Noninvasive Ventilation (NIV)

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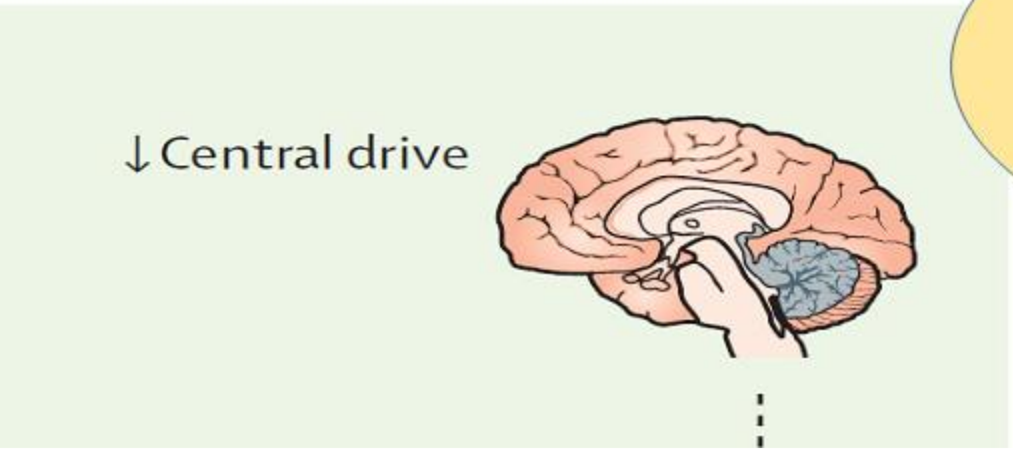
•Definition

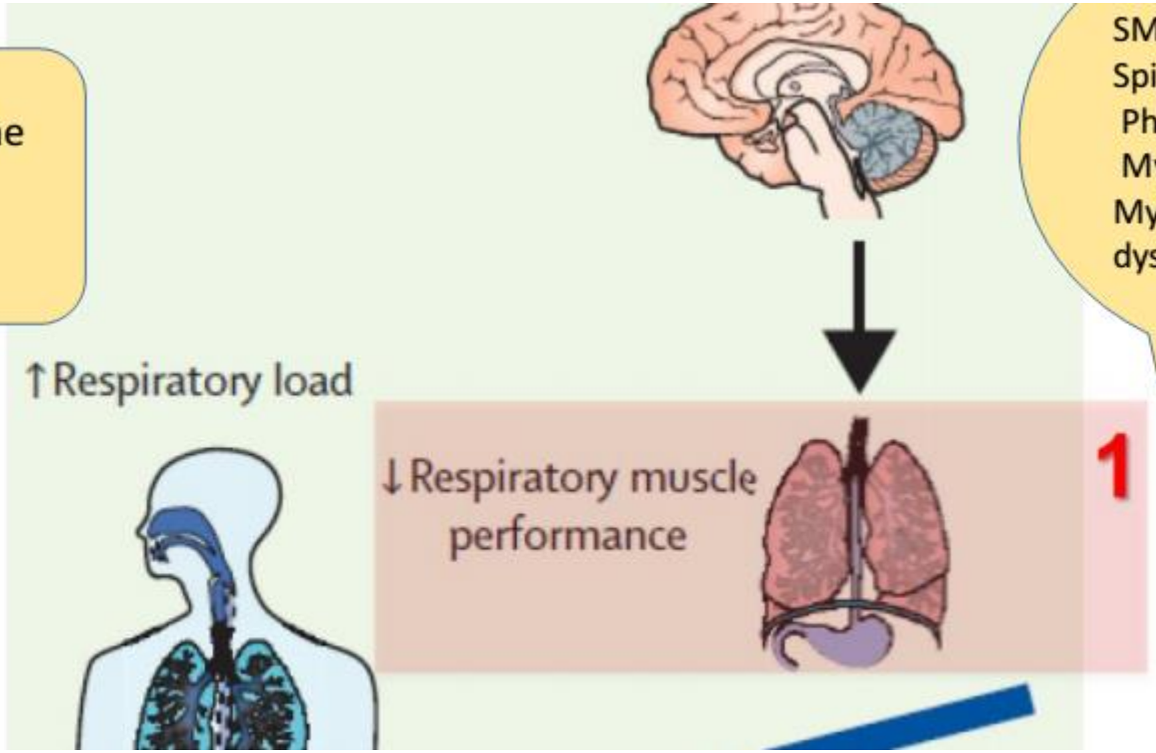
- Non-invasive ventilation (NIV) refers to the delivery of mechanical ventilation to the lungs using techniques that do not require an invasive artificial airway(ETT, TT).

