Non invasive Ventilation (NIV)

Acute Care

Overview

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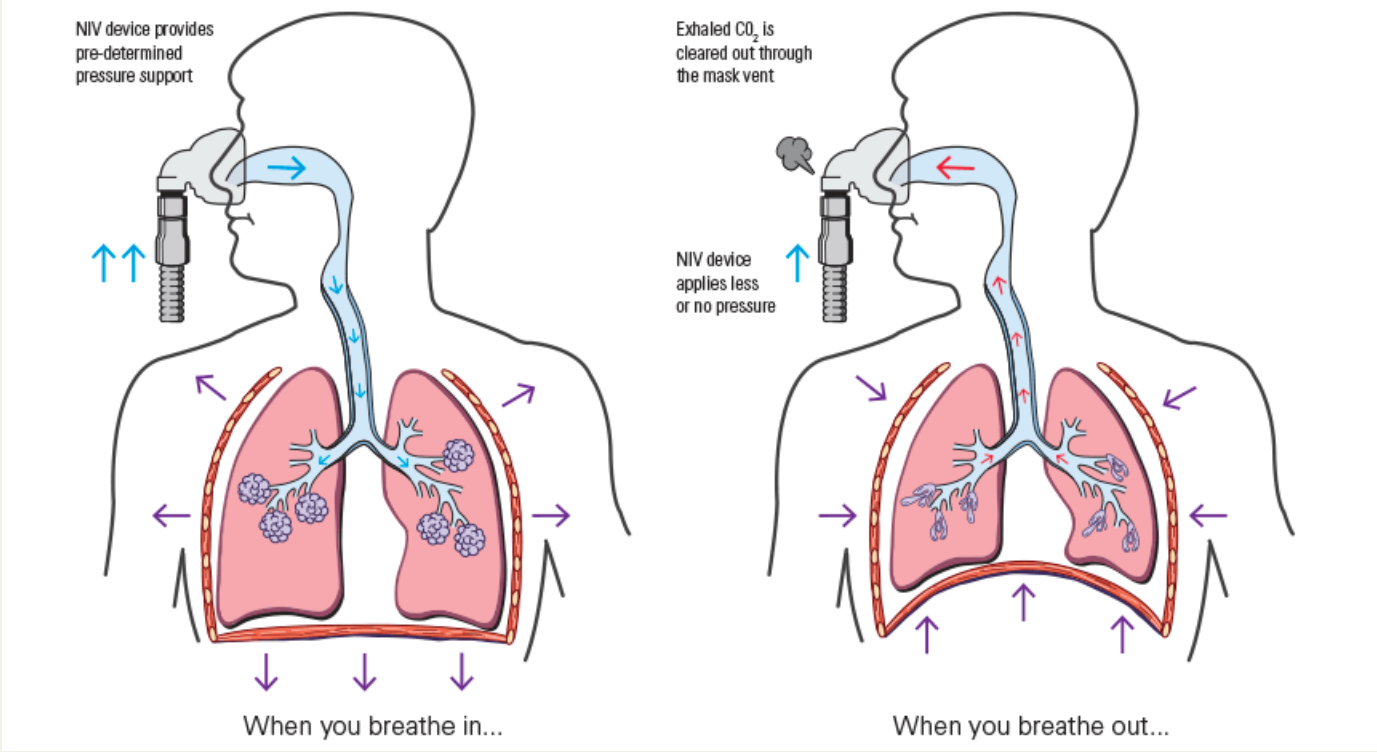
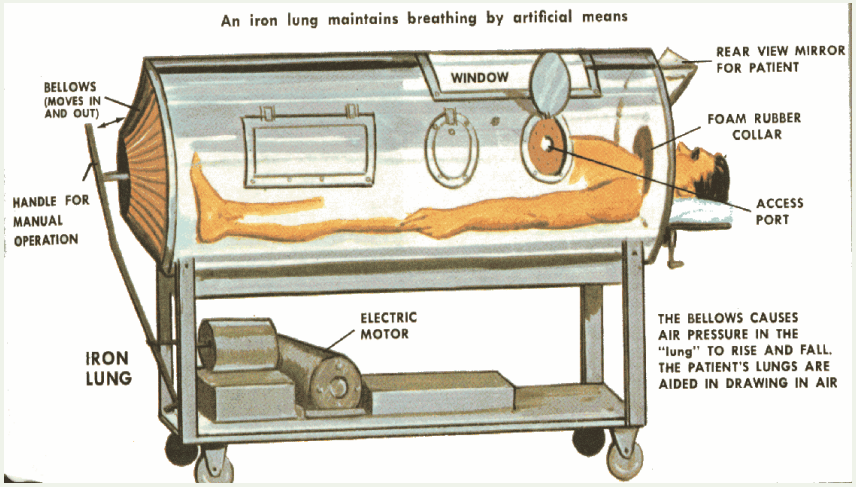
Non Invasive Ventilation(NIV)

