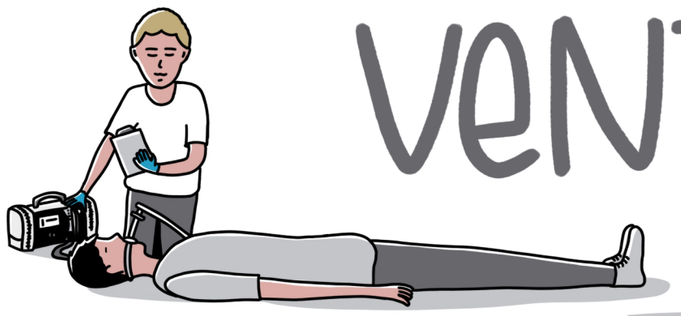


VENTILATION MODES

FOR MECHANICAL VENTILATION

A little side note:
Manufacturer-specific names for ventilation modes are commonly used. The DIN EN ISO 19223:2021 standard creates guidelines for these names.

2 IMPORTANT PRINCIPLES

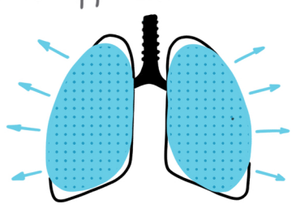
regarding mechanical ventilation

▶ **COMPLIANCE (C)** of the lungs:

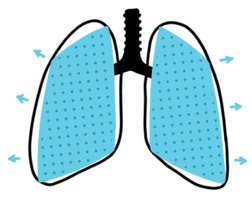
measurement of the elasticity and expansion of the lungs
Indicates how easily the lungs can be stretched when pressure is applied.

$$C = \frac{\Delta V}{\Delta P}$$

C ↑ : lungs are easily stretched.



C ↓ : lungs are less easily stretched



▶ **RESISTANCE (R)** of the airways:

resistance that the airways exert against the air flow.

R ↑ : due to narrow airways, constrictions or other obstructive conditions

→ Increased airway resistance may hinder the air flow and increase the work of the respiratory muscles.

AN UNDERSTANDING OF BOTH PRINCIPLES HELPS...

... when adapting the ventilation parameters:

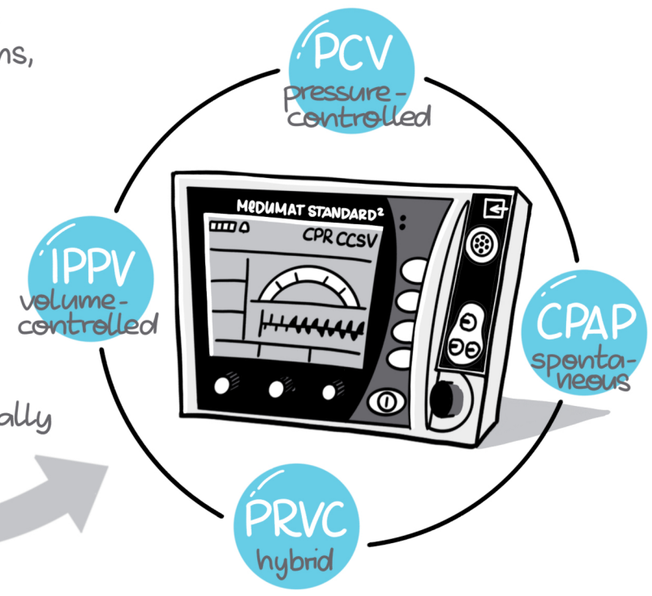
respiratory rate | tidal volume | inspiratory pressure

so as to ensure efficient and safe ventilation and avoid complications,

... as well as selecting the right ventilation mode.

Depends on the medical condition in which ventilation is required.

There are numerous different forms of ventilation, and they can essentially be assigned to the following **4 VENTILATION MODES.**



VOLUME-CONTROLLED VENTILATION (VCV)

IPPV — Intermittent Positive Pressure Ventilation

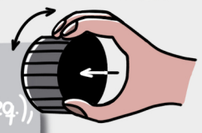
S-IPPV — Synchronized Intermittent Positive Pressure Ventilation

