Introduction to artificial lung ventilation

The aim of this page is to introduce the issue of *artificial lung ventilation* in a simple and practical way. The topic is covered in more detail in the article Artificial pulmonary ventilation.

Why?

- **Lack of oxygen**. Higher concentrations and/or pressures must be used.
- **Excess CO_2**. Sufficient cardiac output must be ensured if the patient does not develop it spontaneously.
- **Inability to protect the respiratory tract**. The patient has or will have a profound impaired consciousness (including planned surgery). Tongue indentation or aspiration should be avoided.
- **Lung collapse** and other mechanical difficulties during ventilation. In certain pathologies (for example, atelectasis) it is necessary to optimize breathing mechanics with the help of a ventilator.

> The goal of ventilation is therefore to maintain tissue **oxygenation'** and **normocapnia** with adequate respiratory mechanics.

How?

Today we mainly use positive pressure ventilation, other UPV methods are reserved for specific cases. Adequate airway securing is required for UPV, endotracheal intubation is considered the gold standard. However, the presence of a foreign body in the trachea forces initial relaxation and usually permanent sedation of the patient.

Endotracheal intubation

Positive pressure breathing can also be implemented in a non-intubated patient – non-invasive ventilation (NIV) works with a sealed face mask and an awake patient. A large number of the risks listed below are thus reduced, yet even NIV is "invasive" to a certain extent. Another link is High-Flow Nasal Oxygen (HFNO).

Risks

UPV is ALWAYS a non-physiological method that only buys time to treat the underlying cause while harming the patient with its side effects. Can cause:

Non-invasive positive pressure pulmonary ventilation (*NPPV, NIV*)

- addiction (the patient is unable to breathe without the aid of the device due to disruption of regulatory, muscle and other functions),
- lung damage (combination of several types of forces),
- infection (invasive entry into the respiratory tract, insufficient release of secretions, aspiration),
- circulatory depression (excess pressure reduces the return of blood to the thoracic veins),
- respiratory tract damage (intubation, suctioning),
- the need for sedation,
- aspiration and silent aspiration,
- insufficient humidification of DC,
- aerosol (infection of nursing staff).

DON'T MESS WITH THE MODES

Abbreviations such as BIPAP, SIMV or ASV are the creations of creative manufacturers. However, the basic setting of the ventilator is easy to understand, for initial management, basic orientation in simple ventilation modes is sufficient.

Synchronization?

From a practical point of view, it is first necessary to distinguish whether the mode is **fully controlled' *or synchronized with the patient's breathing effort***. In a spontaneously ventilating patient, use of a controlled mode may cause lung damage due to the patient being "washed" with the ventilator. Conversely, in a deeply unconscious patient, the synchronized mode may not generate sufficient minute ventilation. **Division of modes according to cooperation with the patient**

- Fully controlled modes - patient activity is not supported: PCV, VCV, IPPV
- Synchronized modes without controlled breaths - the patient breathes on his own, the device only supports him with oxygen or pressure: SPONT, CPAP, PSV
- Combined modes (when the patient breathes on their own, they synchronize, otherwise they breathe on their own): SIMV

Volume × Pressure ?

The fan controls the amount of inhaled air based on two principles, which can be supplemented on modern devices. The ventilator can have a set fixed tidal volume, which it achieves by regulating the pressure used, or a fixed pressure with which air is driven into the lungs, while the tidal volume changes based on lung resistance.

	Volume Modes	**Pressure regimes**
Principle	Fixed Volume –> Unknown Pressure	Fixed pressure –> Unknown volume
Advantages	Assurance of sufficient ventilation	Stable pressure load on the lungs
Disadvantages	Risk of pressure damage to the lungs	Uncertainty of adequate minute ventilation
	Volume Mode is stickler...	Pressure mode is comfortable...
Abbreviations	VCV, IPPV	PCV

Basic set values?

On the ventilator, distinguish groups of values that directly affect oxygenation (Fio2 and PEEP), respiratory rate (set DF and trigger sensitivity) and values that relate directly to the set mode (controlled volumes or pressures). We also set alarms that only monitor the patient's interaction with the ventilator.

Check the basic setpoints first, then look at the resulting pressures/volumes and alarm settings

- **FiO_2** – oxygen fraction; 0.21–1.0 (21–100%). Too much oxygen is toxic, the target SatO2 is about 92-98%, no more.
  - In acute situations up to 100%, without lung pathology initial ~40%.
  - On single Air fans
- **PEEP** - pressure at the end of exhalation, prevents the collapse of the alveoli, but too much can cause acute lung damage. It affects oxygenation.
  - Standard initial value of 5 cm H_2O.
- **Respiration rate** (RR respiration rate) - is set according to the required minute ventilation or capnometry.
  - Usually 10-16 breaths/minute.
- **Trigger** - the patient's effort value to enable synchronization with the ventilator.
  - Vacuum -0.5 to -2 cm H_2O, flow 3–5 ml/min.
  - For a sedated patient on controlled ventilation, switch off.
- **Vt** - tidal volume (*for volume-controlled ventilation*).
  - Most often 6 ml/kg of ideal weight. Some ventilators use '*MV* minute volume as a set value. The fan creates the third value according to the set frequencies and volumes. MV = Vt * RR
  - **Pmax** - the highest pressure that the ventilator can try to use to achieve the set tidal volume.
    - The usual default setting is 40, but we recommend 30 cm H_2O as an initial setting for protective ventilation.
- **Pinsp** - pressure during inspiration (**for pressure-controlled ventilation**).
  - About 12–15 cm H_2O above the PEEP value, adjust according to the resulting tidal volumes.
  - Some ventilators use *Pplat* or other abbreviations to describe the maximum pressure in the cycle, so PEEP must be subtracted for the inspiratory value.
- Other possible set values:
  - inspiratory time 1.2 to 1.5 sec,
  - ratio I:E 1:2 or Ti 33%,
  - pause 10% or 0.2-0.4 s.

Don't change what you don't understand!

UPV main passwords finally

this part is still unfinished

- It is necessary?

  "Artificial sleep" is a meaningless euphemism. Can it be bridged with the help of HFNO or NIV? How long will the patient need it?

- Disconnecting as soon as possible.

  Enable spontaneous respiratory activity with acceptable sedation. With a suitable setting, one ventilation mode can be used to go from fully controlled ventilation to supportive ventilation to complete spontaneous breathing.

- Take his hand

  Ambuvak is a quick solution to most problems I can't deal with.

Links

Related Articles

- Artificial lung ventilation
- Artificial pulmonary ventilation (neonatology)
- Artificial pulmonary ventilation/SŠ (nurse)
- UPV/SŠ complications (nurse)

External links

- Basics of UPV; Peter Košut (https://telemedicina.med.muni.cz/pdm/detska-anesteziologie-resuscitace/res/f/zaklady-umele-plicni-ventilace.pdf)
- Presentation of UPV, ventilators, modes; Pavel Hude (https://www.akutne.cz/res/publikace/1konf-3-pavel-hude.pdf)
- HFNO pros and cons; Ivana Zýková (https://www.youtube.com/watch?v=7eY04BAAo3g)
- Oxygen therapy, CPAP, high-flow nasal oxygen; Pavel Dostál (https://www.ipvz.cz/vzdelavaci-akce/dokumenty/12751-doc-dostal-oxygenoterapie-high-flow-cpap.pdf)
- ROX index - prediction of the need for intubation according to the patient's oxygenation (https://www.mdcalc.com/rox-index-intubation-hfnc)