

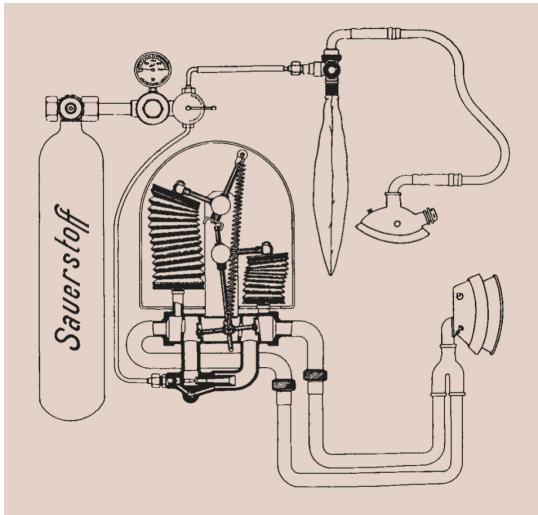
Mechanical ventilation Modes

Continuing development of BASIC is supported by an unrestricted educational grant from

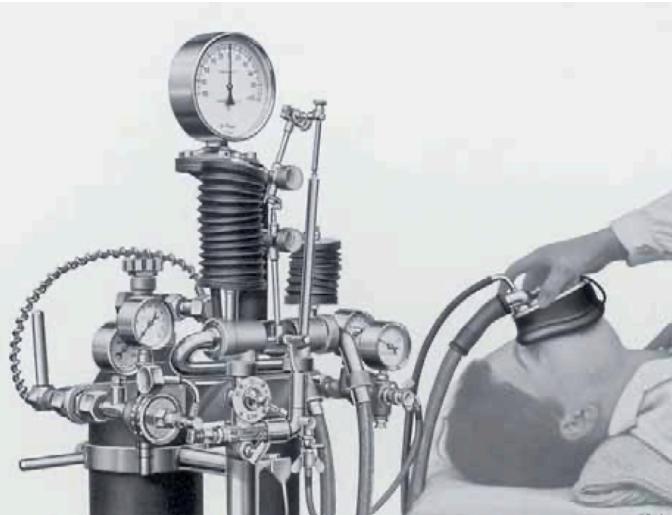


BASIC

Modes



Pulmotor, Dräger, patented 1907



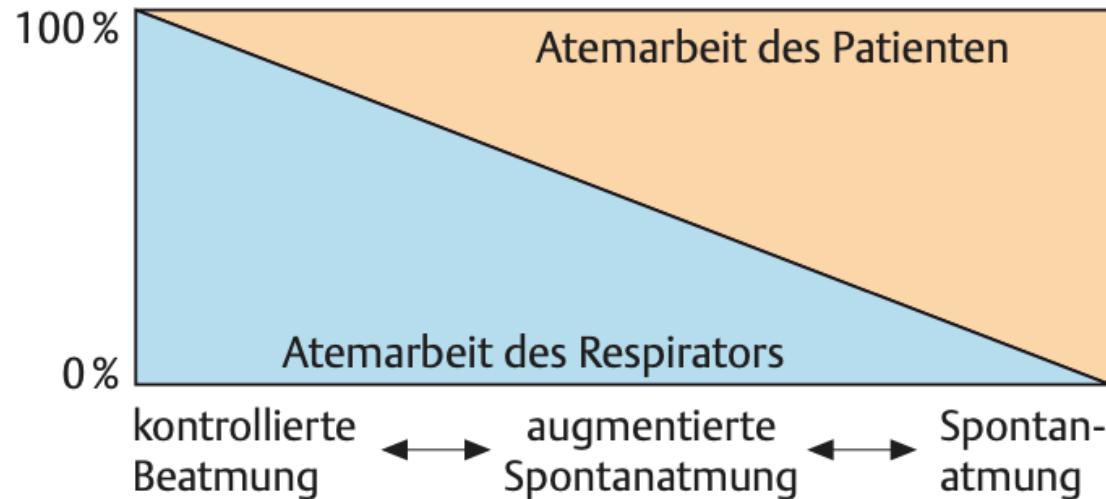
HAMILTON-S1

Der weltweit erste automatische Beatmungsmodus



BASIC

Modes



Change of pressure, volume and flow over time describes the different breathing modes

CMV

- Volume pre-set assist control
- Pressure pre-set assist control

ASB

- Pressure support



Modes

It's complicated, but easy...

| Vendor | Hamilton Medical | Dräger | CareFusion | Covidien | Maquet | GE Medical | Chatburn |
|------------------|------------------|--------------------|-----------------|-----------|------------------|-------------|-----------|
| Ventilator | G5, S1 | V500 | AVEA | PB 840 | SERVO-i | Carestation | --- |
| Volume-CMV | (S)CMV | VC-AC | Volume A/C | AC-VC | Volume control* | VCV | VC-CMVs |
| Pressure-CMV | P-CMV | PC-AC | Pressure A/C | AC-PC | Pressure control | PCV | PC-CMVs |
| Adaptive-CMV | APVcmv | VC-AC + AutoFlow | PRVC A/C | AC-VC+ | PRVC | PCV-VG | PC-CMVa |
| Volume-SIMV | SIMV | VC-SIMV | Volume SIMV | SIMV-VC | SIMV(VC) + PS | SIMV-VC | VC-IMVs,s |
| Pressure-SIMV | P-SIMV | PC-SIMV | Pressure SIMV | SIMV-PC | SIMV(PC) + PS | SIMV-PC | PC-IMVs,s |
| Adaptive-SIMV | APVsimmv | VC-SIMV + AutoFlow | PRVC SIMV | SIMV-VC+ | SIMV(PRVC) + PS | SIMV-PCVG | PC-IMVa,s |
| Pressure support | SPONT | SPN-CPAP / PS | CPAP / PSV | SPONT PSV | PS/CPAP | CPAP/PS | PC-CSVs |
| Volume support | VS | SPB-CPAP / VS | --- | VS | VS | --- | PC-CSVa |
| Biphasic | DuoPAP | PC BiPAP | APRV / BiPhasic | BiLevel | Bi-Vent | BiLevel | PC-IMVs,s |
| APRV | APRV | PC-APRV | | | | | PC-IMVs,s |



