his use of the NPPV system, the patient admits that he uses the system only for about 2 hours because of uncomfortable nasal dryness and sinus pain.

The RT examines the patient's NPPV equipment and notes that it includes an unheated passover humidifier and the the nasal mask appears to fit well without significant leakage. What can be done to increase the patient's comfort and tolerance of the NPPV system?

Clinical Rounds 19-3

Improvement in gas exchange and other symptoms related to chronic hypoventilation may take several weeks for those who use NPPV only intermittently. Patients who can tolerate NPPV for at least 4-6 hours in each 24hr period are most likely to show improvement in symptoms. This patient's lack of compliance and intolerance of NPPV are most likely responsible for his poor physiological improvement. Nasal dryness and congestion are common complications of NPPV and every effort should be made to minimize their occurrence. A room-temperature humidifier attached to he CPAP machine adds moisture and often is helpful for patients with nasal drying or congestion. Cold, dry air coming directly from the CPAP mask may increase nasal resistance by means of increased nasal congestion. Heated humidification is more expensive but may be attempted in particularly difficult cases. Nasal irritation and congestion may be treated with nasal sprays. Patients with persistent difficulties may benefit from referral to and ENT specialist.

Complications

- Mask discomfort
- Air pressures/Gas flows –gastric insufflation
- Aspiration pneumonia
- Pneumothorax
- Hypotension
- Hypoxemia, Mucus plugging
- Respiratory arrest

Weaning

- Reversal of the cause of respiratory failure
- Stabilization of the patient's condition
- Gradually decreasing the level of support (both ventilatory and oxygenation)
- Gradually increase the amount of time off NPPV

Team Approach

- Time intensive therapy
- Cooperation between disciplines
- Patience
- Role of the RT: initiating, troubleshooting, weaning