

Artificial ventilation in anesthesia and intensive care medicine



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Physiology of breathing

Breathing in: Air *passively* follows the pressure gradient from the environment (higher pressure) into the lung (lower pressure)

Breathing out: Due to elastic reset forces, the lung is compressed and air is pressed out again.

Artificial ventilation

Air is **actively** pressed into the patient's lungs by the ventilator.

source: R. Larsen, T. Ziegenfuß, *Pocket Guide Beatmung*, S. 17, DOI 10.1007/978-3-662-53728-2_2,
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When do we need artificial ventilation?

- 1. General anaesthesia (i.e. opioid-induced depression of respiratory function)**
- 2. When the patient's breathing fails/is insufficient because of**
...
 - lung failure due to infection**
 - ARDS (Acute Respiratory Distress Syndrome)**
 - chest trauma**
 - ...**

How is the ventilator connected to the patient?

Ventilation via ...

endotracheal breathing tube

laryngeal tube

laryngeal mask

Modes of artificial ventilation

1. Modes for patients **without** spontaneous breathing activity
2. Modes for patients **with** spontaneous breathing activity

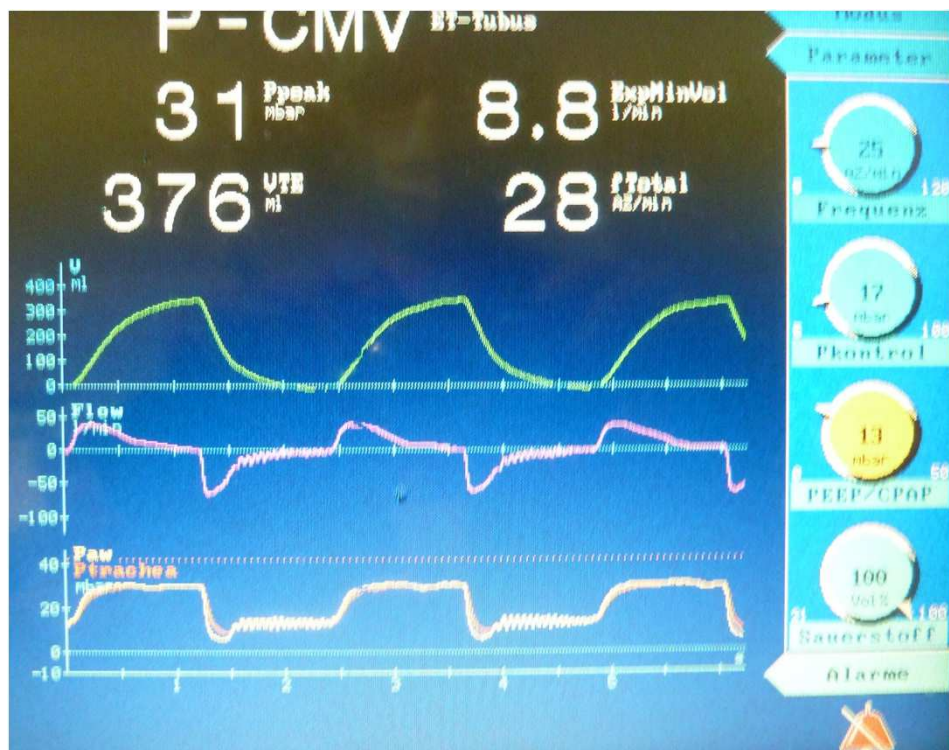
Main parameters for setting up artificial ventilation:

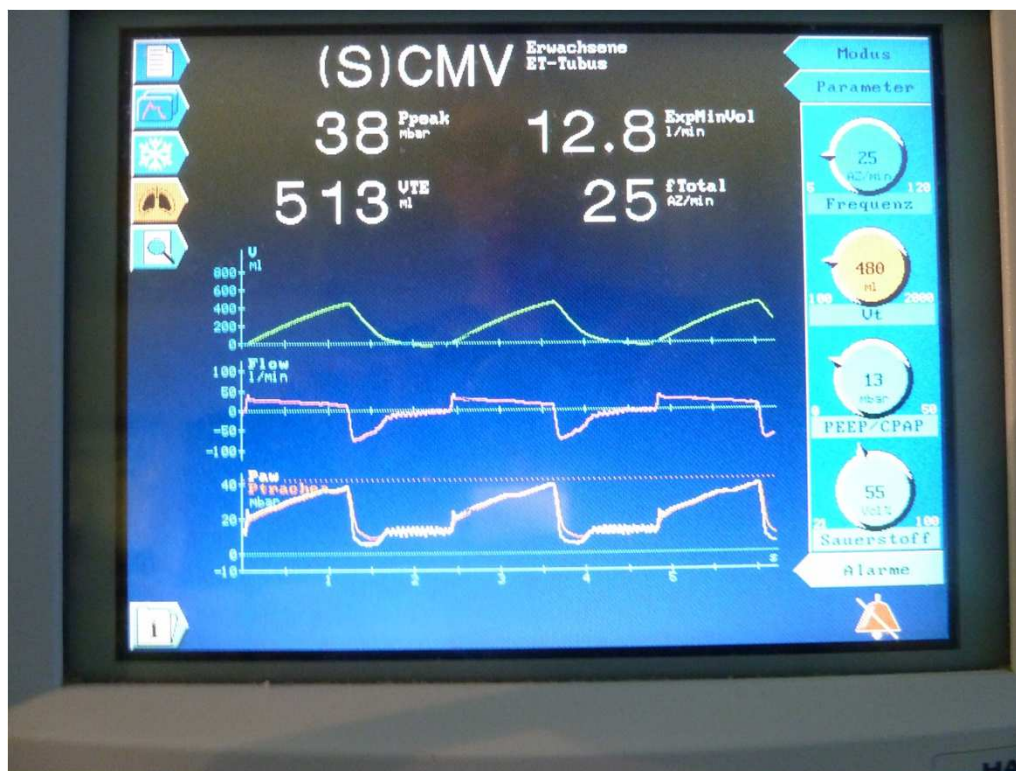
- Tidal volumen (6-8 ml/kg bodyweight)
- Respiratory frequency (age-dependent; about 10/min [adult])

Control value: expiratory CO_2 (33-43 mmHg)

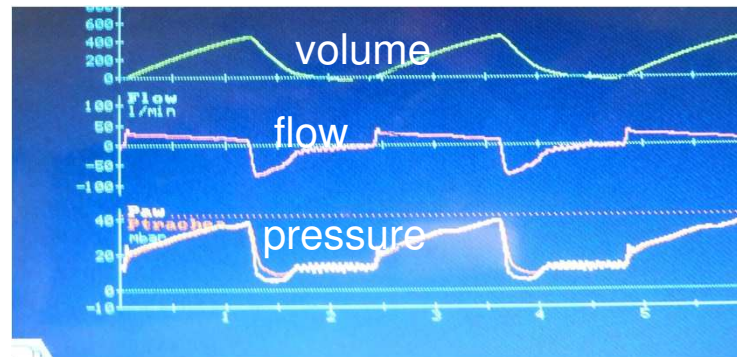
**Modes of artificial ventilation
for patients
without spontaneous breathing activity**

