Lec.4

NON-INVASIVE VENTILATION

- Non-invasive ventilation (NIV) refers to the administration of ventilatory support without using an invasive artificial airway (endotracheal tube or tracheostomy tube).
- Non-invasive ventilation (NIV) augments spontaneous ventilation using the tight- fitting nasal or oronasal mask without endotracheal intubation. This can be used in a large number of conditions if there is no contraindication. The application of NIV should not delay clinically indicated endotracheal intubation.

Advantages and disadvantages

- The advantages of
  - being readily taken on and off to facilitate weaning,
  - maintaining some ability to communicate,
  - avoids the complications of sedation and ventilator-associated pneumonia.
- The main disadvantages of NIV are
  - no direct protection of the airway,
  - no deep suctioning below the vocal cords,
  - limited ability to apply high pressures
  - development of intolerance to the mask over time.

Interfaces

There are 6 types of interfaces that can be used during NIV therapy in the acute setting. Choosing the appropriate interface for patients with ARF involves

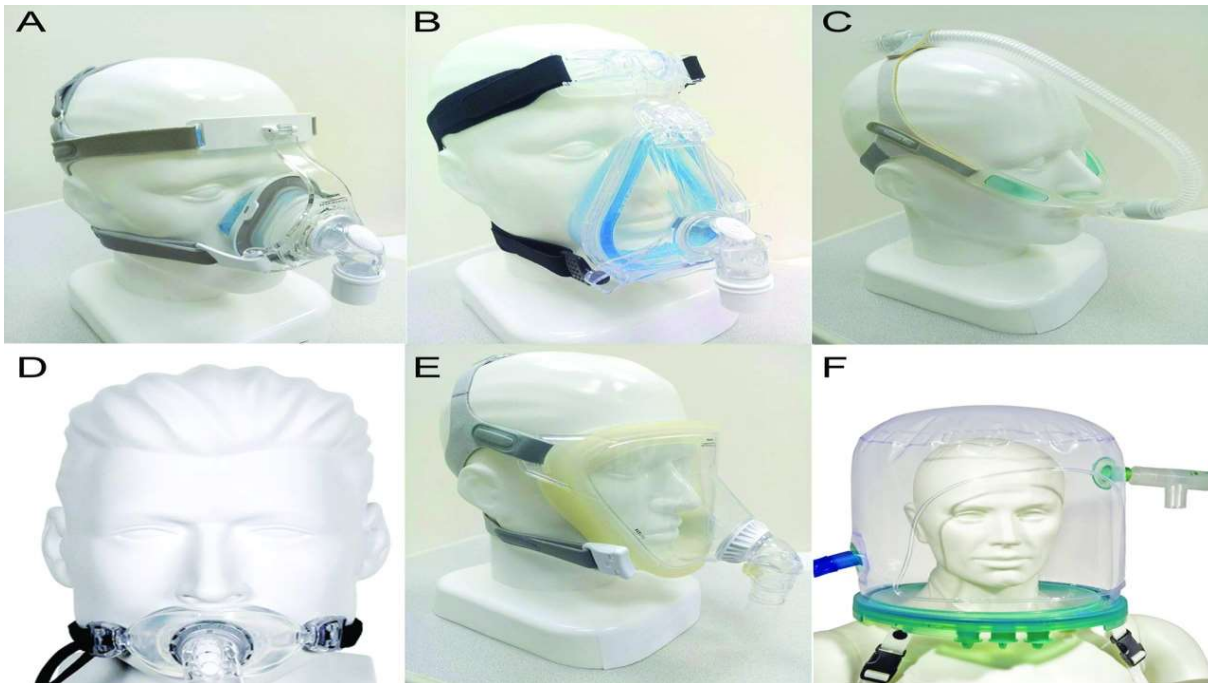
- consideration of patient preferences and tolerance, and
- determining the correct size and fit is essential to successful ventilation.

Although interfaces are constructed from a variety of materials, the most commonly used material is silicone, although gel masks are available from some manufacturers as well.