Modes

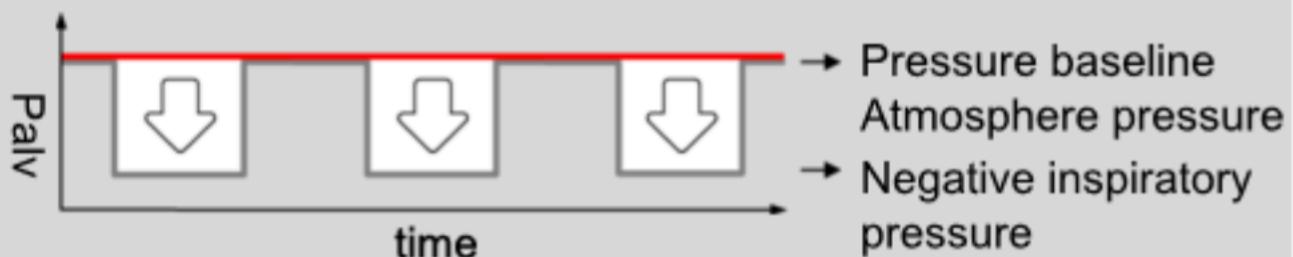
IPPV

Pao
is raised
during inspiration



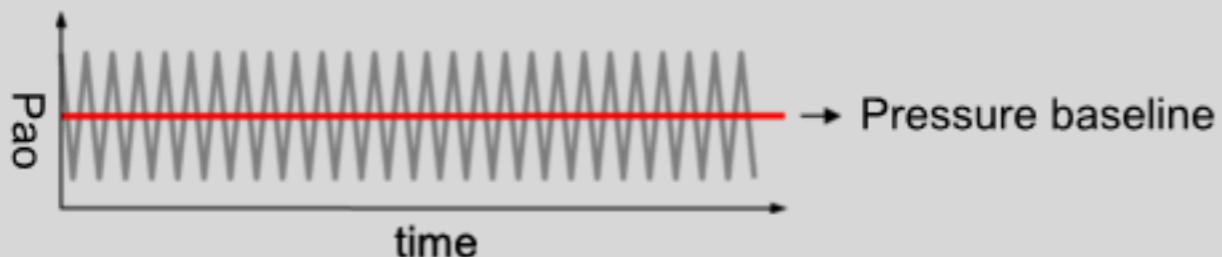
INPV

Palv
is lowered
during inspiration

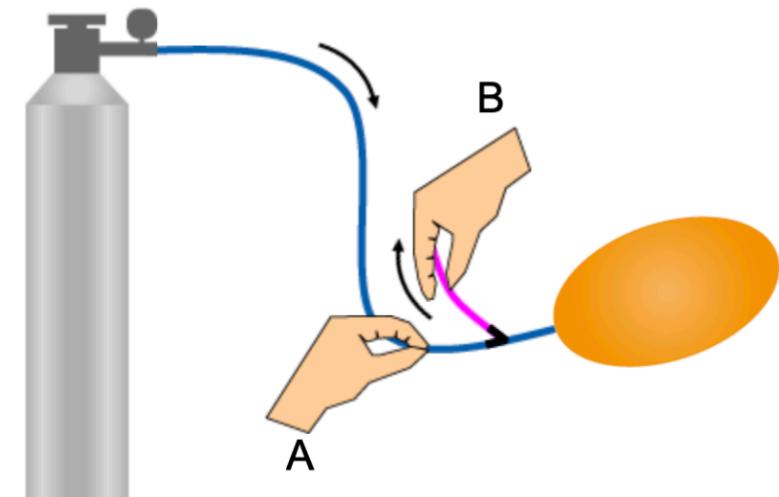
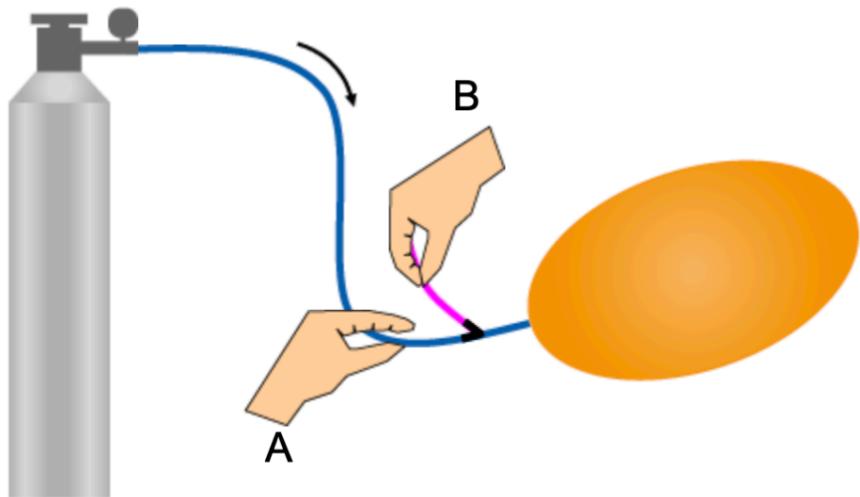
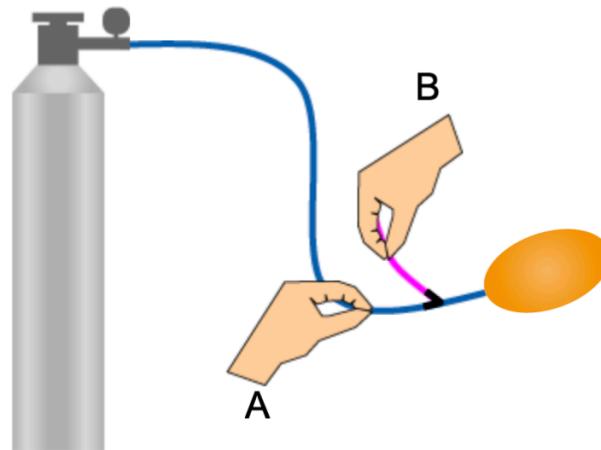