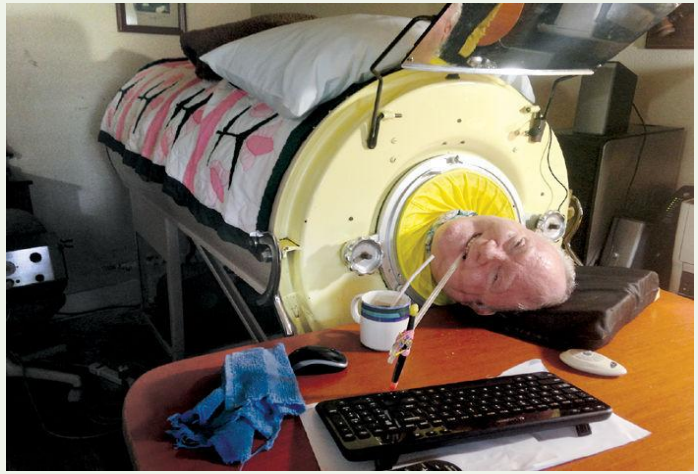
- Delivery of ventilation to the lungs without an invasive airway (endotracheal or tracheostomy)
- Avoid the adverse effects of intubation or tracheostomy (early and late)

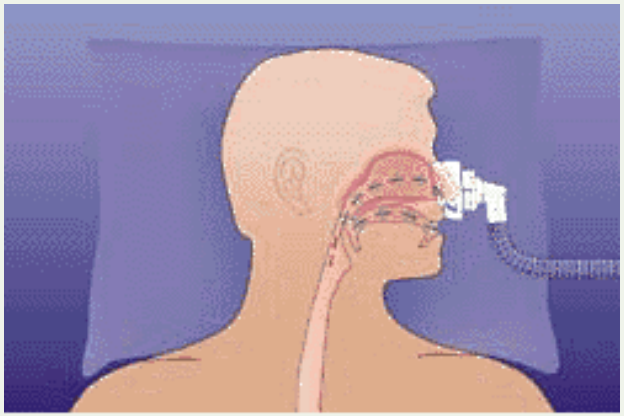


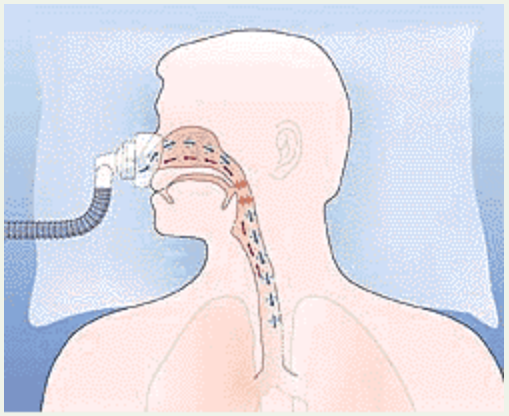
Types of NIV

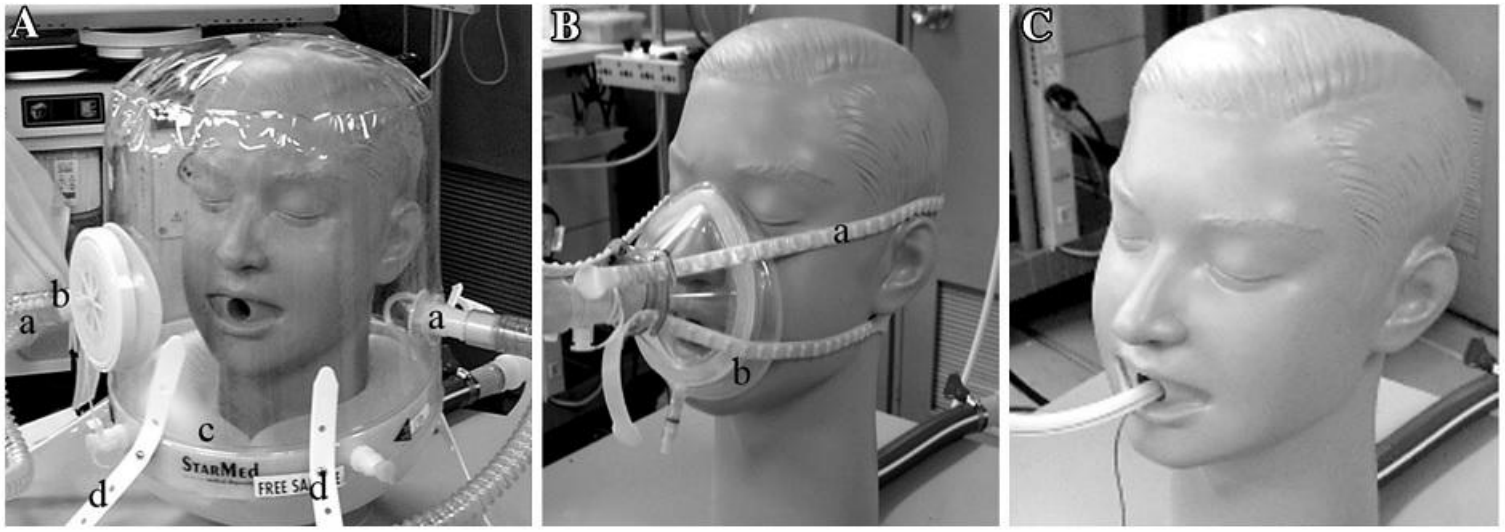
- Negative pressure ventilation (iron or tank-chest cuirass)
- Abdominal Displacement(Pneumobelt-Rocking bed)
- Positive pressure ventilation(pressure BIPAP- CPAP, Volume)