Types of interfaces

- **Nasal mask:** this mask covers the nose only and rests on the upper lip, the sides of the nose, and the nasal bridge (fig. A).
- **Oro-nasal mask** (also referred to as a face mask): this mask covers the nose and mouth and rests on the chin, the sides of the nose and mouth, and the nasal bridge (fig. B).
- **Nasal pillow mask**: this mask fits on the rim of the nostrils. This type of mask is usually recommended for individuals who find nasal or oro-nasal masks uncomfortable or experience skin breakdown on the nasal bridge. Nasal pillows are used mainly in stable patients with sleep-disordered breathing (fig. C).
- **Oral mask**: this mask fits inside the mouth between the teeth and lips and has a tongue guide to prevent the tongue from obstructing the airway passage. This type is not common in practice (fig. D).
- **Total face mask**: this mask covers the whole face and is used mainly in patients with AHF (fig. E).
- **Helmet**: the helmet is a transparent hood that covers the entire head and face of the patient and has a rubber collar neck seal. It is used as an alternative to the Oro-nasal

mask in patients with acute hypoxemic respiratory failure or acute cardiogenic pulmonary edema in certain countries. it was developed to improve tolerability and reduce complications in patients with ARF on NIV. it is not commonly used in patients with acute hypercapnic respiratory failure (fig. F).



Nasal masks (general advantages)

- Best suited for more cooperative patients
- Better in patients with a lower severity of illness
- Not claustrophobic
- Allows speaking, drinking, coughing, and secretion clearance
- Less aspiration risk with emesis
- Generally, better tolerated

Nasal masks (cautions, disadvantages)

- More leaks possible (e.g., mouth breathing or lacking teeth patients)
- Effectiveness limited in patients with nasal deformities or blocked nasal passages

Oronasal masks (general advantages)

- Best suited for less cooperative patients
- Better in patients with a higher severity of illness
- Better for patients with mouth-breathing
- Better in edentulous patients
- Generally, more effective ventilation

Oronasal masks (cautions, disadvantages)

- Claustrophobic
- Hinder speaking and coughing
- Risk of aspiration with emesis

Clinical criteria for using NIPPV

- Moderate to severe respiratory distress
- Tachypnea (respiratory rate > 25/min)
- Accessory muscle use or abdominal paradox
- Blood gas derangement pH < 7.35, $PaCO_2$ > 45 mmHg
- PaO_2/FiO_2 < 300 or SpO_2 < 92% with FiO_2 0.5

Contraindications for using NIPPV

- Non-availability of trained medical personnel
- Inability to protect the airways—
    - comatose patients,
    - patients with cerebrovascular accident or bulbar involvement,
    - confused and agitated patients,
    - upper airway obstruction
- Hemodynamic instability—
    - uncontrolled arrhythmia,
    - patients on very high doses of inotropes,
    - recent myocardial infarction

- Inability to fix the interface—
    - facial abnormalities,
    - facial burns,
    - facial trauma,
    - facial anomaly
- Severe gastrointestinal symptoms—
    - vomiting,
    - obstructed bowel;
    - recent gastrointestinal surgery,
    - upper gastrointestinal bleeding
- Life-threatening hypoxemia
- Copious secretions
- Conditions in which NIV has not been found to be effective

Monitoring for NIPPV

The patient must be monitored very closely clinically. All this must be documented every 15 min for the first hour in the clinical notes.

- Mask comfort
- Tolerance of ventilator settings
- Respiratory distress
- Respiratory rate
- Sensorium
- Accessory muscle use
- Abdominal paradox
- Ventilator parameters
- Air leaking
- Adequacy of pressure support
- Adequacy of PEEP
- Tidal volume (5-7 mL/kg)
- Patient-ventilator synchrony
- Continuous oximetry (until stable)
- ABG, baseline and 1-2 h, then as indicated.