INPV

Pao
is swinged at a
high frequency

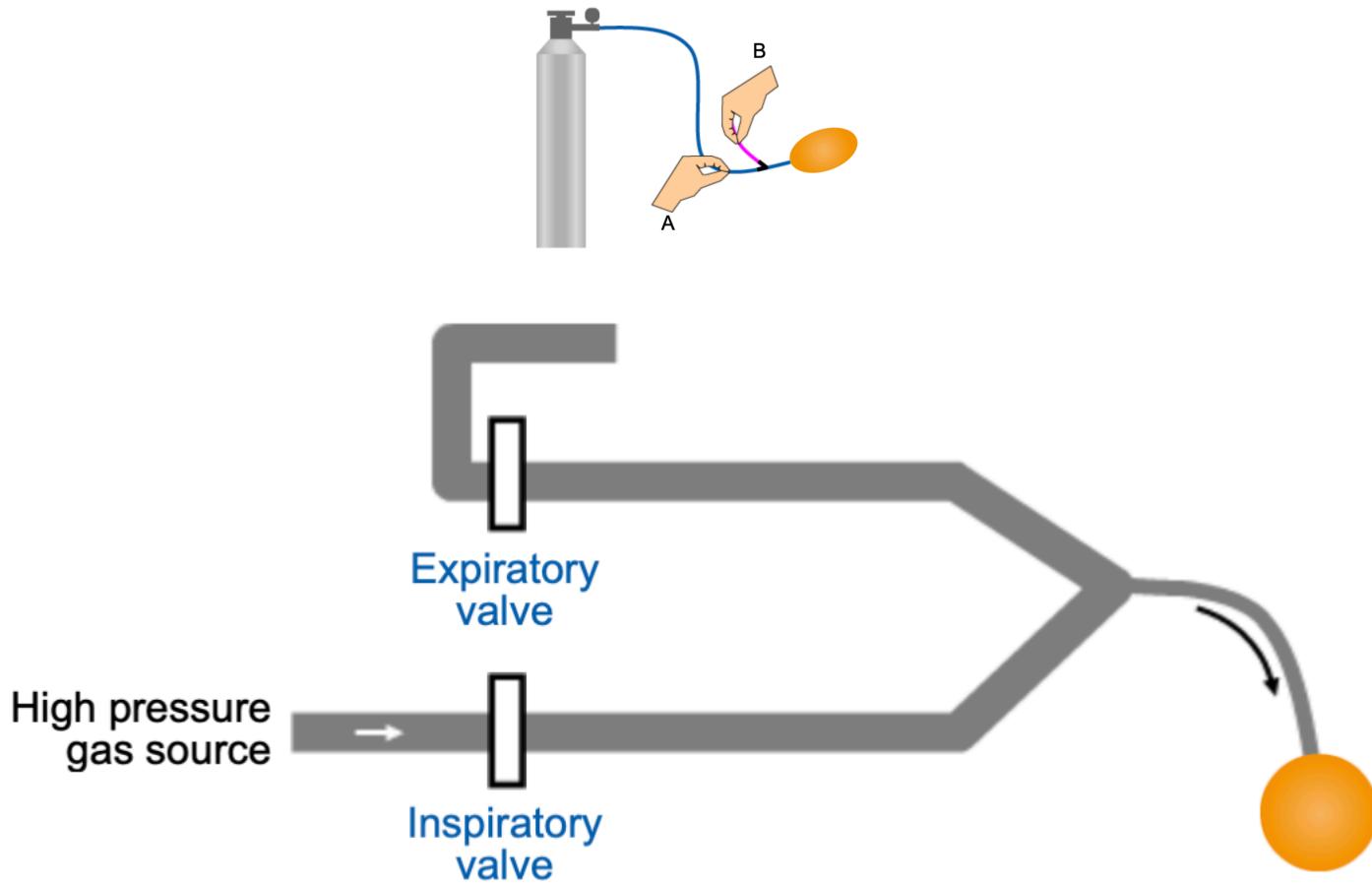


Concept of a respirator

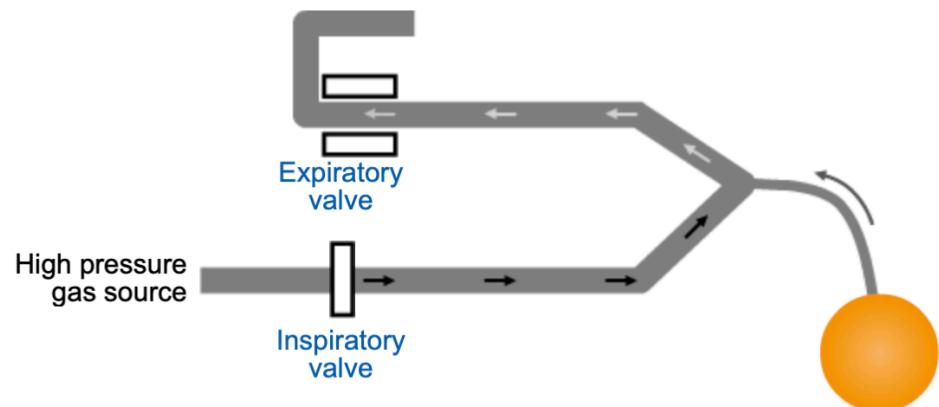
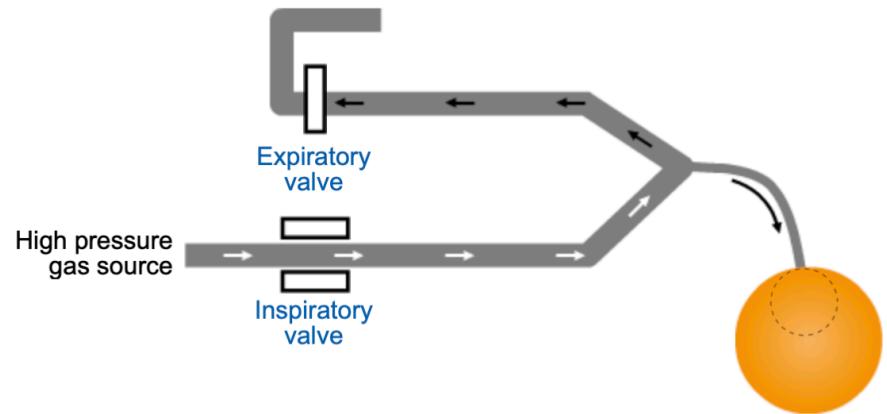
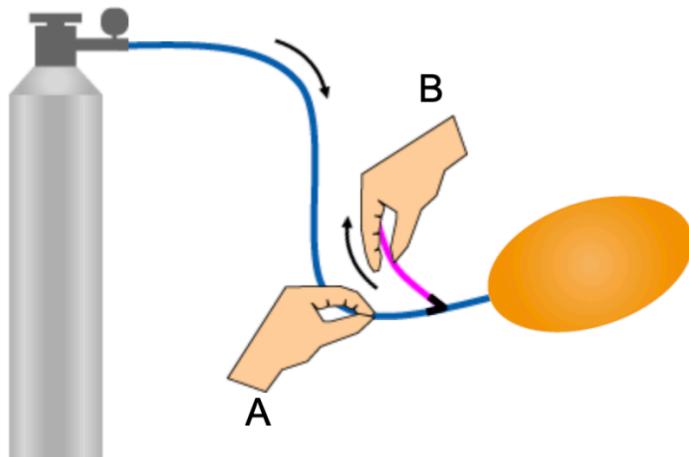
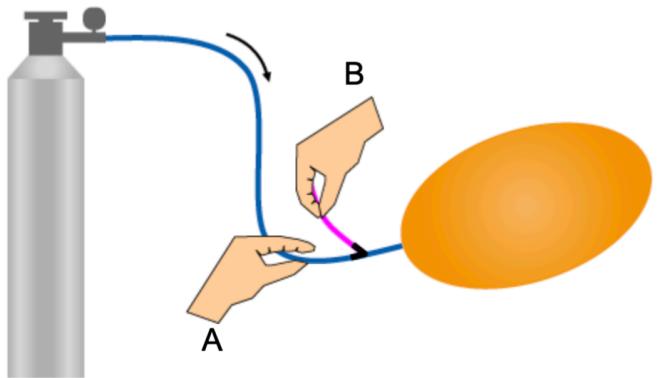


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Concept of a respirator

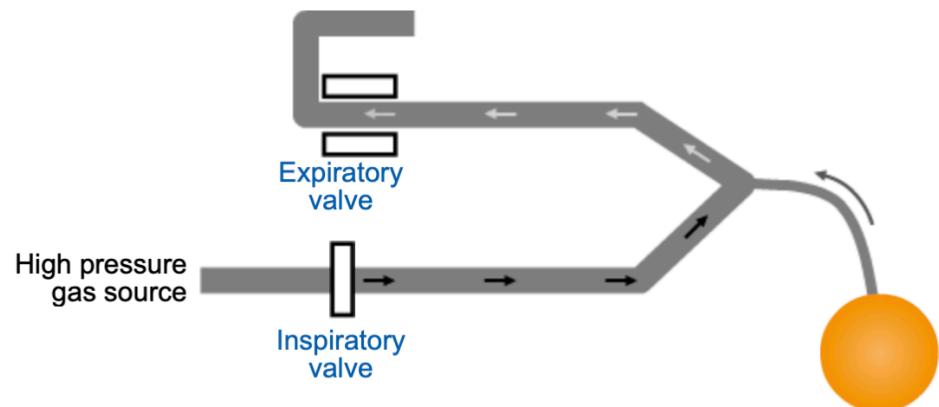
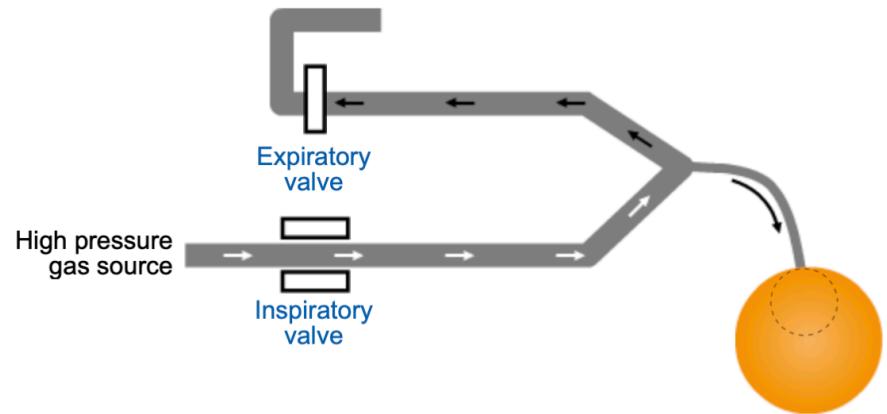
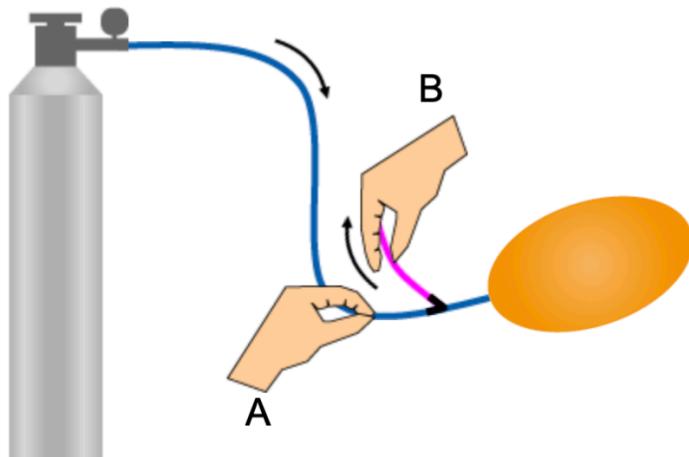
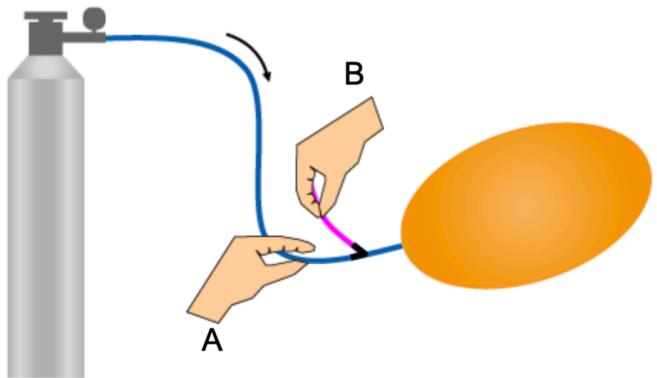


