Noninvasive Ventilation Overview Methods of Delivery

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1. When can non-invasive ventilation be indicated?

2. When is non-invasive ventilation contraindicated?

3. Which ventilator is the best choice for non-invasive ventilation?


PHILIPS

Learning Objectives (1 of 3)

- List the goals and benefits of noninvasive ventilation (NIV).
- Discuss indications for NIV and the relative strength of the supporting evidence for each indication.
- List the selection and exclusion criteria for successful NIV.
- List the factors that predict successful NIV.

Learning Objectives (2 of 3)

- Describe how to recognize NIV failure.
- Identify the types of patient interfaces available for NIV and describe how to choose an appropriate interface for a patient.
- List common interface-related adverse effects and discuss how to avoid them.
- Discuss the types of mechanical ventilators and ventilation modes used to provide NIV.

Learning Objectives (3 of 3)

- Discuss the causes and resolution of patient-ventilator asynchrony in NIV.
- Describe the role of the respiratory therapist during the initial application of NIV.
- Describe the ongoing ventilator management of NIV in the acute care setting.
- List potential complications associated with NIV and possible solutions.

Introduction to Noninvasive Ventilation

- Supports ventilation without artificial airway
  - Bag-mask provides the earliest example
- NIV includes:
  - Noninvasive positive pressure ventilation (NPPV)
  - The noninvasive application of continuous positive airway pressure (CPAP)

Goals and Benefits of Using NIV (1 of 2)

- Acute care setting
  - Improve gas exchange
  - Avoid intubation
  - Decrease mortality
  - Decrease length of time on ventilator
  - Decrease length of hospitalization
  - Decrease incidence of ventilator-associated pneumonia
  - Relieve symptoms of respiratory distress
  - Improve patient-ventilator synchrony
  - Maximize patient comfort

Goals and Benefits of Using NIV (2 of 2)

- Long-term setting
  - Relieve or improve symptoms
  - Enhance quality of life
  - Avoid hospitalization
  - Increase survival
  - Improve mobility

Acute Care Indications

- COPD
- Hypercapnic respiratory failure due to COPD is primary indication for NIV
  - Strong evidence of efficacy in reducing
    - Need for intubation
    - Hospital mortality and length of stay
    - Complications
  - Standard of care for managing an acute exacerbation of COPD
    - First-line therapy

Asthma and NIV

Although a favorable response to NIV would be anticipated in acute asthma, little evidence supports this application.

Recent reviews concluded that there is not enough evidence to support the use of NIV in acute asthma and that medical treatment alone may usually be effective.

The use of NIV for asthmatic patients who decline intubation and for selected patients who are likely to cooperate with mask therapy has been suggested, but more data are needed to generally recommend this approach.

NIV to facilitate weaning

NIV has been used in patients with persistent weaning failure (patients in whom the spontaneous breathing trial failed)

Shortening the length of stay and lowering the incidence of complications (ventilator-associated pneumonia or septic shock).

Early extubation and immediate application of NIV when patients meet weaning criteria can be a useful approach to increase weaning success rates and may reduce mortality in COPD patients.

There is no strong evidence in terms of avoiding reintubation with patients with COPD.

NIV can also be used after planned extubation in patients at high risk of deterioration as it could prevent postextubation ARF and reintubation.

Acute Care Indications

- Hypoxemic respiratory failure
  - Clinical trials of NIV to manage acute hypoxemic respiratory failure have yielded conflicting results
  - NIV as a general approach to managing respiratory failure in the absence of hypercapnia has shown mixed results
- Acute cardiogenic pulmonary edema:
  - Mask CPAP of 8 to 12 cm H_2O and 100% O_2 is first-line therapy to treat hypoxemia associated with severe cardiogenic pulmonary edema
  - NIV reserved for those with ventilatory failure also

Acute Care Indications

- Pneumonia
  - Improves outcomes only for COPD patients who develop pneumonia
  - NIV use for pneumonia may also lead to greater mortality than other modes of noninvasive oxygen supplementation such as high-flow nasal cannula
- Acute lung injury and ARDS
  - Patients with risk factors such as hemodynamic instability, metabolic acidosis, or profound hypoxemia are more likely to fail
  - The evidence to date does not support routine NIV use in patients with ALI/ARDS
  - Failure was predicted if PaO_2/FiO_2 ratio was less than 175 after the first hour of NIV

Acute Care Indications

- Immunosuppressed patients
  - RCTs involving immunosuppressed patients and patients awaiting solid organ transplantation who developed hypoxemic respiratory failure found decreased intubation rates and mortality with NIV compared with standard therapy
- DNI and comfort measures only
  - Use only if it makes patient more comfortable or to manage a reversible disorder
- Postoperative use shows promise
  - Insufficient evidence to support NIV use

Acute Care Indications

- Postoperative respiratory failure
  - Requires a cautious approach
  - If hypoxemia does not significantly improve with NIV, these patients should be reintubated without delay
- Prevention of reintubation in high-risk patients
  - Studies have shown lower reintubation rates with NIV
  - Patients with hypercapnia gained the most benefit from NIV