- Disorders that cause disequilibrium in the respiratory balance



Congenital central hypoventilation syndrome
Brain injury by tumors or infection (encephalitis)
Brainstem dysfunction (Chiari malformation)

Anatomical abnormalities of the upper airway
Lower airway obstruction



SMA
Spinal cord injury
Phrenic nerve injury
Myasthenia
Myopathies and dystrophies

NIV - Advantages

- \- Non invasiveness
- \- Flexibility in initiating and removing mechanical ventilation
- \- Allows intermittent application
- \- Improves patient comfort
- \- Reduces the need for sedation
- \- Oral patency
- \- Preserves speech, swallowing and expectoration,reduces the need for nasogastric tubes.

- Avoids the complications of endotracheal intubation
  - Early (local trauma, aspiration)
  - Late (injury to hypopharynx, larynx, and trachea, nosocomial infections)
- Reduces infectious complications(pneumonia,sinusitis, sepsis)
- Less cost

Disadvantages

✦ System

– Slower correction of gas exchange abnormalities

– Gastric distension (occurs in <2% patients)

✦ Mask

- Barotruma(Air leakage syndrome) = rate from 1.4 to 9 %
- Transient hypoxemia from accidental removal
- Eye irritation
- Facial skin breakdown and ulceration and necrosis:most common complication(12%)

✦ Lack of airway access and protection

- Suctioning of secretions
- Aspiration

✦ Hemodynamic instability(decreasing VR and depressed CO)

- So avoiding NIV in patients with shock

complications:

Major: Barotrauma, Aspiration, Hemodynamic instability

Minor: skin break down ,Nasal mucosal trauma ,Gastric distension, Eye irritation or injury

CONTRAINDICATIONS FOR NIV IN PEDIATRICS:

1. Cardiac and/or respiratory arrest
2. Acute complete airway obstruction(eg, epiglottitis, progressive upper airway edema, or burns)
3. Risk of pulmonary aspiration
4. Active acute digestive hemorrhage(GIB)
5. Severe hemodynamic instability
6. Coma (Glasgow score below 10)
7. Patients in whom two or more organs other than the lungs are failing
8. Patients who are unable to protect their airway (swallowing alterations, poor airway pulmonary secretion clearance, inability to cough, etc.)
9. Uncooperative patient.(eg:severe agitation)
10. Trauma, facial malformation or surgery
11. Untreated Pneumothorax

Respiratory insufficiency

$PaO_2 < 60$ mmH (hypoxemic respiratory insufficiency) and/or $PCO_2 > 45$ mmHg (ventilatory insufficiency or hypercapnic respiratory insufficiency) in a patient who is conscious, resting and breathing room air.

A pure hypoxemia with normal or low CO_2 levels is characteristic of a chronic intrinsic pulmonary pathology (emphysema, pulmonary fibrosis, etc) and in these situations the primary measure is oxygen therapy, not NIV.

- Nevertheless chronic hypercapnic respiratory insufficiency is a classic indication for NIV and has had good results.

Interface:

- A number of patient-ventilator interfaces are available for use during NIV
in the pediatric population including:
  - Nasal cannula
  - Nasal mask
  - Full-face mask
  - Helmet
- A full-face mask or helmet more reliably provides continuous positive airway pressure (CPAP) or bilevel positive airway pressure (BiPAP) but may cause agitation, especially in infants and younger children. A nasal cannula or nasal mask is often better tolerated but pressure leak due to a poor
interface seal or through the mouth may limit effectiveness.


- Our typical approach is to start with a nasal interface (prongs or masks) in infants, toddlers, and younger children, who may not tolerate a full face mask, provided they are adequately supported via the nasal interface despite the potential of an air leak through the mouth.

- We commonly use face masks as the initial interface in school-age children and adolescents with less severe disease.