Concept of a respirator



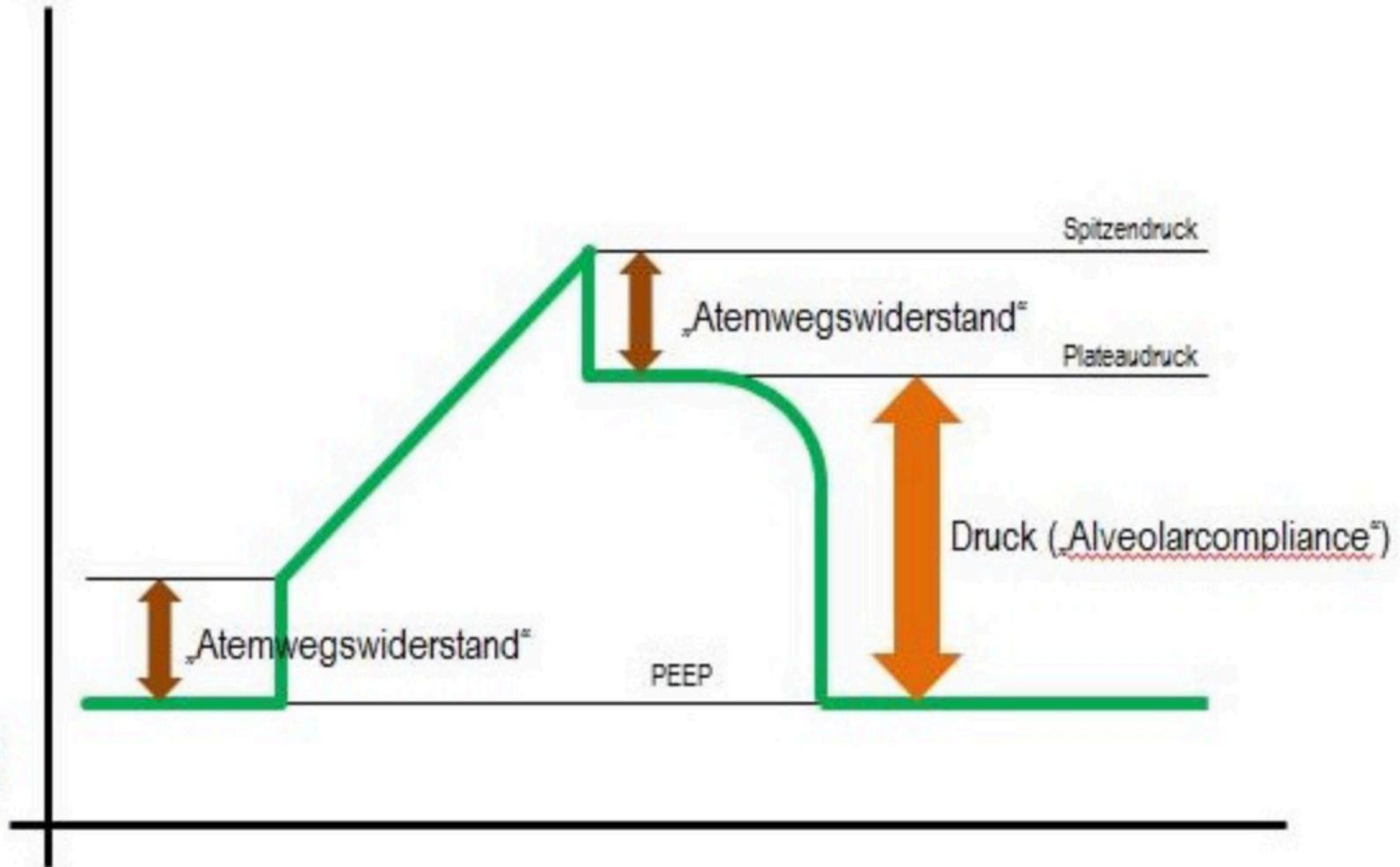
BASIC

Concept of a respirator



BASIC

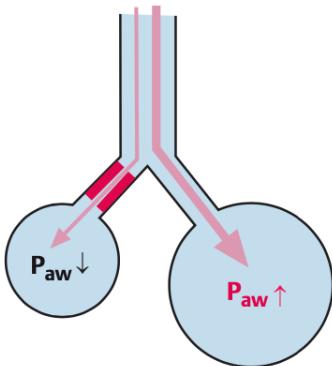
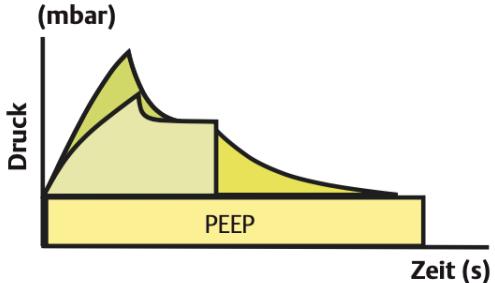
Pressure, Flow and Volume Curves



P-CMV vs V-CMV

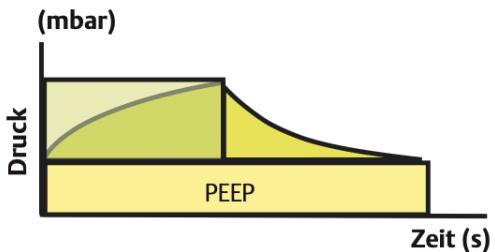
obstructive patient

volumenkontrollierte Beatmung

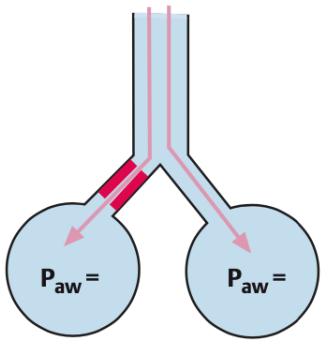


Überdehnung der Kompartimente mit normaler Resistance

druckkontrollierte Beatmung



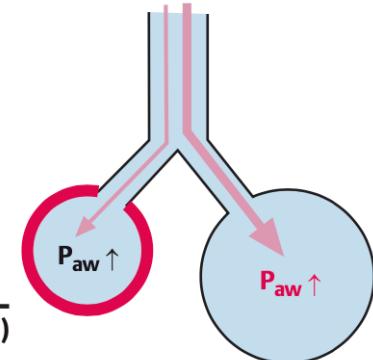
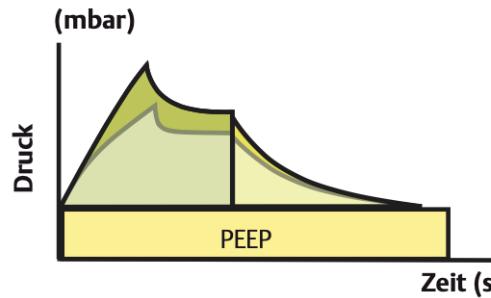
P_{aw} = Atemwegsdruck