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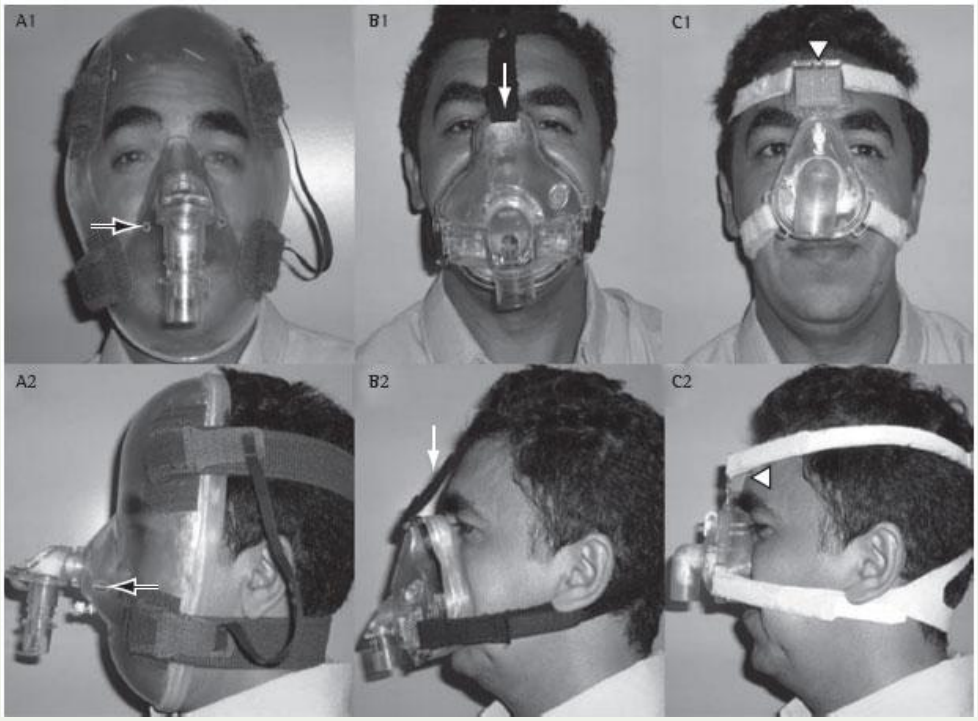
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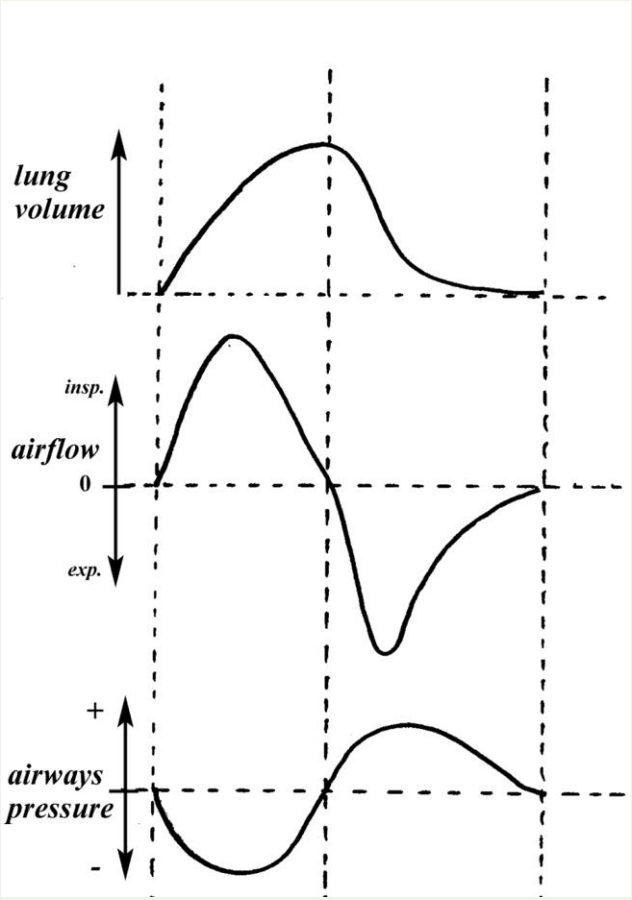
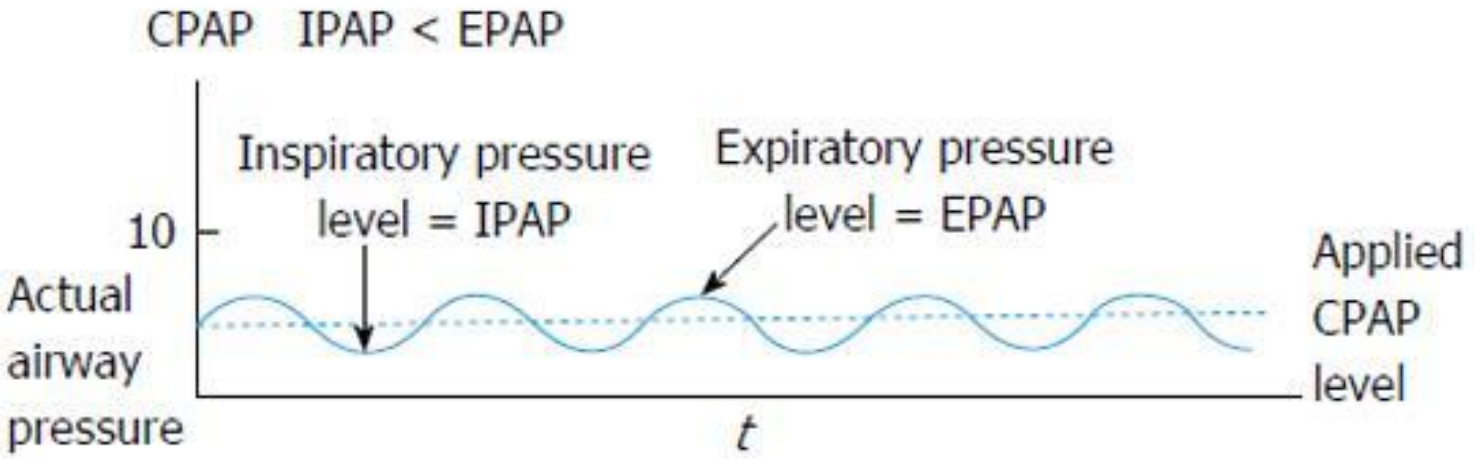
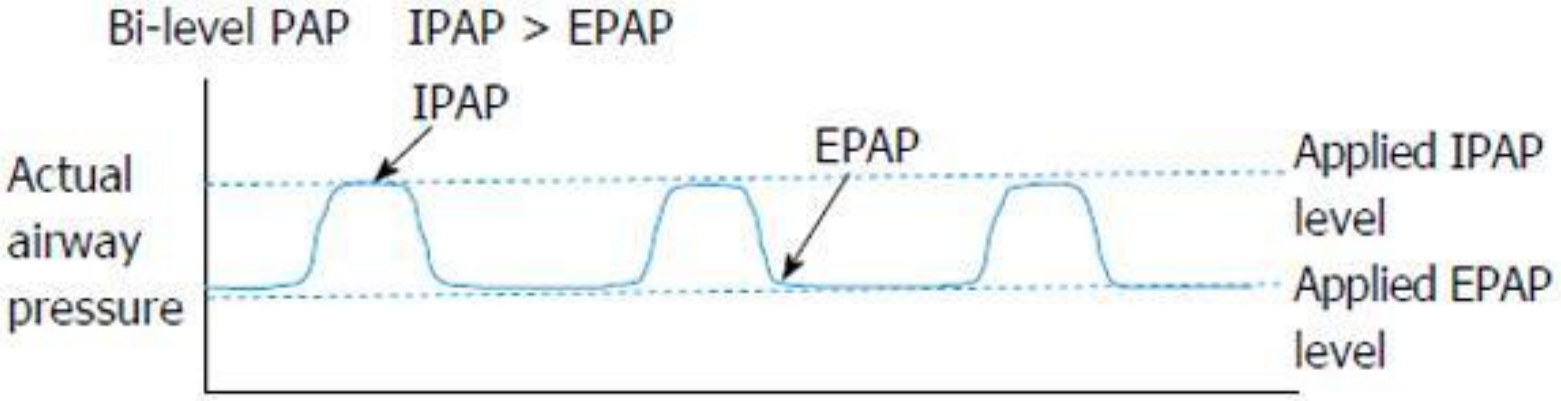
Normal Breathing:



PAP Breathing:





NIV:

Contraindications:

- Coma (?palliation)
- Cardiac arrest
- Respiratory arrest
- Any condition requiring immediate intubation

Relative:

- Cardiac instability - Shock and need for pressor support, ventricular dysrhythmias, complicated acute myocardial infarction
- GI bleeding - Intractable emesis and/or uncontrollable bleeding
- Inability to protect airway - Impaired cough or swallowing, poor clearance of secretions, depressed sensorium and lethargy
- Status epilepticus
- Potential for upper airway obstruction - Extensive head and neck tumors, any other tumor with extrinsic airway compression, angioedema or anaphylaxis causing airway compromise
- Staff learning curve and time requirements (nursing and respiratory therapy),

NIV:

Patient Selection:

•Patient cooperation (an essential component that excludes agitated, belligerent, or comatose patients)

•Dyspnea (moderate to severe, but short of respiratory failure)

•Tachypnea (>24 breaths/min)

•Increased work of breathing (accessory muscle use, pursed-lips breathing)

•Hypercapnic respiratory acidosis (pH range 7.10-7.35)

•Hypoxemia (PaO 2/FIO_2 <200 mm Hg, best in rapidly reversible causes of hypoxemia)

NIV:

Suitable (most patients):

- Chronic obstructive pulmonary disease
- Cardiogenic pulmonary edema

Suitable (selected patients):