Long-Term Care Indications

- Stable COPD
  - Positive inspiratory pressure improves gas exchange and may unload the respiratory muscles, allowing them to recover, gain strength, and reduce fatigue resulting in improved quality of life
  - Should decrease the symptoms of nocturnal hypoventilation and sleep-disordered breathing
  - At the present time, there is not enough evidence to support routine treatment with NIV in patients with stable COPD

Long-Term Care Indications

- Obesity-hypoventilation syndrome (OHS)
  - Defined as chronic daytime hypoventilation (PaCO2 greater than 45 mm Hg) associated with obesity (body mass index greater than 30 kg/m2) when no other known cause for hypoventilation is present
  - A RCT of CPAP versus NPPV in patients with OHS without severe nocturnal desaturations found that both modes were equally effective in decreasing daytime PaCO2
  - At the present time, nocturnal NPPV is recommended for OHS when nasal CPAP and other first-line therapies fail to alleviate the hypoventilation

Selecting Appropriate Patients for NIV

- In acute respiratory failure
- Two or more of the following should be present:
  - Use of accessory muscles
  - Paradoxical breathing
  - Respiratory rate greater than or equal to 25 breaths/min
  - Moderate to severe dyspnea (increased dyspnea in COPD patients)
  - $PaCO_2$ greater than 45 mm Hg with pH less than 7.35
  - PaO_2/FiO_2 ratio less than 200

Selecting Appropriate Patients for NIV

- Exclusion criteria in acute respiratory failure
  - Apnea
  - Inability to protect airway/high aspiration risk
  - Hemodynamic or cardiac instability
  - Lack of patient cooperation
  - Inability to use a noninvasive interface because of facial burns, trauma, or abnormal anatomy
  - Excessive amounts of secretions

Predictors of success in the acute care setting for NIV

- Predictors of success in the acute care setting
  - Minimal air leak (less than 24 liters/min)
  - Low severity of illness (Apache 2 score)
  - Respiratory acidosis ($PaCO_2$ greater than 45 mm Hg but less than 92 mm Hg)
  - pH less than 7.35 but greater than 7.22
  - Improvement in gas exchange within 1 to 2 hours of initiation
  - Improvement in respiratory rate and heart rate

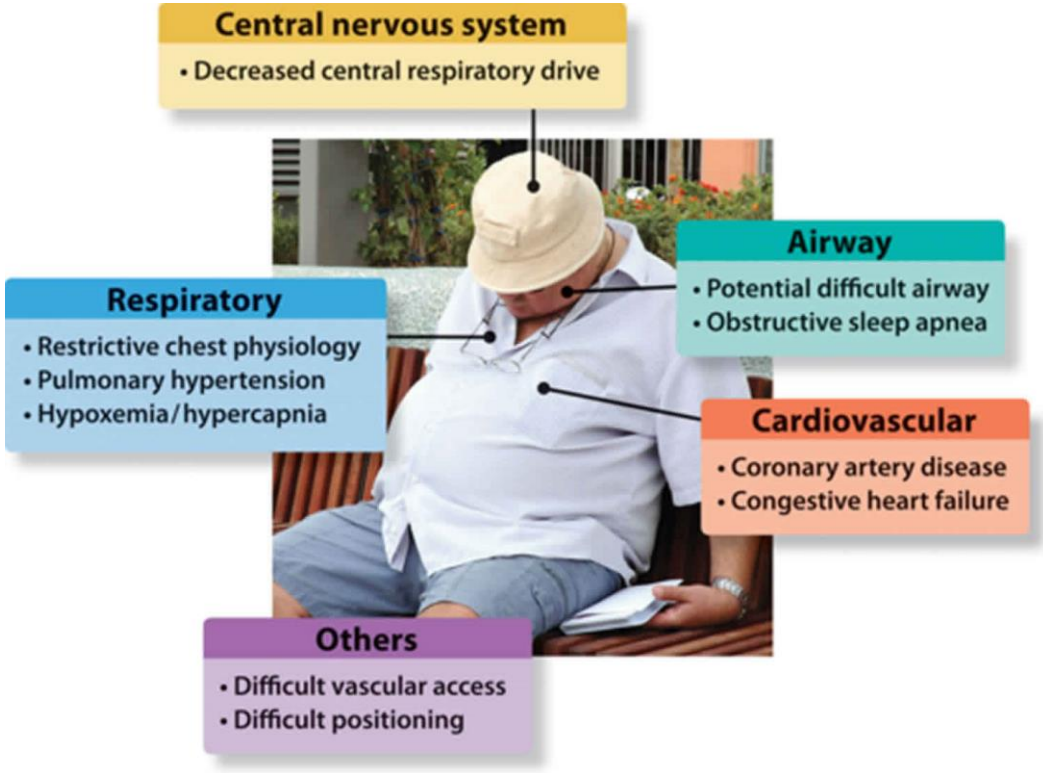
Restrictive Thoracic Patients for NIV

- In restrictive thoracic disease
- Pulmonary fibrosis, Sarcoidosis, Obesity, ALS
  - Patients should have symptoms of chronic hypoventilation and lack of sleep quality
  - Patients should meet one of the following measurable parameters:
    - $PaCO_2$ 45 mm Hg or greater
    - Nocturnal O_2 saturation less than 88% for 5 minutes
    - Maximal inspiratory pressure less than 60 cm H_2O
    - FVC less than 50% of predicted