gleiche Druckverteilung in den Kompartimenten

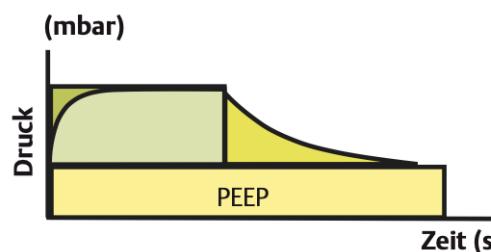
restrictive patient

volumenkontrollierte Beatmung

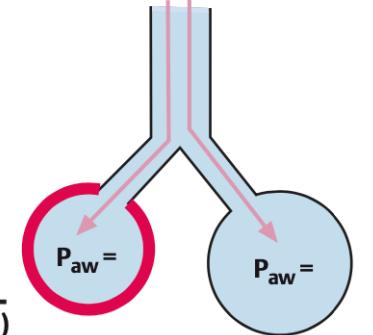


Überdehnung der Kompartimente mit normaler Compliance

druckkontrollierte Beatmung



P_{aw} = Atemwegsdruck



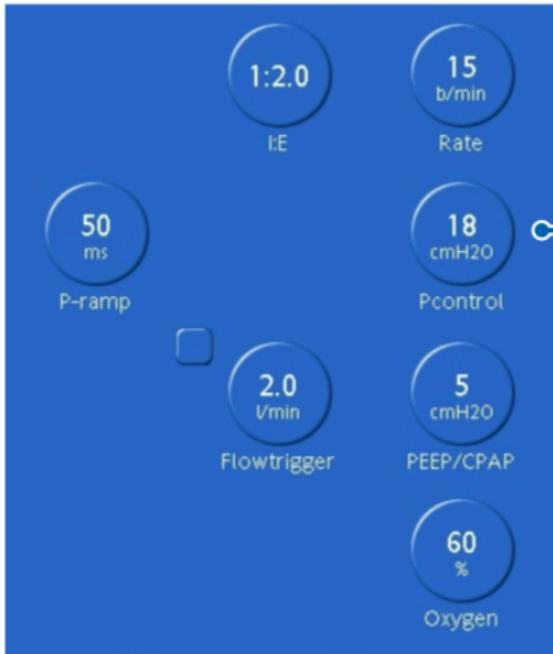
gleiche Druckverteilung in den Kompartimenten



BASIC

Controlled mechanical ventilation (CMV)

Basic controls



- V_t for volume-CMV
- $P_{control}$ for pressure-CMV

- Pressure CMV: P_{insp}
- Volume CMV: Tidal volume
- Rate
- PEEP
- FiO_2
- T_i or $I:E$



BASIC

Controlled mechanical ventilation(CMV)

Basic settings

| | Rate | Tidal Volume | Phoch | I:E | PEEP | FiO2 |
|-----|-------------|---------------------|------------------------|------------|-------------|-------------|
| PCV | 10-15 | 6-8ml/kg* | 10-12mbar über PEEP | 1:2 | 5-8mbar | 0.5 |
| VCV | | 6-8ml/kg* | max 30mbar** | | | |