settings



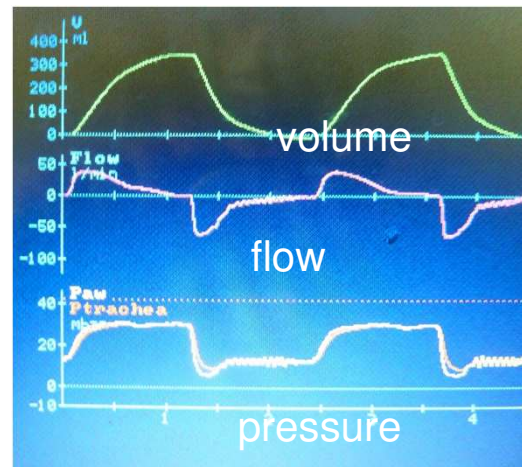


VCV

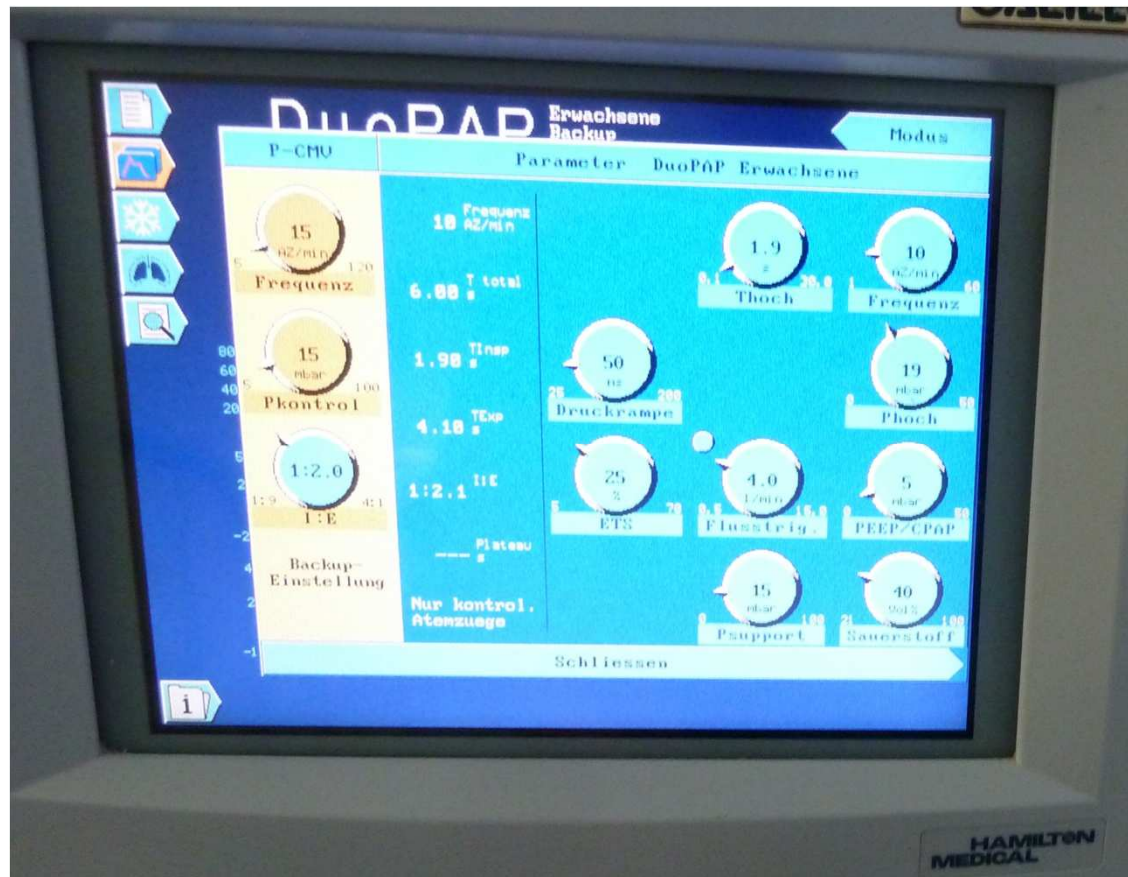


versus

PCV



**Modes of artificial ventilation
for patients
with spontaneous breathing
activity
i.e. used during weaning from
ventilator**