SIMV — Synchronized Intermittent Mandatory Ventilation

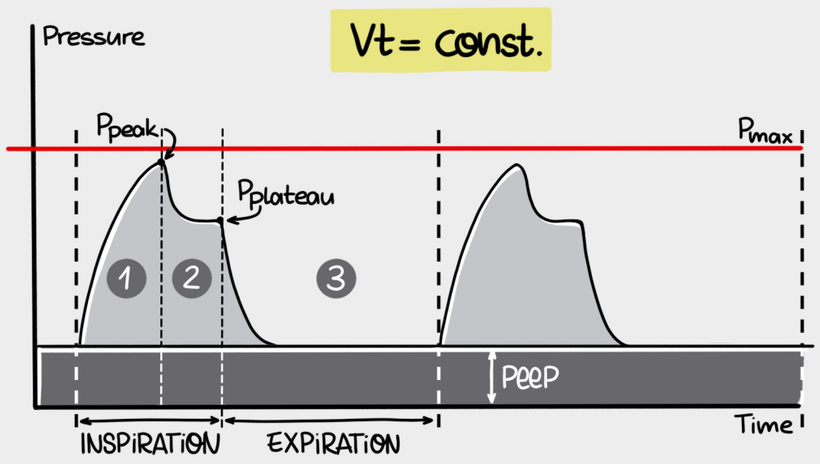
SIMV + ASB — SIMV + Assisted Spontaneous Breathing

WITH VCV, THE PATIENT IS GIVEN A PREDETERMINED RESPIRATORY MINUTE VOLUME (Vt = const.) UP TO A MAXIMUM OF THE SET PRESSURE LIMIT (pMax).

Adjustable:
Tidal volume (Vt), respiratory rate (Freq.), max. ventilation pressure (pMax), positive and -expiratory pressure (PEEP)



Example diagram based on a decelerating flow:



Phase 1: Depending on the parameters, a flow is supplied to the lungs until the desired volume is reached, while maintaining the pMax.

Phase 2: The pressure drops slightly until the end of the inspiratory phase (pPlateau).

Phase 3: Expiration lowers the pressure level back to the PEEP level.

⊕ Ensures constant ventilation
⊕ Enables precise control of respiratory volume

⊖ May offer less protection for the lungs
⊖ Risk of increased peak pressure due to reduced compliance

Further info

PRESSURE-CONTROLLED VENTILATION

PCV — Pressure Controlled Ventilation

aPCV — Assisted Pressure Controlled Ventilation

BiLevel — BiLevel Positive Airway Pressure (auch BiPAP)

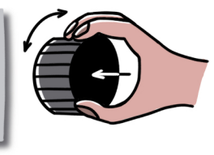
BiLevel + ASB — BiLevel + Assisted Spontaneous Breathing

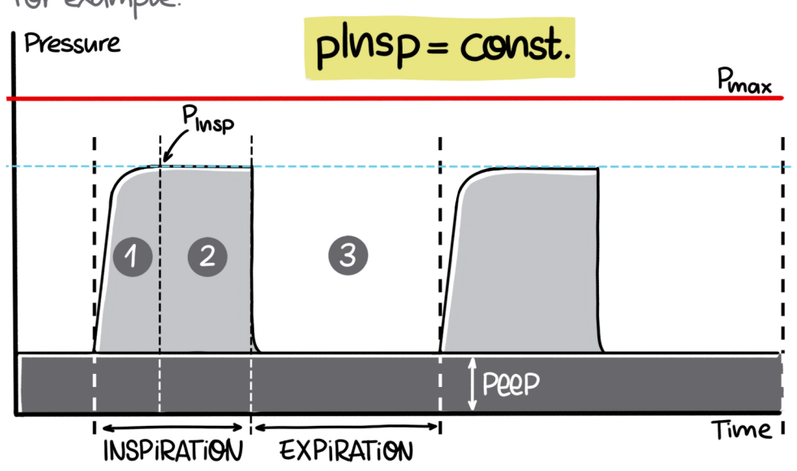
CCSV — Chest Compression Synchronized Ventilation

WITH PCV, A TARGET PRESSURE LEVEL (pInsp = const.) IS SET, WHICH SHOULD BE REACHED DURING INSPIRATION AND EXPIRATION. THE ADMINISTERED TIDAL VOLUME IS DETERMINED BY THE PATIENT'S "C" AND "R"

In the event of increased resistance and/or reduced compliance, less volume can be applied at the same pressure, for example.

Adjustable:
pInsp, Freq., pMax, PEEP





Phase 1: The lungs are supplied with respiratory gas volume until the set pInsp is reached.

Phase 2: The pressure is maintained within the I:E and the volume is distributed in the lungs.