Complications of NIV and corrective action

Complications	Corrective action
• Mask discomfort • Excessive leaks around mask • Pressure sores	• Check mask for correct size & fit • Minimize headgear tension • Use spacers or change to a different mask • Use wound care dressing over nasal bridge
• Nasal or oral dryness or nasal congestion	• Add or increase humidification • Irrigate nasal passage with saline • Apply topical decongestants
• Aerophagia/gastric distension	• Use lowest effective pressure for adequate tidal volume • Use simethicone agents
• Aspiration	• Make sure patients are able to protect the airway
• Mucus plugging	• Ensure adequate hydration • Ensure adequate humidification • Avoid excessive O_2 flow rates (>20 L/Min) • Allow short breaks from NIV to permit directed coughing techniques
• Hypotension	• Avoid excessively high peak pressure (≥20 cm H_2O)

Discontinuation of NIV

It is very important to know when to discontinue NIV and intubate and ventilate the patient.

- NIV failure.
  - Worsening mental status
  - Deterioration of pH and PaCO2 after 1–3 h of therapy
  - Refractory hypoxemia—when even a brief discontinuation of NIV leads to significant fall in oxygen saturation
- Intolerance to NIV.
- Hemodynamic instability.
- Inability to clear secretions

Modes of NIV

NIV is divided into two main types,

- negative-pressure ventilation (NPV) and
- noninvasive positive-pressure ventilation (NIPPV); which is further subdivided into several subtypes, including
  - continuous positive airway pressure (CPAP),

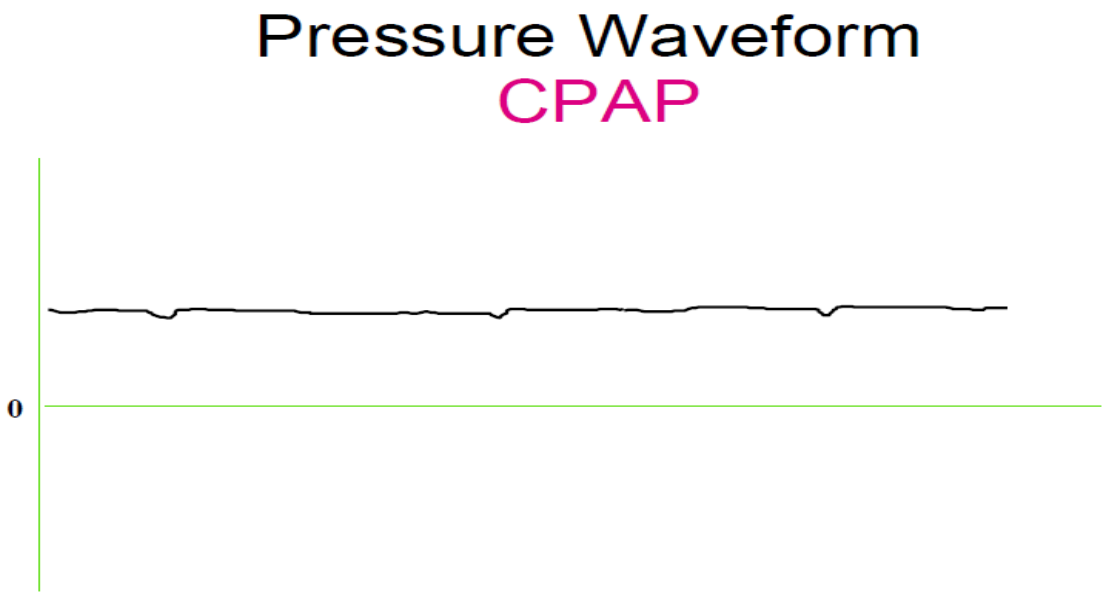
- bilevel positive airway pressure (BiPAP), and
- volume-assured pressure support (VAPS).

Choosing the initial mode of ventilation is based

- in part on past experience,
- in part on the capability of ventilators available to provide support, and
- in part on the condition being treated.