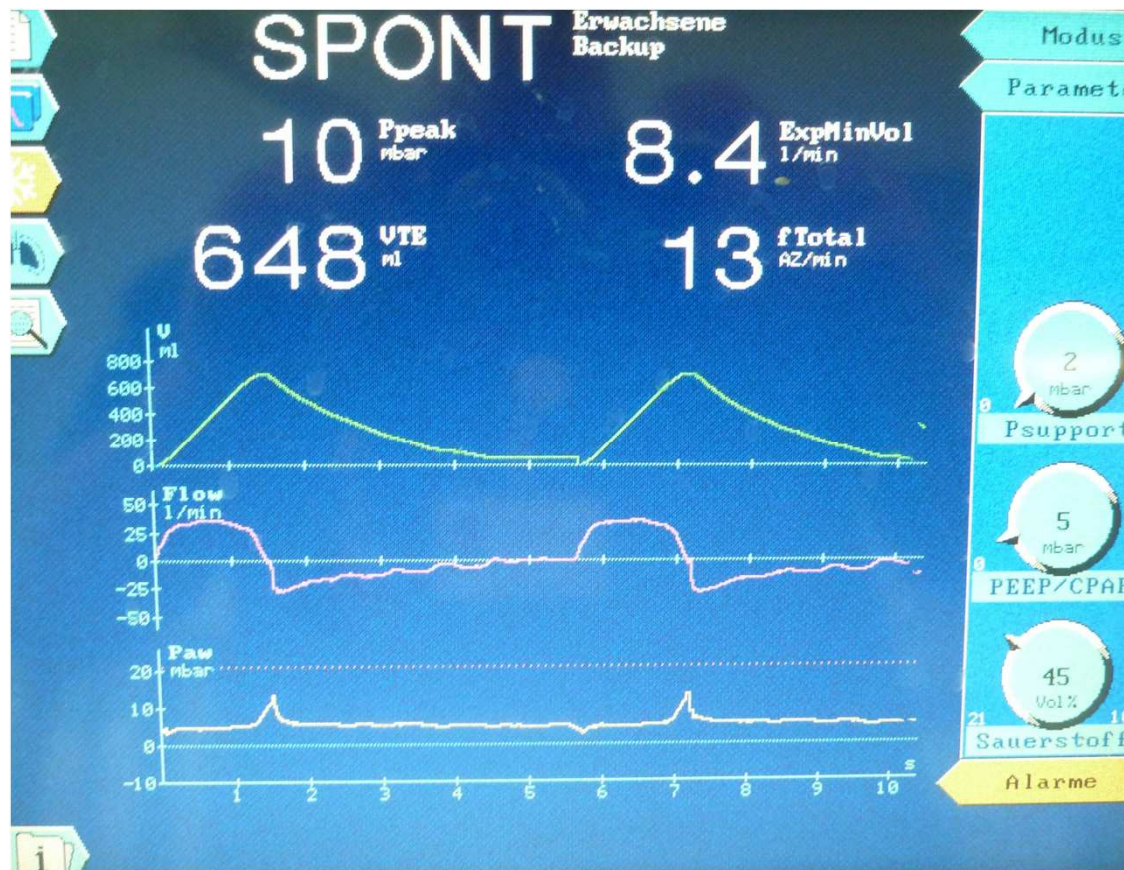
Ideally ventilator support of spontaneous breathing should be possible
in between 0 to 100%

The ventilator augments each spontaneous breath of the patient upon
recognizing a „trigger“

Increase in spontaneous breathing frequency = increase of ventilator assist

Examples: When breathing frequency doubles, ventilator assist doubles as well
In apnoea ventilator assist = 0