- We also use a full face mask as the initial interface for any infant or child with more severe hypoxia or hypercarbia to ensure adequate seal and delivery of PEEP.

Interface sizing:

- Nasal and full face masks are typically available in three sizes: infant and small child , youth , and standard (adult).
- The clinician should choose the mask that covers the nose, or nose and mouth without contacting the eyes.
- The smallest mask that properly fits should also be used to limit dead space (volume of inhaled gas not reaching the alveoli for gas exchange).
- Masks that appear to be the best anatomic match should then be tested for adequacy of seal during initiation of NIV.
- If the patient complains of discomfort or a large leak is noted,alternative sizes or types of interfaces can be trialed.

Monitoring:

- Patients receiving NIV warrant the same level of monitoring as children undergoing invasive support with endotracheal intubation and mechanical ventilation including continuous cardiorespiratory and pulse oximetry, frequent blood pressure measurement, and ongoing monitoring of ventilation (eg, frequent blood gas measurements or transcutaneous CO_2(TC CO_2).

Monitoring response:

- **physiological:**

a) Continuous oximetry
b) Exhaled tidal volume
c) ABG :intial,1,2-6hrs

- **Objective:**

a) Respiratory rate
b) Chest wall movement
c) Coordination of respiratory effort with NIV
d) HR and BP
e) Mental state
f) Accessory muscle use

- **Subjective:**

a) Dyspnea
b) comfort

NIV MODES IN PEDIATRIC:

- Which mode?

  CPAP(Hypoxemia)

  BiPAP(Hypercapnia and hypoxemia)
- Which device?

✈ Continuous positive airway pressure (CPAP)

• Delivers a constant positive pressure to the airways and aims to maintain airway patency throughout the entire breathing cycle.

✈ Biphasic positive airway pressure (BiPAP)

• assist the breathing of the patient by delivering a supplemental higher positive pressure during every inspiration.

The fundamental indications for CPAP in pediatric patients are:

- Obstructive sleep apnea syndromes,
- Neonate ventilatory weaning,
- Cardiac pulmonary edema,
- Pulmonary edema due to negative pressure,
- Tendency toward upper airway obstruction.

CPAP:

- CPAP ≈ PEEP

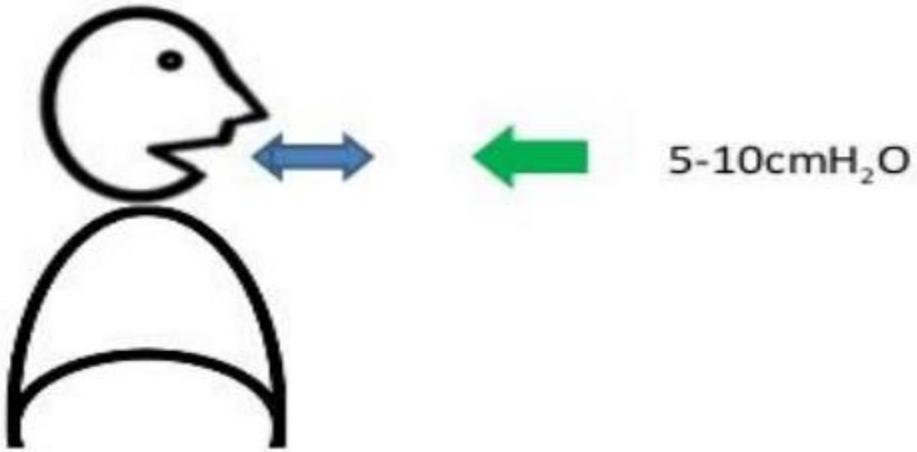
- CPAP reduces preload and afterload

- Hence it is a very effective for treatment of pulmonary edema.