- After discontinuation of mechanical ventilation (COPD)
- Community-acquired pneumonia (and COPD)
- Asthma
- Immunocompromised state (known cause of infiltrates)
- Postoperative respiratory distress and respiratory failure
- Do-not-intubate status
- Neuromuscular respiratory failure (better in chronic than acute; avoid if upper airway issues)
- Decompensated obstructive sleep apnea/cor pulmonale
- Cystic fibrosis
- Mild *Pneumocystic jirovecii* pneumonia
- Rib fractures

Use with caution:

- Idiopathic pulmonary fibrosis (exacerbation)
- Acute respiratory distress syndrome (consider helmet ventilation)

Modes of ventilation

- past experience
- capability of ventilators available
- condition being treated

Modes Used:

- CPAP : most basic, for CHF, OSA
- BiPAP : mostly Used
- PAV : doubtful benefit compared with BiPAP
- AVASP :mostly for chronic use in neuromuscular weakness
- PC : Ti is fixed as compared to PS in BiPAP.

BiPAP SetUp

Initial IPAP/EPAP settings:

- Start at 10 cm water/5 cm water
- Pressures less than 8 cm water/4 cm water not advised as this may be inadequate
- Initial adjustments to achieve tidal volume of 5-7 mL/kg (IPAP and/or EPAP)
- Think of PS (IPAP –EPAP)

Subsequent adjustments based on arterial blood gas values:

- Increase IPAP by 2 cm water if persistent hypercapnia
- Increase IPAP and EPAP by 2 cm water if persistent hypoxemia
- Maximal IPAP limited to 20-25 cm water (avoids gastric distension, improves patient comfort)
- Maximal EPAP limited to 10-15 cm water
- FIO_2 at 1.0 and adjust to lowest level with an acceptable pulse oximetry value
- Back up respiratory rate 12-16 breaths/minute

OutCome:

Predictors of success after a trial of NIV (1-2 h):

- Decrease in $PaCO_2$ greater than 8 mm Hg
- Improvement in pH greater than 0.06
- Correction of respiratory acidosis

Predictors of failure are as follows:

- Severity of illness: Acidosis (pH <7.25), hypercapnia (>80 and pH <7.25), APACHE II score higher than 20
- Level of consciousness: Low GCS <8
- Failure of improvement with 12-24 hours of noninvasive ventilation

COPD:(++++)

- COPD is the most suitable condition for noninvasive ventilation.
- most effective in patients with moderate-to-severe disease
- Hypercapnic respiratory acidosis is the best responders (pH 7.20-7.30).
- Also effective in patients with a pH of 7.35-7.30, but no added benefit is appreciated if the pH is greater than 7.35.
- Obtunded COPD patients can be treated, but the success rate is lower.
- Improvement after a 1 to 2 hour trial may predict success

Cardiogenic Pulmonary Edema:(+++)

•Well suited for patients with cardiogenic pulmonary edema.

•CPAP and BiPAP modalities both are effective, with CPAP possibly being more effective.

•Greatest benefits are realized in relief of symptoms and dyspnea.

•A decrease in intubation and mortality rates is not a universal experience.

•Patients with hypercapnic respiratory acidosis may derive the greatest benefit from noninvasive ventilation.

•Importantly, adjust to standard therapy, including diuresis.

•Benefit may be seen with as few as 2 hours of support.

Post-extubation: (+/-)

- NIV is effective as a bridge support after early extubation.
- NIV is an adjunct to weaning (substitutes noninvasive support for invasive support).
- Patients with underlying COPD are most likely to benefit from noninvasive ventilation after early extubation.
- Noninvasive ventilation is not as effective in patients with postextubation respiratory distress.
- COPD patients are a subgroup who may benefit in that situation.

Community acquired pneumonia:(+/-)

- Noninvasive ventilation not established to be beneficial
- Secretions may be limiting factor
- Improvement with noninvasive ventilation best achieved in patients also with COPD
- Hypercapnic respiratory acidosis may define group likely to respond
- Decrease in intubation rate and mortality may be limited to those also with COPD

Asthma:(+/-)

- Similar pathophysiology to COPD; limited reported experience with noninvasive ventilation
- Mostly case series with reported benefit
- Prospective, randomized studies based on emergency department settings
- Improvement in spirometry main outcome measure
- Fewer admissions with noninvasive ventilation; intubation not an outcome measure
- Hypercapnic asthma patients not represented in randomized trials
- Noninvasive ventilation probably beneficial, but experience limited

Postoperative:(++)

- Postoperative hypoxemia related to atelectasis or pulmonary edema
- Occurrence following multiple types of surgery (eg, lung, cardiac, abdominal)
- Randomized trials with postoperative CPAP demonstrate benefit
- Applied as prophylactic support or with development of hypoxemia
- Benefit noted with level CPAP levels in 7.5- to 10-cm water range
- Lower intubation rates, days in ICU, and pneumonia