Goals Normoventilation

- pH 7.35 - 7.45
- paCO₂ 35-45mmHg / 4.6-6kPa
- pO₂ 80-100mmHg / 10-13kPa

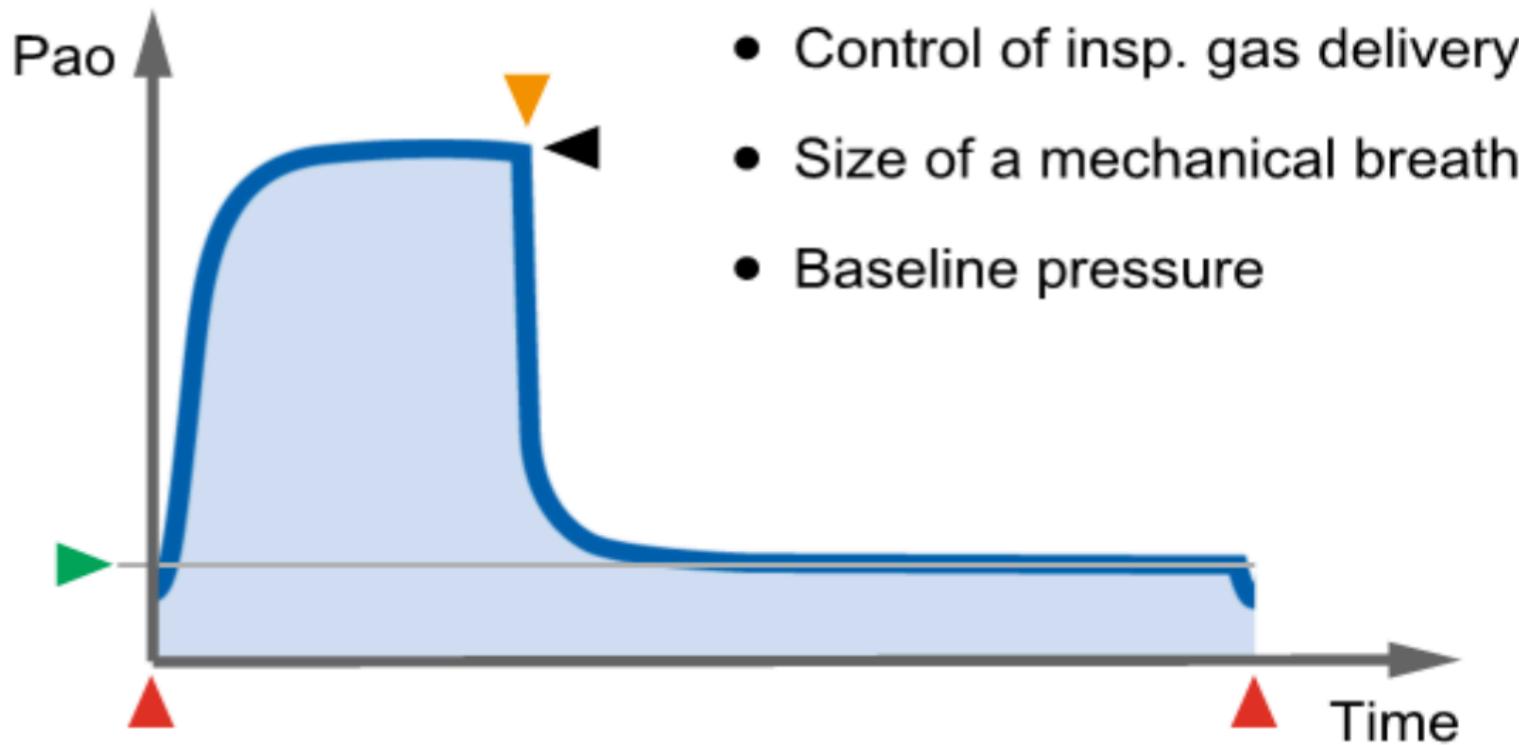
* PBW

** resp. P_{plat}-PEEP = max 15mbar = Driving pressure



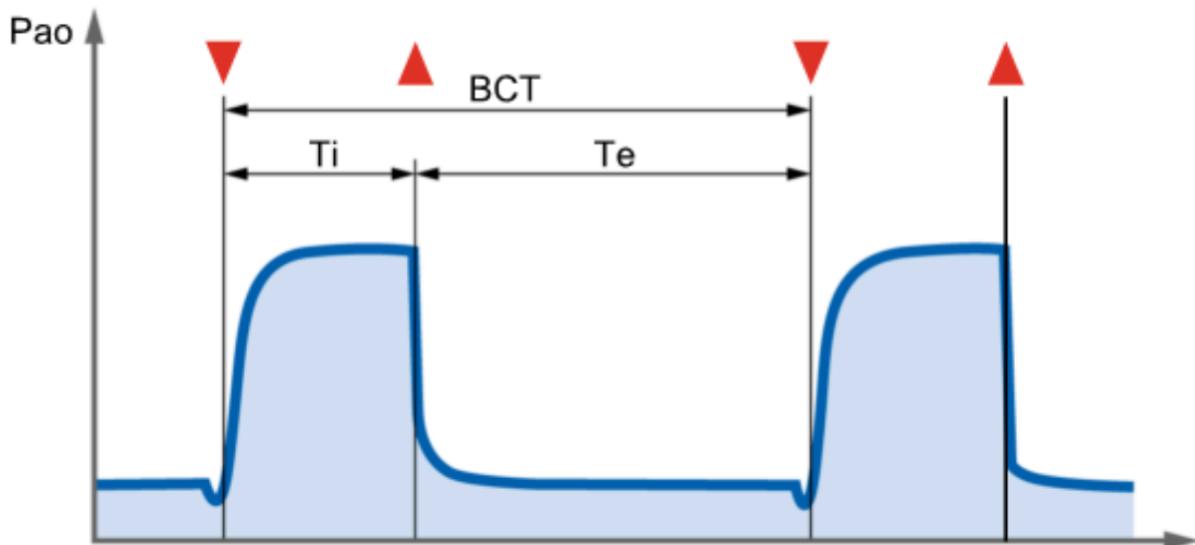
BASIC

Basic settings

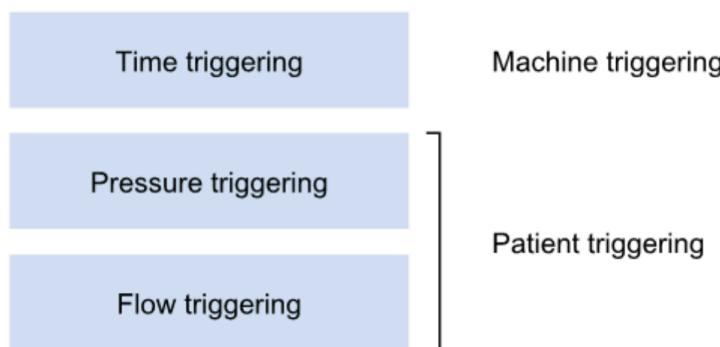


Basic settings

Mechanical breath timing

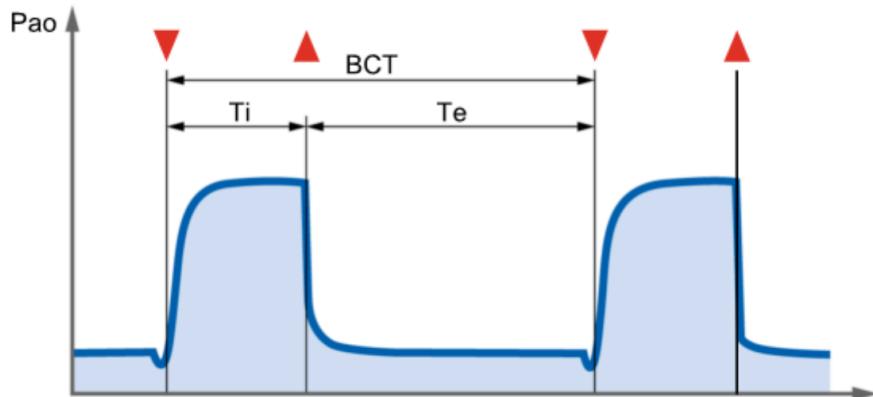


Triggering: refers to the time point when inspiration starts
Cycling: refers to the time point when inspiration ends

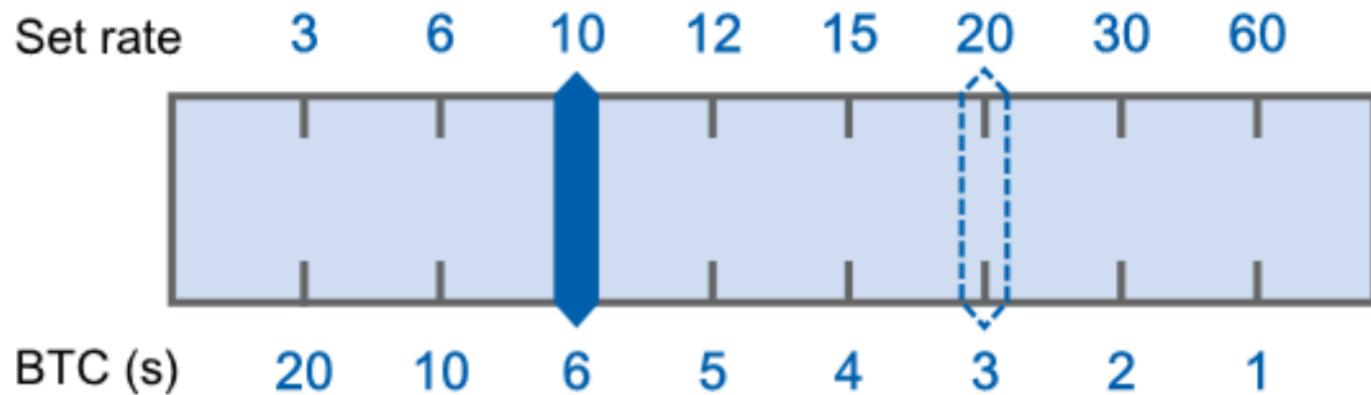


Basic settings

Machine triggering: Time triggering

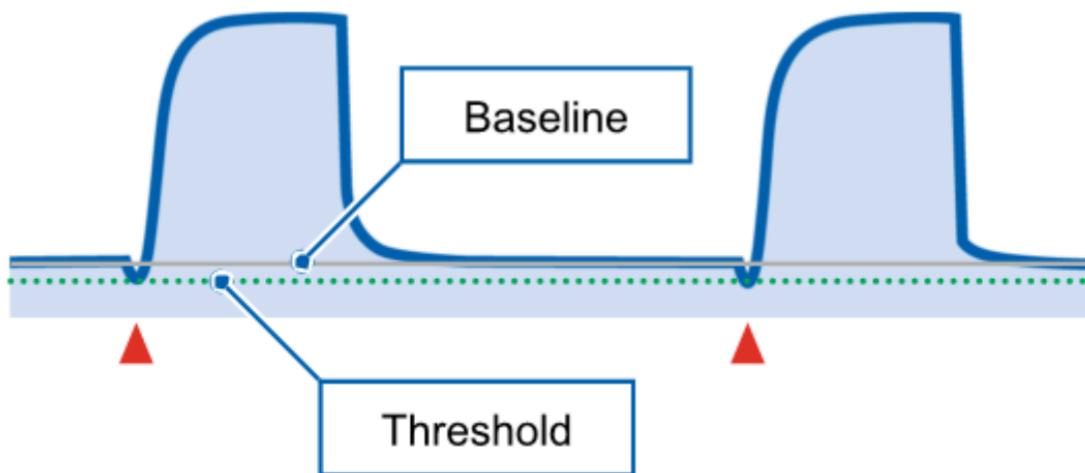
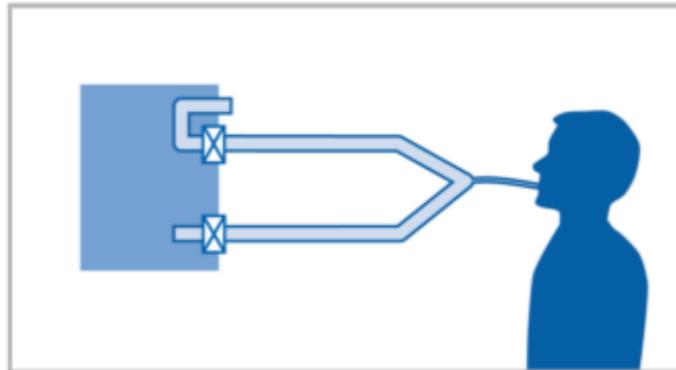


$$BCT \text{ (s)} = \frac{60}{\text{Set rate (b/min)}}$$



Basic settings

Patient triggering: Pressure triggering



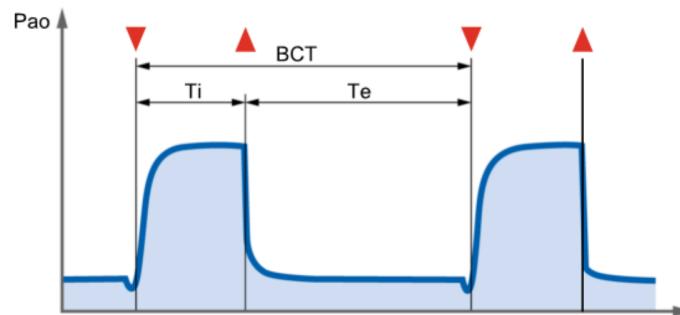
If the pressure drop reaches a set virtual threshold, the ventilator is triggered and starts the delivery of inspiratory gas.