Phase 3: The pressure drops to the defined starting point (PEEP) by the end of the expiratory phase.

⊕ Prevents the set pressure from being exceeded
⊕ Ensures lower airway pressures

⊕ Reduces the risk of barotrauma
⊕ Avoids harmful peak pressures

⊖ Lack of certainty regarding the applied tidal volumes; therefore, flow measurement is mandatory for pressure-controlled ventilation.

Further info

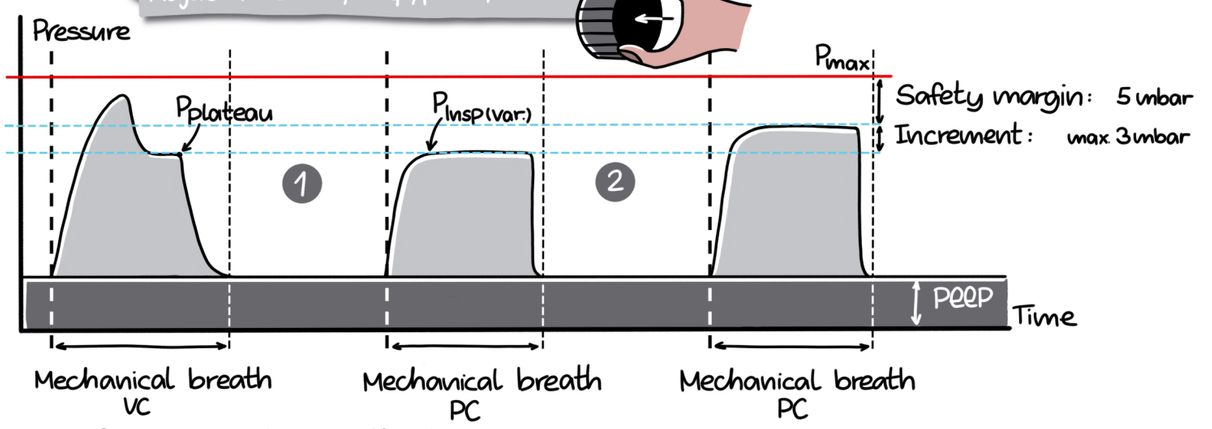
HYBRID VENTILATION (PRVC)

PRVC — Pressure Regulated Volume Controlled

PRVC + ASB — + Assisted Spontaneous Breathing — Pressure Regulated Volume Controlled

PRVC COMBINES THE BENEFITS OF VOLUME AND PRESSURE CONTROLLED VENTILATION.

Adjustable: Vt, Freq., pMax, PEEP



Phase 1: Test breath using VC to select the pInsp, which means the target Vt is reached via pressure-controlled mechanical breaths.

Phase 2: The pressure level is constantly adjusted "breath-by-breath" and set to the lowest level.

⊕ Uniform ventilation of the lungs
⊕ Constant tidal volume Vt
⊕ The patient can largely determine ventilation rythm, ventilation cycle and inspiration duration themselves
⊕ Reduces the risk of barotrauma

⊖ Ventilation rate remains constant regardless of patient's own breathing
⊖ Not widely available, and possible lack of experience in its use

SPONTANEOUS VENTILATION MODES

CPAP — Continous Positive Airway Pressure

CPAP + ASB — CPAP + Assisted Spontaneous Breathing

CPAP is mostly applied by the emergency medical services during non-invasive ventilation in the event of oxygenation and ventilation disorders.

RESPIRATION IS NOT CONTROLLED, BUT TAKES PLACE INDEPENDENTLY VIA A VENTILATION MASK OR HELMET. THE VENTILATOR ONLY ASSISTS SPONTANEOUS BREATHING.

CPAP:

▶ Continuous delivery of a positive inspiration flow, regardless of the patient's own breathing
▶ Independent breathing at the set CPAP pressure level

CPAP + ASB:

▶ Detection of inspiratory efforts with synchronous delivery of pressure support, which makes breathing easier.
▶ In both modes, mechanical aprea ventilation can be switched on if spontaneous breathing is not possible.

⊕ Improved oxyenation for relevant clinical conditions in comparison to pure oxygen inhalation
⊕ Patient is relieved of breathing effort
⊕ Can be used non-invasively via to the mask

⊖ Cannot be used if the patient is unconscious

WEINMANN medical technology

VISUAL BY ANNA BREUER