Possibilities for individual adaption are little



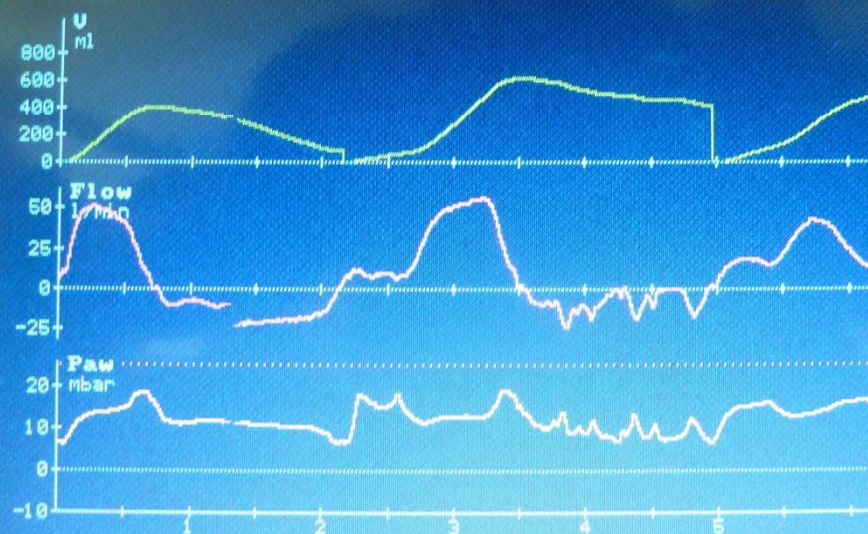
NIV Erwachsene
Backup

17 Ppeak
mbar

7.7 ExpMinVol
l/min

357 VTE
ml

27 fTotal
AZ/min



Modus

Parameter

8

mbar

Psupport

8

mbar

PEEP/CPAP

25

Vol%

Sauerstoff

Alarme

- **ASB** Assisted Spontaneous Breathing – unterstützte Spontanbeatmung, auch **ASV** = Assisted Spontaneous Ventilation
- **ASV**
 - Adaptive Support Ventilation – Closed-Loop-Beatmung, eine Weiterentwicklung von **MMV**
 - **Adaptive Servoventilation** eine nichtinvasive Beatmung bei zentralem **Schlaf-Apnoe-Syndrom**
- **ATC** Automatic Tube Compensation – Automatische Tubuskompensation
- **BiPAP** Biphase Positive Airway Pressure – zweiphasische positive Atem-Druckunterstützung
- **BiPAP** Bilevel Positive Airway Pressure – zweiphasische positive Atem-Druckunterstützung bei der NIV
- **CMV** Continuous Mandatory Ventilation – kontinuierliche, vollständig mechanische Ventilation
- **CPAP** Continuous Positive Airway Pressure – kontinuierlicher positiver Atemwegsdruck
- **CPPV** Continuous Positive Pressure Ventilation – kontinuierliche Überdruckbeatmung
- **EPAP** Expiratory Positive Airway Pressure – positiver expiratorischer Atemwegsdruck
- **HFPV** High Frequency Positive Pressure Ventilation – Hochfrequenzüberdruckbeatmung
- **HFOV** High Frequency Oscillatory Ventilation – Hochfrequenzbeatmung
- **HfV** High Frequency Ventilation – Hochfrequenzbeatmung
- **ILV** Independent Lung Ventilation – seitengetrennte Überdruckbeatmung
- **IPAP** Inspiratory Positive Airway Pressure – positiver inspiratorischer Atemwegsdruck
- **IPPV** Intermittent Positive Pressure Ventilation – intermittierende Überdruckbeatmung
- **IPV** Intrapulmonary Percussive Ventilation – Hochfrequente offene Überdruckbeatmung, invasiv, noninvasiv (Synonym: HFPV-High Frequency Percussive Ventilation)
- **IRV** Inverted Ratio Ventilation – Beatmung mit umgekehrten Atemphasen/Zeit-Verhältnis
- **LFPPV** Low Frequency Positive Pressure Ventilation – Niedrigfrequenzüberdruckbeatmung
- **MMV** Mandatory Minute Volume – (vorgegebenes) maschinelles Minutenvolumen
- **NIV** Noninvasive Ventilation (nichtinvasive Beatmung)
- **NPPV** Noninvasive Positive Pressure Ventilation
- **PAV** Proportional Assist Ventilation – *proportional druckunterstützte Beatmung*
- **PC** Pressure Control – druckgesteuerte, vollständig mechanische Ventilation
- **PCMV (P-CMV)** Pressure Controlled Mandatory Ventilation – druckgesteuerte, vollständig mechanische Ventilation
- **PCV** Pressure Controlled Ventilation – druckgesteuerte, vollständig mechanische Ventilation
- **PEEP** Positive Endexpiratory Pressure – positiver endexpiratorischer Druck
- **PNPV** Positive Negative Pressure Ventilation – Wechseldruckbeatmung
- **PPS** Proportional Pressure Support – proportional druckunterstützte Beatmung (Draeger), siehe auch **PAV**
- **PRVC** Pressure Regulated Volume Controlled; – Druckgeregelte volumenkontrollierte Beatmung (Weinmann), siehe bei Fa. Draeger = Autoflow Beatmung
- **PSV-Beatmung** Pressure Support Ventilation – unterstützte Spontanbeatmung, siehe auch **ASB**
- **S-CPPV** Synchronized Continuous Positive Pressure Ventilation – synchronisierte kontinuierliche Überdruckbeatmung
- **S-IPPV** Synchronized Intermittent Positive Pressure Ventilation – synchronisierte intermittierende Überdruckbeatmung
- **(S)IMV** (Synchronized) Intermittent Mandatory Ventilation – (synchronisierte) intermittierende maschinelle Beatmung
- **VCMV (V-CMV)** Volume Controlled Mandatory Ventilation – volumengesteuerte, vollständig mechanische Ventilation
- **VCV** Volume Controlled Ventilation – volumengesteuerte, vollständig mechanische Ventilation
- **ZAP** Zero Airway Pressure – Spontanatmung unter Atmosphärendruck

APV **APRV** **SPONT**
DuoPAP **BIPAP**
SIMV **PSV** **PAV**

**Many of these ventilation modes differ in rather small details
regarding their physical / physiological parameters**