BASIC

Basic settings

Cycling



Time cycling
(machine)

For passive patients

Flow cycling
(patient)

For active patients



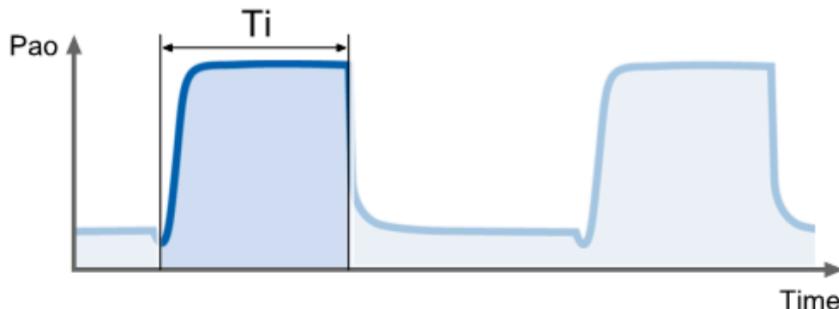
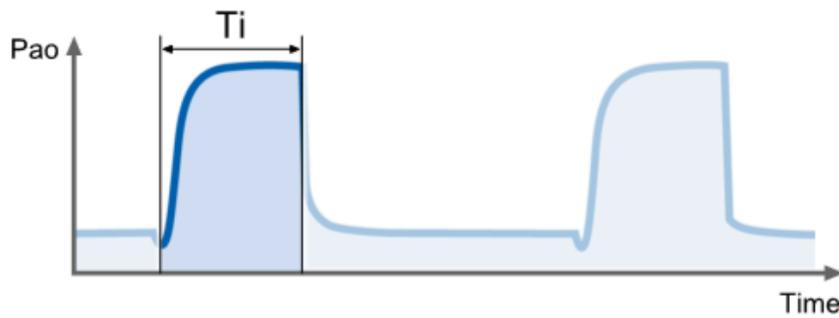
BASIC

Basic settings

Cycling: Ti

Time cycling
(machine)

For passive patients



Operator sets directly T_i in seconds. The ventilator switches from inspiration to expiration when the set T_i is over

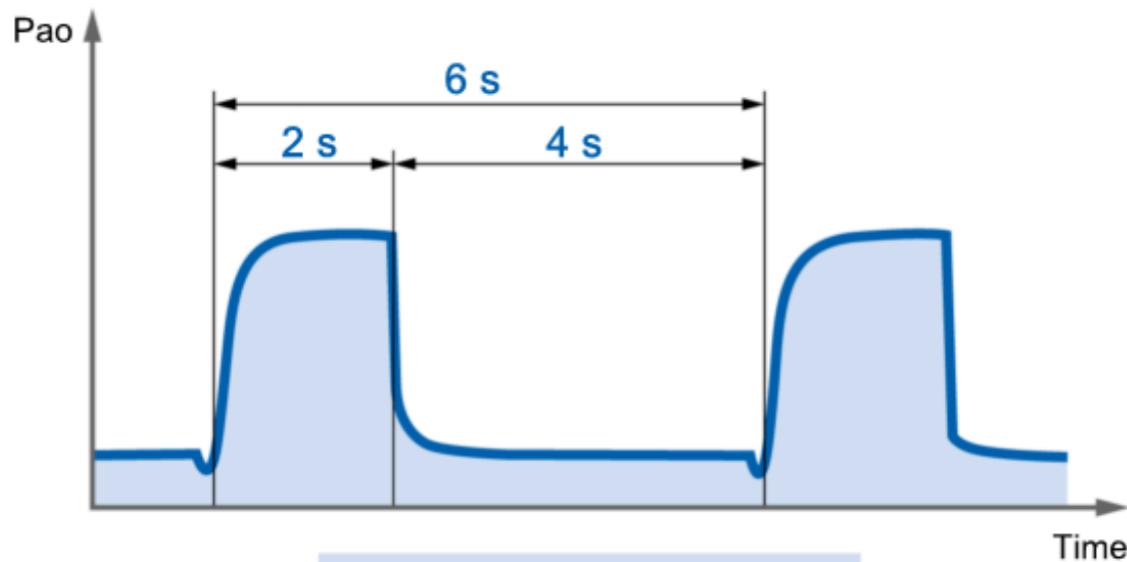


Basic settings

Cycling: I:E ratio

Time cycling
(machine)

For passive patients



I:E ratio = 1:2



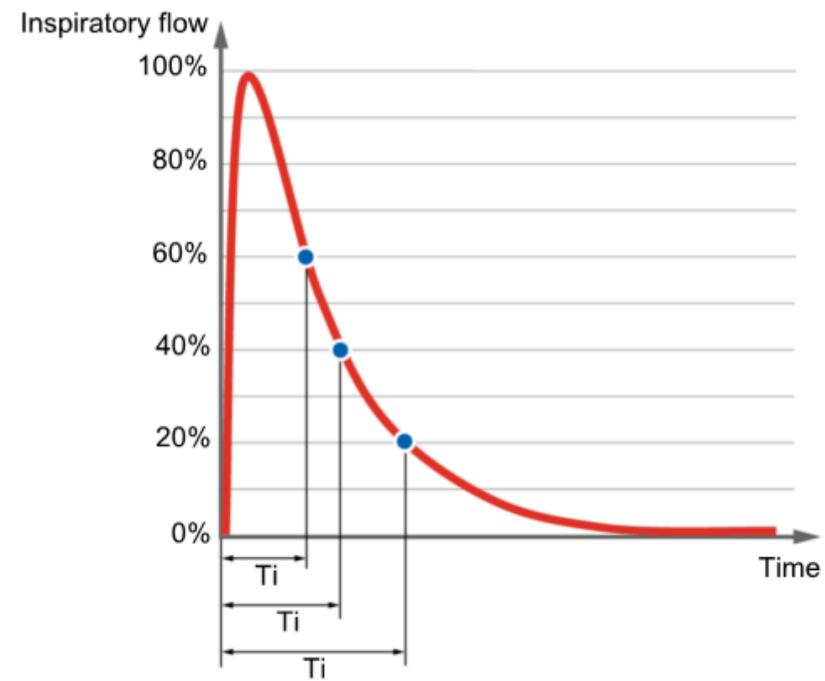
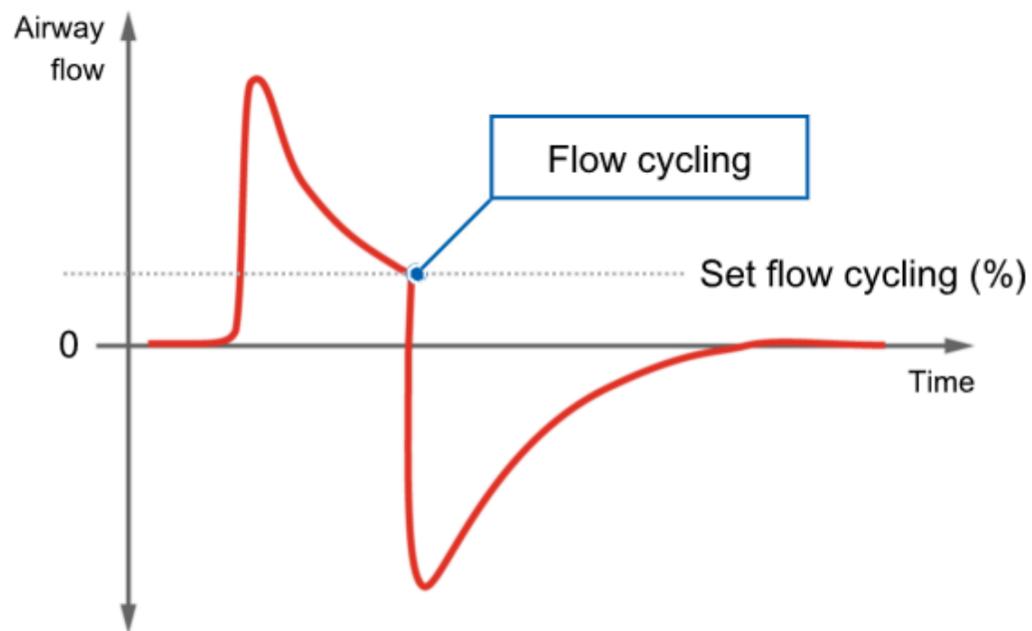
BASIC

Basic settings

Cycling: Flow cycling

Flow cycling
(patient)