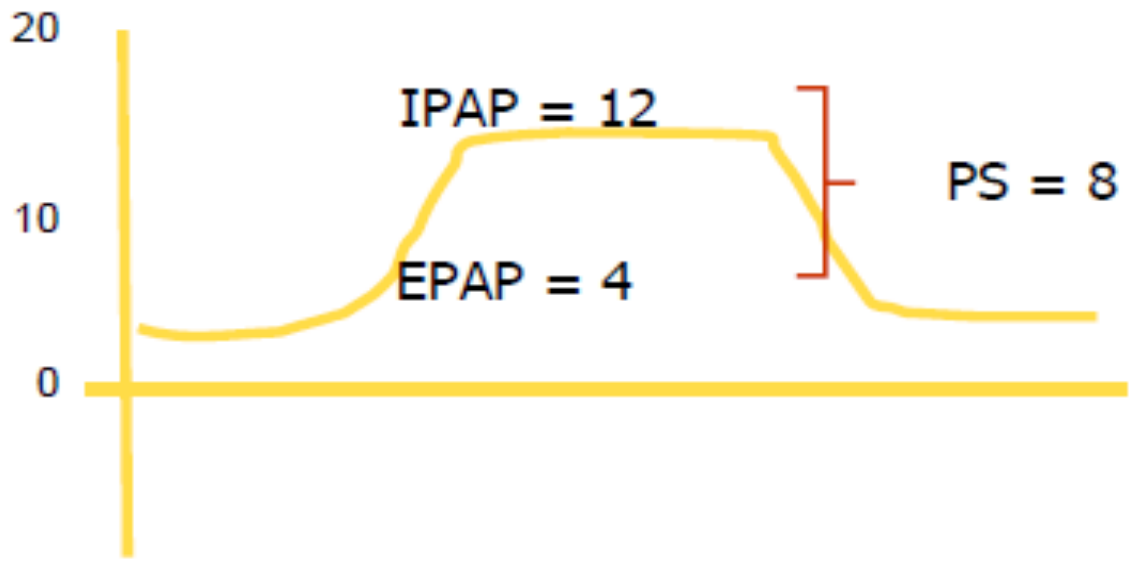
NIV-CPAP

- Improve oxygenation by increasing FRC and recruiting collapsed alveoli
- It provides certain positive airway pressure throughout all phases of spontaneous ventilation
- It is similar to breathing with your head stuck out of a moving car
- CPAP » PEEP
- CPAP reduces preload and afterload. Hence it is a very effective for treatment of pulmonary oedema with low work of breathing.
- Pressures are usually limited to 5-12 cm of H_2O, since higher pressure tends to result in gastric distension requiring continual aspiration through a nasogastric tube.



NIV- BiPAP

- IPAP + EPAP(CPAP)
- The higher pressure augments alveolar ventilation and CO_2 clearance
- The lower pressure maintains alveolar recruitment
- *IPAP:* assists in improving tidal volume, thus decreasing CO_2
- *EPAP: improve FRC,* helps recruit more alveoli, thus increasing O_2. may reduce work of breathing associated with autopeep.
- Differential in pressure between inspiration and expiration allows for better patient-ventilator synchrony and thus more comfort
- EPAP » PEEP
- IPAP –EPAP » PS
- Augments TV
- Reduces Atelectasis
- Reduces WOB (work of breathing)



NIPPV for acute exacerbation of COPD

The largest amount of supportive evidence for the use of NIPPV (particularly bilevel) is in the management of COPD exacerbation. Complications arising from dynamic hyperinflation in this population lead to excessive elastic and resistive forces that increase respiratory muscle workload and ultimately lead to respiratory failure. Intubation and invasive mechanical ventilation become difficult because of the complicated lung mechanics associated with COPD.

- The use of NIPPV in these patients results in
  - Lower failure rates compared to standard medical therapy,
  - Lower requirement for intubation,
  - Lower mortality and decreased length of stay in hospital.
- The level of applied EPAP helps to splint open airways at risk of collapsing, and the delivered pressure (IPAP) assists with the increased respiratory muscle workload.

NIPPV for acute cardiogenic pulmonary edema

The use of NIPPV for acute cardiogenic pulmonary edema (ACPE) is aimed at treating the respiratory complications related to the presence of pulmonary edema.