Clinical indication[#]	Certainty of evidence[¶]	Recommendation
Prevention of hypercapnia in COPD exacerbation	⊕⊕	Conditional recommendation against
Hypercapnia with COPD exacerbation	⊕⊕⊕⊕	Strong recommendation for
Cardiogenic pulmonary oedema	⊕⊕⊕	Strong recommendation for
Acute asthma exacerbation		No recommendation made
Immunocompromised	⊕⊕⊕	Conditional recommendation for
De novo respiratory failure		No recommendation made
Post-operative patients	⊕⊕⊕	Conditional recommendation for
Palliative care	⊕⊕⊕	Conditional recommendation for
Trauma	⊕⊕⊕	Conditional recommendation for
Pandemic viral illness		No recommendation made
Post-extubation in high-risk patients (prophylaxis)	⊕⊕	Conditional recommendation for
Post-extubation respiratory failure	⊕⊕	Conditional recommendation against
Weaning in hypercapnic patients	⊕⊕⊕	Conditional recommendation for

[#]: all in the setting of acute respiratory failure; [¶]: certainty of effect estimates: ⊕⊕⊕⊕, high; ⊕⊕⊕, moderate; ⊕⊕, low; ⊕, very low.

Switching to Invasive Ventilation:

- Worsening pH and arterial partial pressure of carbon dioxide ($PaCO_2$)
- Tachypnea (over 30 breaths/min)
- Hemodynamic instability
- Oxygen saturation by pulse oximeter (SpO_2) less than 90%
- Decreased level of consciousnees
- Inability to clear secretions
- Inability to tolerate interface

Take Home

- Cost Effective & Low Tech
- Use in selected conditions are very promising
- May think of using in resource poor setting as salvage means
- May be used in ICUs through already existing Invasive Ventilators by only procuring masks
- Newer indications and understanding emerging
- May be used by hospitalists and Internists in our country


THANK YOU

Criteria for Terminating Noninvasive Positive Pressure Ventilation and Switching to Invasive Mechanical Ventilation

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- Well suited for patients with cardiogenic pulmonary edema.
- CPAP and BiPAP modalities both are effective, with CPAP possibly being more effective.
- The greatest benefits are realized in relief of symptoms and dyspnea.
- A decrease in intubation and mortality rates is not a universal experience.
- Patients with hypercapnic respiratory acidosis may derive the greatest benefit from noninvasive ventilation.
- Importantly, adjust to standard therapy, including diuresis.
- Benefit may be seen with as few as 2 hours of support.

- NIV is effective as a bridge support after early extubation.
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Benefits of Using NIPPV

- NPPV provides greater flexibility in initiating and removing mechanical ventilation
- Permits normal eating, drinking and communication with your patient
- Preserves airway defense, speech, and swallowing mechanisms

Benefits of Using NIPPV Compared to Invasive Ventilation

- Avoids the trauma associated with intubation and the complications associated with artificial airways
- Reduces the risk of ventilator associated pneumonia (VAP)
- Reduces the risk of ventilator induced lung injury associated with high ventilating pressures

Other Benefits of Using NIPPV

- Reduces inspiratory muscle work and helps to avoid respiratory muscle fatigue that may lead to acute respiratory failure
- Provides ventilatory assistance with greater comfort, convenience and less cost than invasive ventilation
- Reduces requirements for heavy sedation
- Reduces need for invasive monitoring

clinical Benefits of Noninvasive Positive Pressure Ventilation

ACUTE CARE

- Reduces need for intubation
- Reduces incidence of VAP
- Shortens stay in intensive care unit
- Shortens hospital stay
- Reduces mortality
- Preserves airway defenses
- Improves patient comfort
- Reduces need for sedation

CHRONIC CARE

- Alleviates symptoms of chronic hypoventilation
- Improves duration and quality of sleep
- Improves functional capacity
- Prolongs survival

Potential indicators of success in NPPV use

Younger age
Lower acuity of illness (APACHE score)
Able to cooperate, better neurologic score
Less air leaking
Moderate hypercarbia ($PaCO_2$ >45 mmHG, <92 mmHG)
Moderate acidemia (pH <7.35, >7.10)
Improvements in gas exchange and heart respiratory rates within first 2 hours

Indication ,Signs and Symptoms ,and Selection Criteria for Noninvasive Positive Pressure Ventilation in Acute Respiratory Failure in Adults

Indications	Signs and Symptoms	Selection Criteria
✓Acute exacerbation of chronic obstructive pulmonary disease(COPD) ✓Acute asthma ✓Hypoxemic respiratory failure ✓Community – acquired pneumonia ✓Cardiogenic pulmonary edema ✓Immunocompromised patients ✓Postoperative patients ✓Postextubation (weaning) status ✓"Do not intubate"statuse	Moderate to severe dyspnea ■RR > 24 breaths/min ■ Use of accessory muscles ■ Paradoxical breathing	$PaCO_2$ > 45 torr , PH < 7.35 or $PaCO_2 / F_1 O_2$ <200

Contraindications to NPPV

Cardiac or respiratory arrest
Nonrespiratory organ failure
Severe encephalopathy (eg, GCS <10)
Severe upper gastrointestinal bleeding
Hemodynamic instability or unstable cardiac arrhythmia
Facial or neurological surgery, trauma, or deformity
Upper airway obstruction
Inability to cooperate/protect airway
Inability to clear secretions
High risk for aspiration