Nocturnal Hypoventilation Patients for NIV

In nocturnal hypoventilation caused by disorders (Not restrictive lung disease and COPD)

- First-line therapy includes weight loss
- O_2 therapy
- Respiratory stimulants
- CPAP
- NIV is recommended as the initial therapy for moderate to severe cases



Patient Interfaces: Masks

- 18% to 40% failure rate for NIV
- Nasal mask, fill face helmets, oro-nasal mask
- Covers the nose or mouth or full face
- Made of hard, clear plastic with a cushion below for contact with face
- A strap assembly holds mask on face
  - Do not overtighten because it may cause tissue necrosis

Patient Proper Sizing of Masks

- Air leaks, mask discomfort, and skin lesions
  - Proper fitting mask
  - Reduces incidence of pressure sores and tissue necrosis
  - Reduces leaks
  - Increases patient comfort
  - Improves likelihood of long-term patient tolerance

Ideal noninvasive ventilation interface and securing system
Ideal interface
Leak-free
Good stability
Non-traumatic
Light-weight
Long-lasting
Non-deformable
Non-allergenic material
Low resistance to airflow
Minimal dead space
Low cost
Easy to manufacture (for the moulded interfaces)
Available in various sizes
Ideal securing system
Stable (to avoid interface movements or dislocation)
Easy to put on or remove
Non-traumatic
Light and soft
Breathable material
Available in various sizes
Works with various interfaces
Washable, for home care
Disposable, for hospital use

Patient Interfaces: Picking the right mask

- The choice of interface is generally influenced by patient characteristics including facial anatomy, level of comfort, and breathing pattern
- Nasal mask is the most-often used interface for patients who require long-term support
- Chin straps maybe beneficial

Initiation of NIV

Choose a location with appropriate monitoring based on the severity of the patient's condition.

Position the patient with the head of the bed elevated greater than or equal to 30 degrees.

Select a ventilator and an appropriately sized interface.

Turn on the ventilator and humidifier and connect the interface.

Settings

IPAP

- May be called positive inspiratory pressure (PIP) or inspiratory positive airway pressure (IPAP)

EPAP

- EPAP setting may be adjusted with different objectives depending on the pathology being treated

Driving pressure of Pressure support

- Difference between IPAP and EPAP

Backup respiratory rate

- Ensures minimal ventilation when the patient is unable to trigger a mechanical breath
- Backup respiratory rate should be set to less than the patient's spontaneous respiratory rate to favor breaths triggered by the patient

Inspiratory trigger

- Set at the most sensitive level for best detection of patient inspiratory efforts without causing auto-triggering

Pressure rise time

- Time needed for the airway pressure to increase from EPAP to IPAP

Clinical Assessment Criteria to Identify Success or Failure of NIV

Success easy to identify

- Improved ABGs: $PaCO_2$ decreases, pH increases, PaO_2 increases
- Clinical improvement: decreased RR, V_T increased, diminished accessory muscle use

Failure

- If in 1 to 2 hours the above are not noted; move to intubation
- Waiting too long can result in cardiac arrest

Adjusting NIV

Screen shot of ventilator graphics and information panel of a patient undergoing BiPAP ventilation

- Adjustments determined by patient presentation and ABGs
  - High $PaCO_2$: Increase pressure (V_T) or rate
  - Low $PaCO_2$: Decrease pressure (V_T) or rate
    - Often rate is for backup only; if set in A/C may have above effects, but patient inspiratory efforts override ventilator setting
  - High PaO_2: Decrease oxygen or PEEP
  - Low PaO_2: Increase oxygen or PEEP
    - When PEEP is adjusted, may alter pressure gradient and thus V_T

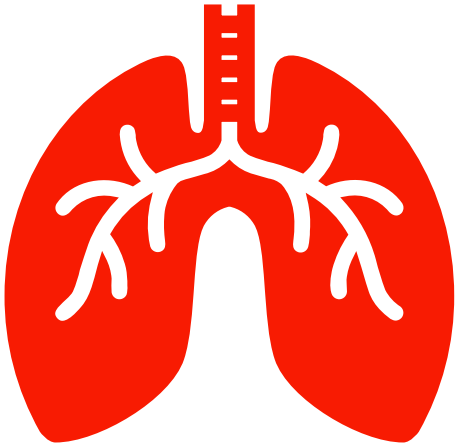
Ventilators for Noninvasive Versus Designated BIPAP Devices Which to choose?

One of the main causes of NIV failure is leak

Critical care ventilators are not uniform in their ability to properly perform in the presence of leaks

Monitoring

1. When can non-invasive ventilation be indicated?



2. When is non-invasive ventilation contraindicated?

3. Which ventilator is the best choice for non-invasive ventilation?

Summary

- Noninvasive ventilation is a great tool to use
- Pay attention to the interface that is used to deliver NIV
- Pay attention to the contraindications of a use
- It is better to use NIV than invasive ventilation

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