- The use of CPAP alone may
  - increase the functional residual capacity,
  - reduce atelectasis,
  - improve respiratory system compliance,
  - reduce right-to-left intrapulmonary shunting and
  - improve cardiac output.
- However, because there is often an associated increased respiratory workload with ACPE, the use of bilevel NIPPV may be more appropriate for the patient to reduce the amount of respiratory distress.

- The patient presentation and response to therapy should therefore influence the choice of mode and pressures used.

NIPPV for ARDS

Acute respiratory distress syndrome (ARDS) is not a good candidate disease for NIPPV, since it is slow to resolve and patients have very severe pulmonary dysfunction, and the literature has been discouraging.

- While CPAP and NIPPV have been shown to improve gas exchange, they do not reduce the eventual need for intubation or mortality.
- Patients with ARDS are also prone to the effects of stress placed on the lungs by positive pressure ventilation and a controlled ventilatory approach targeting small lung volumes is more appropriate.

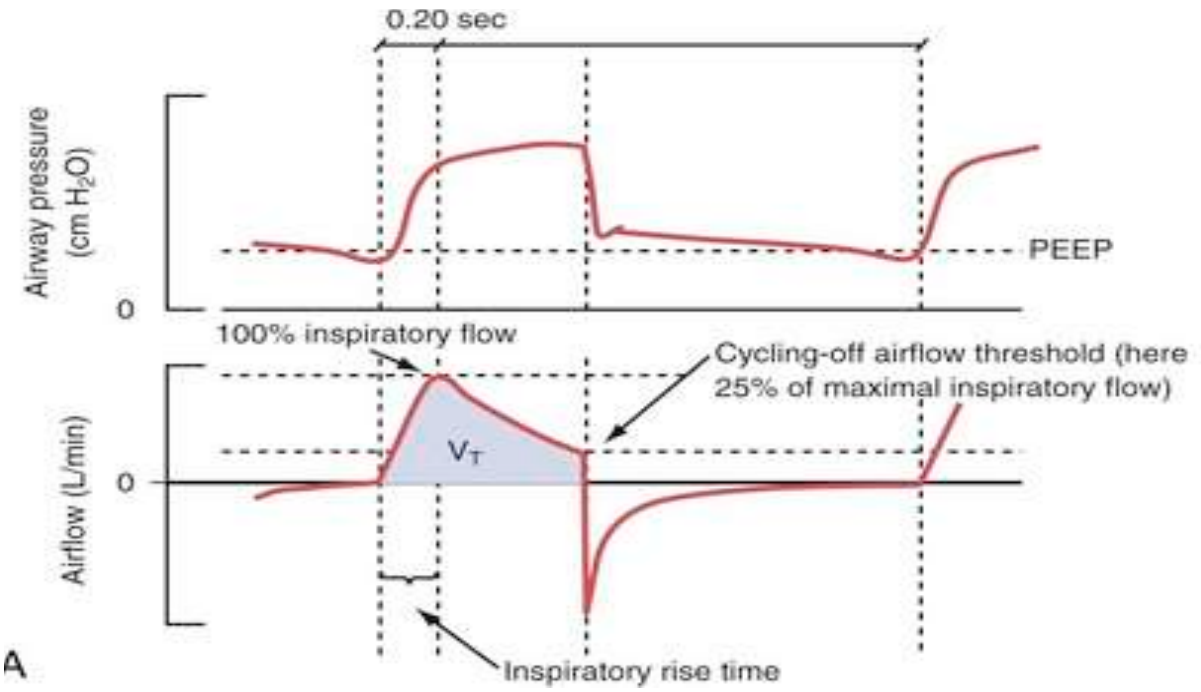
Fraction of inspired oxygen (FiO2)