For active patients

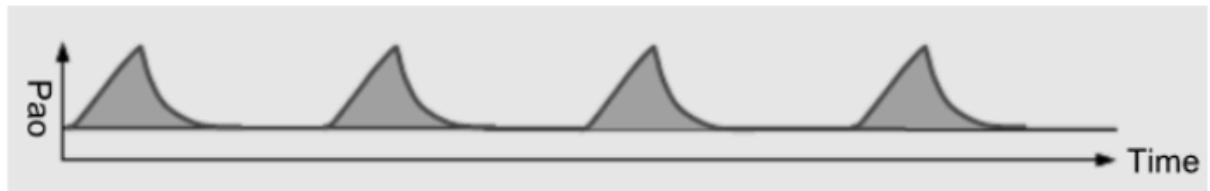


BASIC

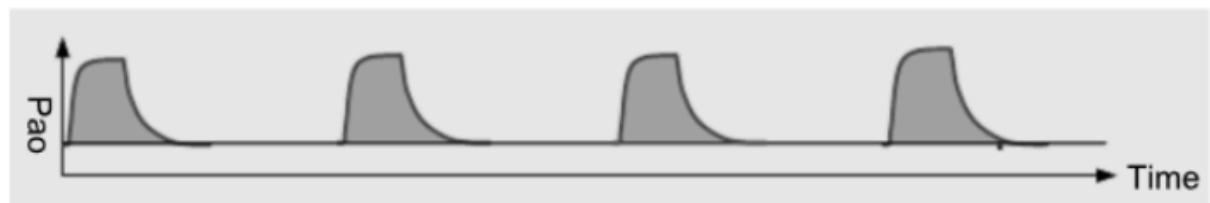
Modes

Passive Patient

Volume-CMV



Pressure-CMV



all breaths are VTMB

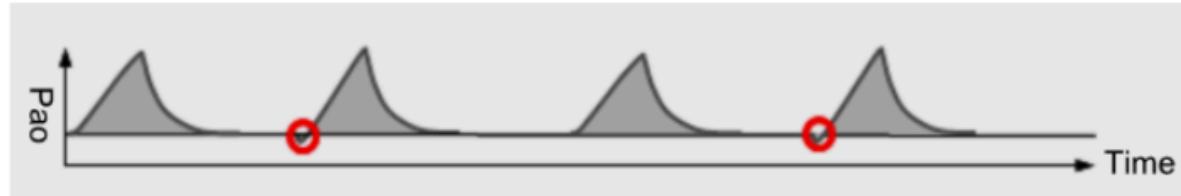


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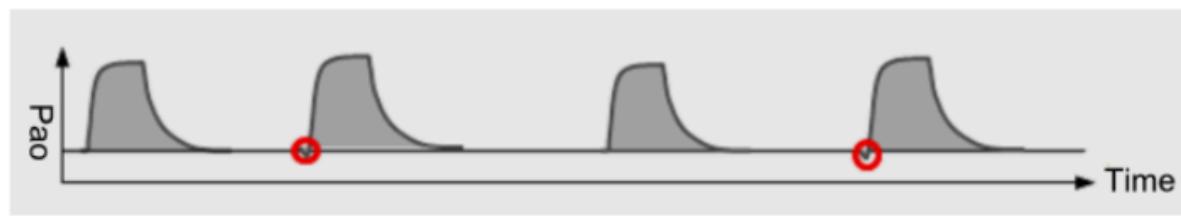
Modes

Partially active Patient

Volume-CMV



Pressure-CMV



Mix of VTMB and PTMB

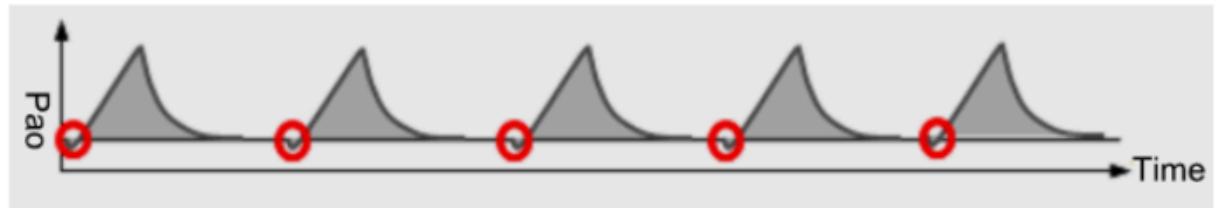


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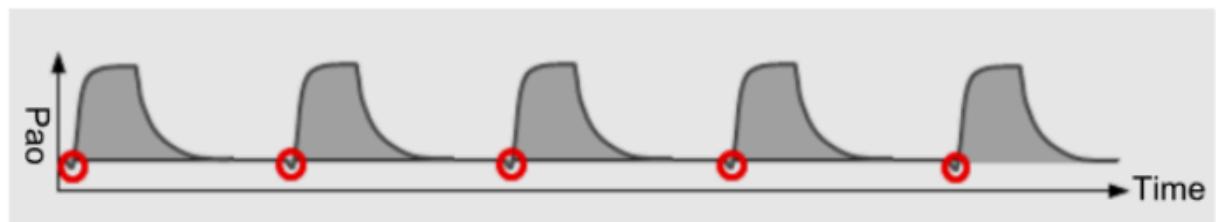
Modes

Active Patient

Volume-CMV



Pressure-CMV



All breaths are PTMB



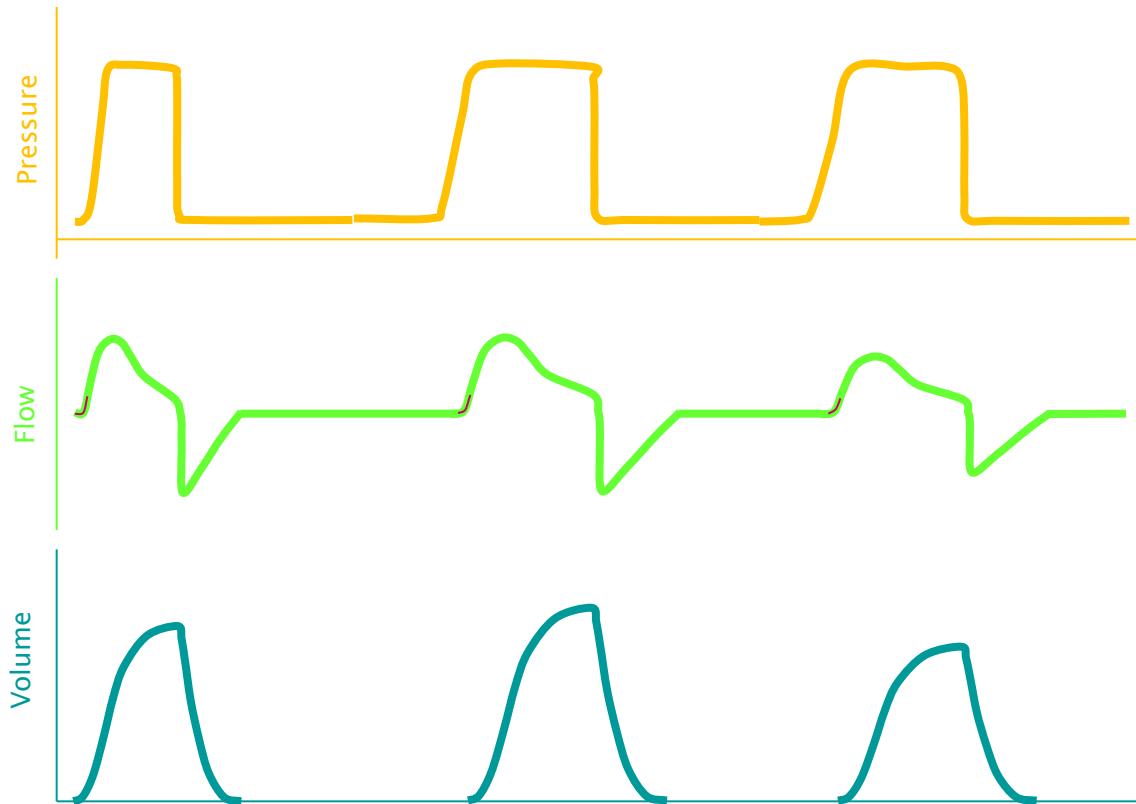
BASIC

Pressure support

- Nomenclature
 - Inspiratory assist
 - Assisted spontaneous breathing



Pressure support



BASIC

Pressure support

- Pressure support of 3.5-14.5 cmH₂O required to overcome the additional work of breathing due to breathing through ETT and demand valve
- Patients who require pressure support of < 6 cmH₂O can probably be extubated