Exclusion Criteria for Noninvaseive Positive Pressure Ventilation

1. Respiratory arrest or need for immediate intubation
2. Hemodynamic instability
3. Inability to protect the airway (impaired cough or swallowing)
4. Excessive secretions
5. Agitated and confused patient
6. Facial deformities or conditions that prevent mask from fitting
7. Uncooperative or unmotivated patient
8. Brain injury with unstable respiratory drive
9. Untreated pneumothorax

Indication , Symptoms ,and Selection Criteria for Noninvasive Positive Pressure Ventilation in Chronic Disorders

Indications	Symptoms	Selection Criteria
✓Restrictive thoracic disorders Muscular dystrophy Multiple sclerosis Amyotrophic lateral scloresis Kyphpscoliosis Post-polio syndrome Stable spinal cord injuries	Fatigue Dyspnea Morning headache Hypersomnolence Cognitive dysfunction	$PaCO_2$ >= 45 mm Hg Nocturnal SpO_2 <=88% for 5 consecutive minutes MIP < 60 cm H_2 FVC < 50% predicted
✓Severe stable chronic obstructive Pulmonary disease (COPD)	After optimal therapy with bronchodialators, O_2 , and other therapy , COPD patients must demonstrate the following : Fatigue Dyspnea Morning hedache Hypersomnolence	$PaCO_2$ >55 mm Hg $PaCO_2$ 50 to 54 mm Hg with SpO_2 <88% for 5 consecutive minutes $PaCO_2$ 50 to 54 mm Hg with recurrent hospitalizations for hypercapnic respiratory failure (morethan two hospitalizations within 12 months)
✓Nocturnal hypoventilation Obstructive sleep apnea Obesity hypoventilation Idiopathic hypoventilation	Fatigue Morning headache Hypersomnolence	Polysomnographical (PSG) evidence of OSA unresponsive to CPAP

Continuous Positive Airway Pressure – CPAP

- Another form of noninvasive support is CPAP that is usually applied through a mask-type device
- CPAP does not actually provide volume change nor does it support a patient's minute ventilation
- However, it is often grouped together in discussions about noninvasive ventilation

CPAP

- CPAP is most often used for two different clinical situations
- First, CPAP is a common therapeutic technique for treating patients with obstructive sleep apnea
- Second, CPAP is used in the acute care facility to help improve oxygenation, for example in patients with acute congestive heart failure (more on this later)

Mask CPAP in Hypoxemic Failure

- **Recruits lung units**
  - improved V/Q matching > rapid correction of PaO_2 & $PaCO_2$[1]
  - increased functional residual capacity
  - decreased respiratory rate and WOB2
- **Reduces airway resistance**[2]
- **Improves hemodynamics in pulmonary edema**
  - decreases venous return
  - decreases afterload and increases cardiac index (in 50%)[1-4]
  - decreases heart rate[1-3]
- **Average requirement: 10cmH_2O**

BIPAP (Bilevel positive airway pressure)

- Pressure target ventilation
- Cycle between adjustable inspiratory & expiratory (IPAP & EPAP)
- IPAP=8-20 cm/H2O EPAP=4-5
- Mode(S, Time triggered ,S/T)
- Improve ventilation depends to difference of IPAP & EPAP