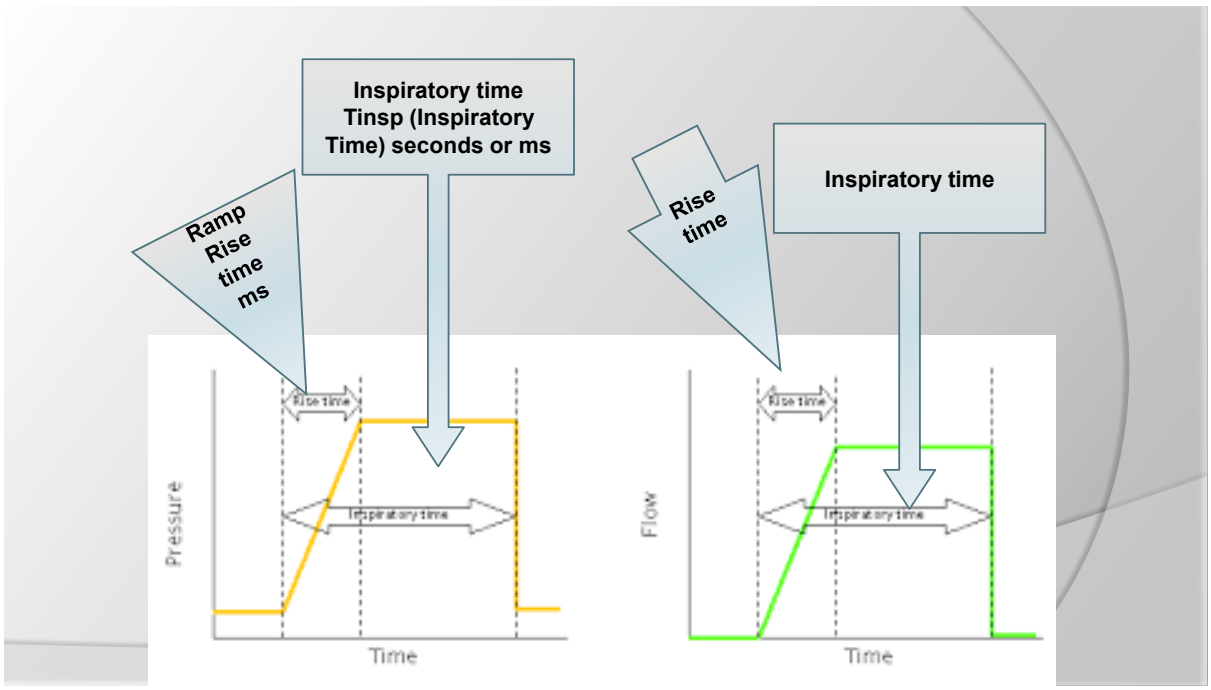
- For all supplemental oxygen delivery devices, the patient is not just breathing the direct oxygen, but rather is breathing a **combination** of room air plus the oxygen from the supplemental device.
- The concentration of oxygen in the air that we breathe is called the **FiO2 (Fraction of inspired oxygen).** If a patient is not receiving any additional oxygen, we often say that the patient is on an FiO2 of 21 (21%) or ***"Room Air"***