CPAP

- Continuous Positive Airways Pressure
  - Same pressure (5-10 cmH_2O) throughout respiratory cycle

- Increases intra-alveolar and intra-bronchiolar pressure
  - Recruits alveoli
  - Dec Pulmonary oedema
  - Increase FRC
  - Dec WOB



BPAP:

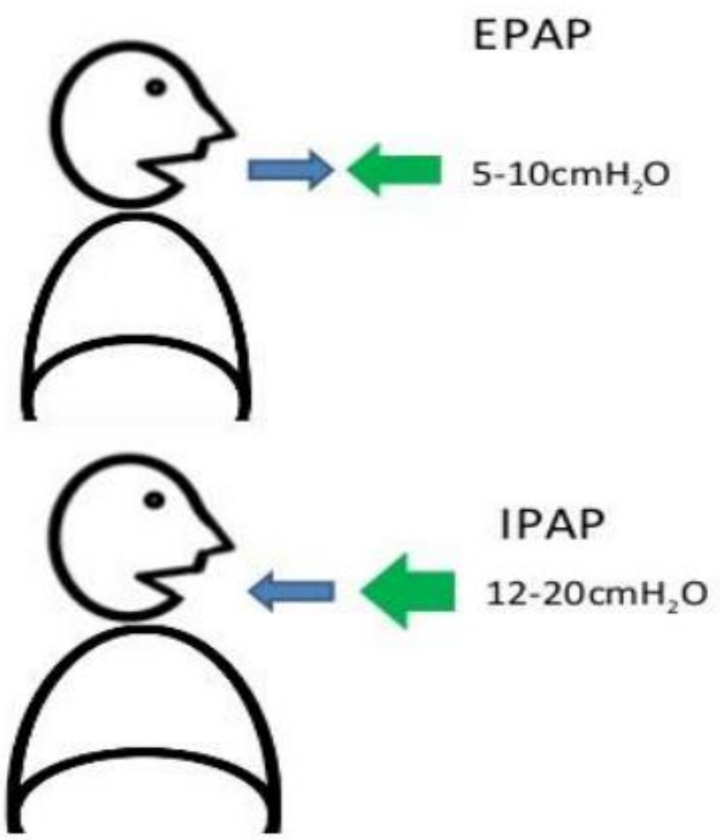
- **Bilevel positive airway support (BPAP), as the name implies, delivers two set levels of positive airway pressure, one during inspiration (IPAP) and one during expiration (EPAP).**

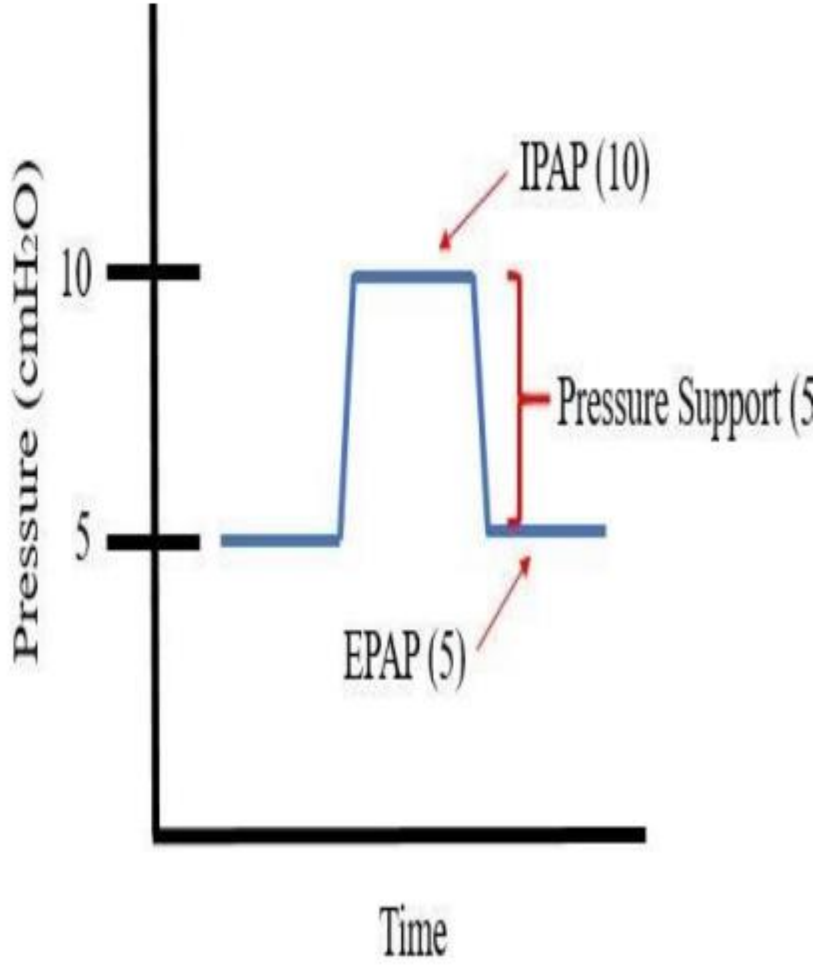
- **When the ventilator detects inspiratory flow, it delivers a higher inspiratory pressure until sensing a reduction in flow or when reaching a set inspiratory time limit. When inspiration terminates (based on flow or time), the device cycles to a lower expiratory pressure.**