Nasal Masks

Respironics Contour Deluxe™ Mask

Dual density foam bridge forehead support

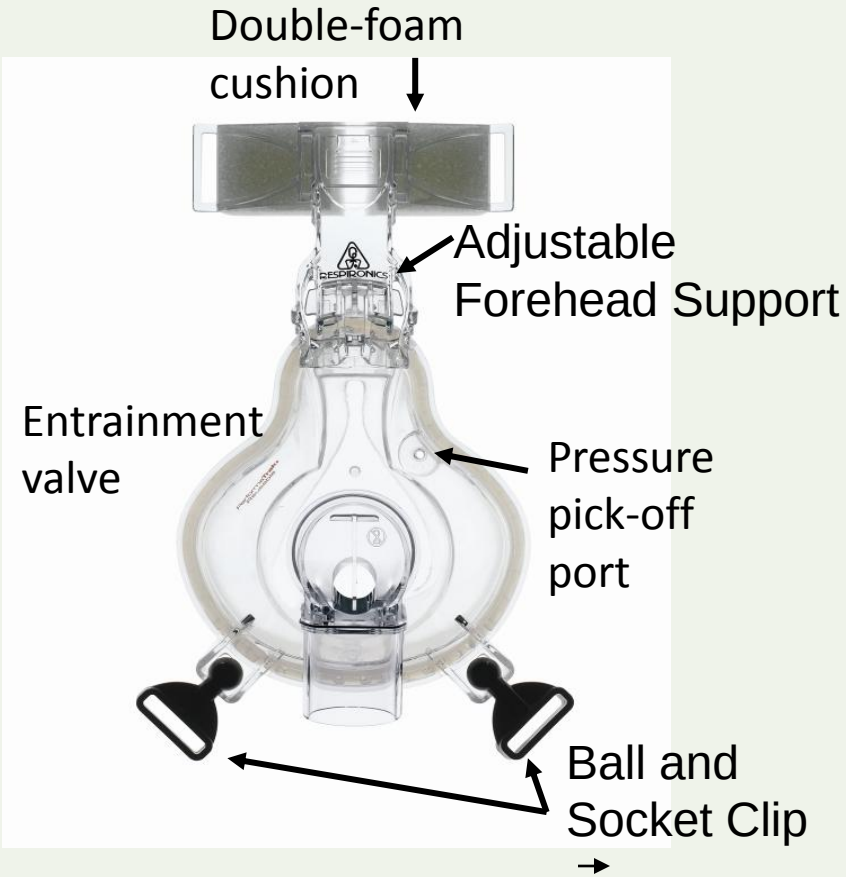
Thin flexible & bridge material

Dual flap cushion

Full Face Masks

- Most often successful in the critically ill patient

Respironics PerformaTrak® Full Face Mask



Nasal Pillows or Nasal Cushions (continued)

- **Suitable for patients with**
  - **Claustrophobia**
  - **Skin sensitivities**
  - **Need for visibility**

Respironics Comfort Lite™ Nasal Mask

Advantages of Nasal Masks

- Less risk of aspiration
- Enhanced secretion clearance
- Less claustrophobia
- Easier speech
- Less dead space

Disadvantages of Nasal Masks

- Mouth leak
- Less effectiveness with nasal obstruction
- Nasal irritation and rhinorrhea
- Mouth dryness

Nasal vs. oronasal (full-face) masks: advantages and disadvantages

Variables	Nasal	Oronasal
Comfort	+++	++
Claustrophobia	+	++
Rebreathing	+	++
Lowers CO2	+	++
Permits expectoration*	++	+
Permits speech•	++	+
Permits eatingΔ	+	-
Function if nose obstructed	-	+

Complications Associated with Mask CPAP/NPPV Therapy

complications	Corrective Action
Mask discomfort Excessive leaks around mask Pressure sores	• Check mask for correct size and fit. • Minimize headgear tension. • Use spacers or change to another style of mask. • Use wound care dressing over nasal bridge.
Nasal and oral dryness or nasal congestion	• Add or increase humidification. • Irrigate nasal passages with saline. • Apply topical decongestants.
Mouthpiece/lip seal leakage	• Use chin strap to keep mouth closed. • Change to full face mask. • Use nose clips.
Aerophagia , gastric distention	• Use custom –made oral appliances. • Use lowest effective pressures for adequate tidal volume delivery. • Use simethicone agents.
Aspiration Mucous plugging	• Make sure patients are able to protect the airway. • Ensure adequate patient hydration. • Ensure adequate humidification. • Avoid excessive oxygen flow rates (>20 l/min). • Allow short breaks from NPPV to permit directed coughing techniques.
Hypotension	• Avoid excessively high peak pressures (<=20 cm H_2O)

Protocol for initiation of noninvasive positive pressure ventilation

1. Appropriately monitored location, oximetry, respiratory impedance, vital signs as clinically indicated
2. Patient in bed or chair at >30 angle
3. Select and fit interface
4. Select ventilator
5. Apply headgear; avoid excessive strap tension (one or two fingers under strap)
6. Connect interface to ventilator tubing and turn on ventilator
7. Start with low pressure in spontaneously triggered mode with backup rate; pressure limited: 8 to 12 cm H2O inspiratory pressure; 3 to 5 cm H2O expiratory pressure
8. Gradually increase inspiratory pressure (10 to 20 cm H2O) as tolerated to achieve alleviation of dyspnea, decreased respiratory rate, increased tidal volume (if being monitored), and good patient-ventilator synchrony
9. Provide O2 supplementation as need to keep O2 sat >90 percent
10. Check for air leaks, readjust straps as needed
11. Add humidifier as indicated
12. Consider mild sedation (eg, intravenously administered lorazepam 0.5 mg) in agitated patients
13. Encouragement, reassurance, and frequent checks and adjustments as needed
14. Monitor occasional blood gases (within 1 to 2 hours) and then as needed

Steps For Initiating NPPV

1. Place patient in an upright or sitting position.Carefully explain the procedure for noninvasive positive pressure ventilation, including the goals and possible complications.
2. Using a sizing gauge , make sure a mask is chosen that is the proper size and fit.
3. Attach the interface and circuit to the ventilator . Turn on the ventilator and adjust it initially to low pressure setting.
4. Hold or allow the patient to hold the mask gently to the face until the patient becomes comfortable with it. Encourage the patient to use proper breathing technique.
5. Monitor oxygen (O_2) saturation; adjust the fractional inspired oxygen ($F_1 O_2$) to maintain O_2 saturation; above 90%.
6. Secure the mask to the patient . Do not make the straps too tight.
7. Titrate the inspiratory and end-expiratory positive airway pressures (IPAP and EPAP) to achieve patient comfort ,adequate exhaled tidal volume, and synchrony with the ventilator. Do not allow peak pressures to exceed 20 cm H_2O.
8. Check for leaks and adjust the Straps if necessary
9. Monitor the respiratory rate, heart rate,level of dyspnea, O_2 saturation , minute ventilation,and exhaled tidal volume.
10. Obtain blood gas values within 1 hour.