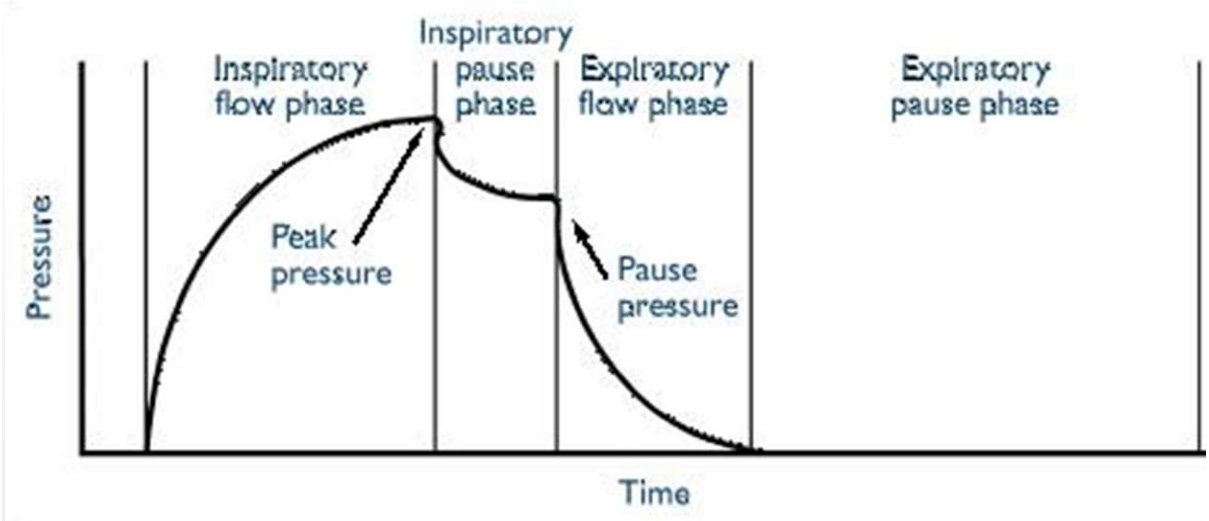
The I:E ratio

- The I:E ratio is the ratio of the duration of inspiratory and expiratory phases
- A normal I:E ratio at rest is about 1:2, and so the default duration of the expiratory phase in mechanical ventilation is approximately twice the duration of the inspiratory phase.

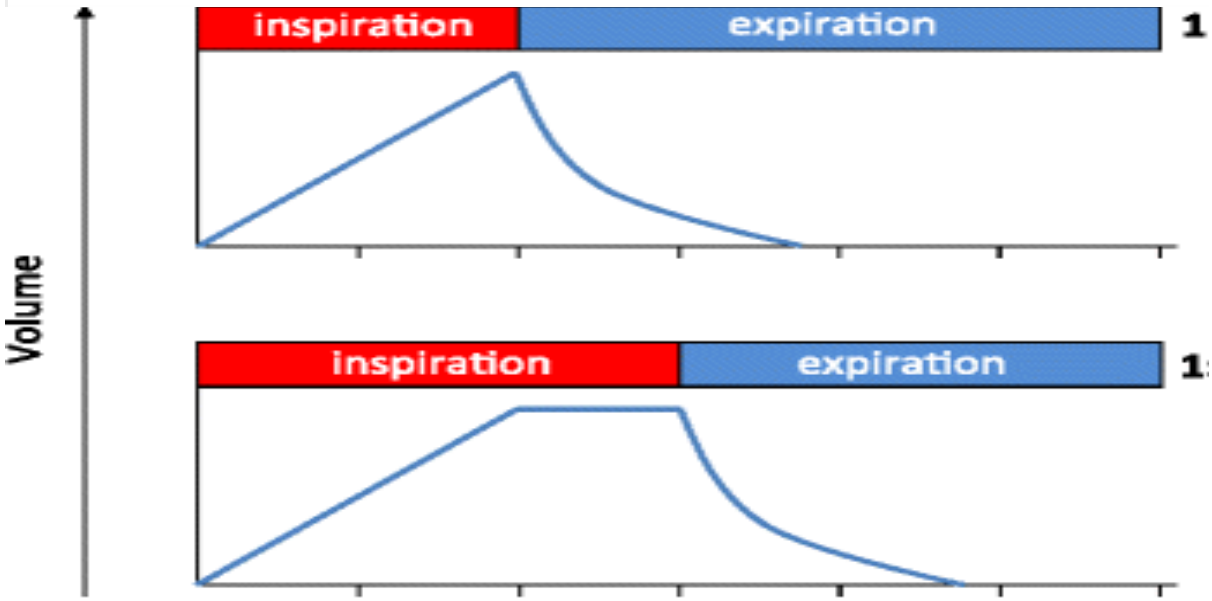
- The **inspiratory** rise **time** determines the rate at which the **ventilator** achieves a target pressure (in pressure control and pressure support modes) or flow rate (in volume control modes).







Phases of the respiratory cycle.[3]



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