BIPAP

- EPAP (PEEP)
  - Recruits alveoli
  - Increases VQ matching
  - Improves oxygenation

- IPAP – EPAP (pressure support)
  - Increases tidal volume
  - Reduces CO_2
  - Improves Ventilation and decrease work of breathing





Initial setting:

CPAP is often started at a pressure of approximately 5 cm H2O and titrated up relatively quickly, as needed, depending upon clinical and physiologic response and patient tolerance. Reported practices patterns describe safe use of initial pressures of 8 to 10 cm H2O with no associated hemodynamic compromise and then titrating up or down as needed to maintain oxyhemoglobin saturation in an acceptable range (eg, 92 to 95 percent).

- BPAP is often initiated with an expiratory PAP (EPAP) of approximately 5 cm H2O and an inspiratory PAP (IPAP) of 8 to 10 cm H2O. These pressures can be titrated up depending upon clinical and physiologic response and patient comfort.

- IPAP pressures of 15 to 22 cm H2O are common.

- Fraction of inspired oxygen (FiO2) – FiO2 can be adjusted to reach the target oxygen saturation,often with a goal of >92 to 95 percent .

- Most commonly, the goal is to increase the PEEP (EPAP or CPAP) so that the FiO2 can be weaned to 50 percent or less.

- Backup ventilation rate – For patients with intermittent apnea or hypopnea, a backup ventilation rate can be programmed to avoid prolonged periods without ventilation

Subsequent adjustments based on arterial blood gas values are as follows:

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

FIO2 at 1.0 and adjust to lowest level with an acceptable pulse oximetry value

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NIV MODES and New modes:

Timed programmed mode (T) :

was the first mode to appear in the earliest units. It requires the operator to program the number of breaths with a given IPAP pressure to be administered to the patient, and the rest of the time the patient has a minimum pressure or EPAP, independent of the patient's respiratory efforts.

Spontaneous mode (S):

Is similar to a continuous flow support pressure, that is to say, the patient does the breathing and the respirator supports each breath with the programmed IPAP while maintaining the minimum continuous pressure (EPAP) the rest of the time. Respiratory frequency and inspiratory time are patient controlled.

Spontaneous or programmed time (S/T) mode:

operator programs a minimum respiratory frequency, and if the patient is breathing faster than that frequency, the ventilator acts as if it were in spontaneous mode, so that each time the patient initiates a respiration, the machine supports it with the programmed IPAP pressure. But, if the patient's respiratory frequency drops below the programmed minimum frequency, the ventilator cycles into an IPAP, the inspiratory time, and EPAP at the already programmed minimum frequency.

PAV(Proportional assist ventilation)

In fact, it is pressure controlled, patient triggered, pressure limited and flow cycled

in the case of hypercarbia, ventilator feels the patient's increased sensitivity to the inhale flow, and, it increases the current volume instead of increasing the number of respiration

- Ventilator generates airway pressure in proportion to the patients effort.
- Follows and adjusts to patient changes.
- If pattients effort and / or demand are increased, the ventilator support is increased.

PAC (Pressure Assist Control)

the inspiration time is preset in the PAC mode. There is no spontaneous/flow cycling. The inspiration can be triggered by the patient when respiratory rate is above a preset value, or time triggered breaths will be delivered at the backup breath rate.

In PAC ventilation, both the inspiratory pressure and the inspiratory time are set and fixed. This differs from BiPAP in which the patient controls the inspiratory time.

This modality may be useful in the neuromuscular disease patient who does not have the respiratory muscle strength to generate an adequate inspiratory time.

THANKS FOR YOUR ATTENTION