Home ventilator

- ST/PCV mode
- AVAPS
- AVAPS-AE mode

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- **Circuit**
- **Setting of ventilator**
- **AVAPS, AVAPS-AE**

■ 요양비의 보험급여 기준 및 방법 [별지 제2호의2서식]

건강보험 인공호흡기 처방전

[ ] 재발급

수진자	건강보험증번호		주민등록번호 등		
	성명		전화번호	(자택)	
				(휴대전화)	
진료과목		상병명		상병코드	

환자상태 및 진료소견 (해당사항에 ☑ 표시)	**※ 아래기준을 모두 만족해야 함.** ① 고이산화탄소혈증 2가지 이상의 임상증상 (☐**제외**: 의식저하 등으로 의사표현이 불가능하여 고이산화탄소혈증 임상증상 파악이 어려움) ☐ 숨이 참 ☐ 피로감 ☐ 두통 ☐ 정신이 맑지 못하고 멍함 ☐ 밤에 자주 깨거나 낮에 졸리고 토막잠을 자주 잠, 혹은 악몽을 자주 꾸거나 가위에 눌림 ☐ 불안하여 안절부절 못함 ☐빈맥 ② 이산화탄소 분압(최소 한 가지 이상) ☐ 동맥혈 가스 검사에서 이산화탄소 분압($ETCO_2$)이 45mmHg 이상 ☐ 호기말 이산화탄소 분압($ETCO_2$)이 40mmHg 이상 * 이산화탄소 분압은 2회 이상의 검사결과지 또는 검사결과를 명시한 소견서를 반드시 첨부
	③ ☐ 24시간 지속적인 인공호흡기 사용자로 호흡기를 이탈하여 ①,② 검사 불가능 (의사소견서로 대체)

처방 구분	☐ 최초 처방 ☐ 재처방(2차 이상)	**인공호흡기 환기타입**	☐혼합형(압력+볼륨) ☐압력형 ☐볼륨형
처방기간	~ . . . . . (개월)	다음 처방일	. .
처방전 사용기간	교부일로부터 ( ) 일간	※ 사용기간 내에 대여·제출하여야 합니다.	

년 월 일

요양기관명(기호) :	( )	(요양기관 직인)
담당의사성명(면허번호) :	(제 호)	
전문과목(전문의 자격번호) :	(제 호)	(서명 또는 인)

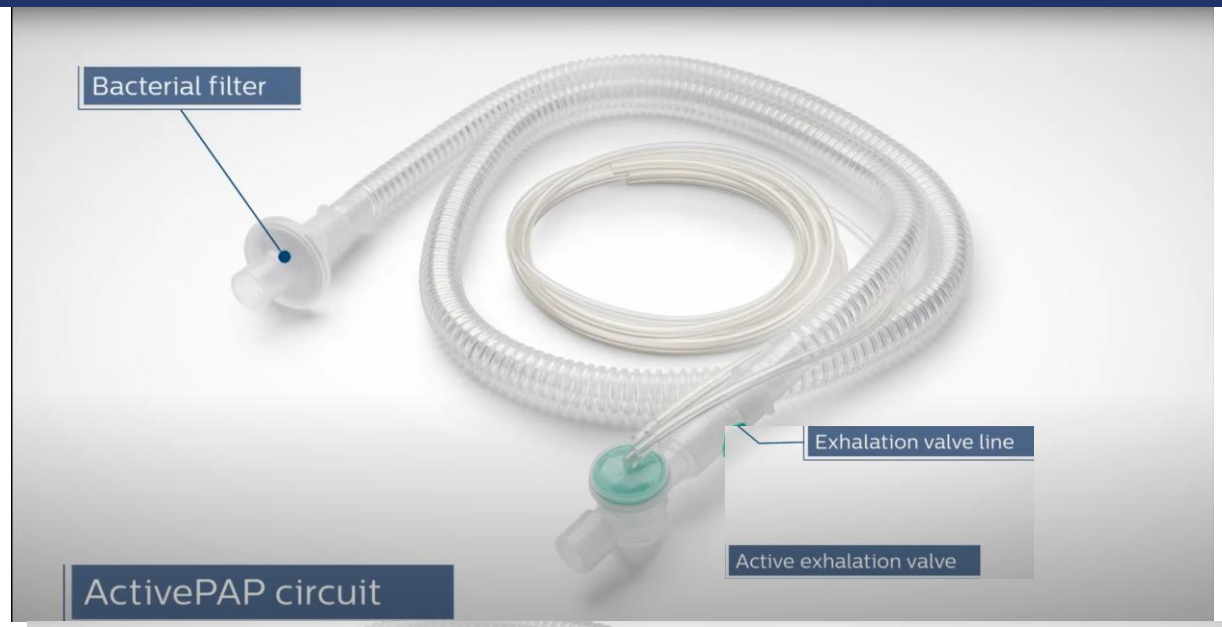
유 의 사 항

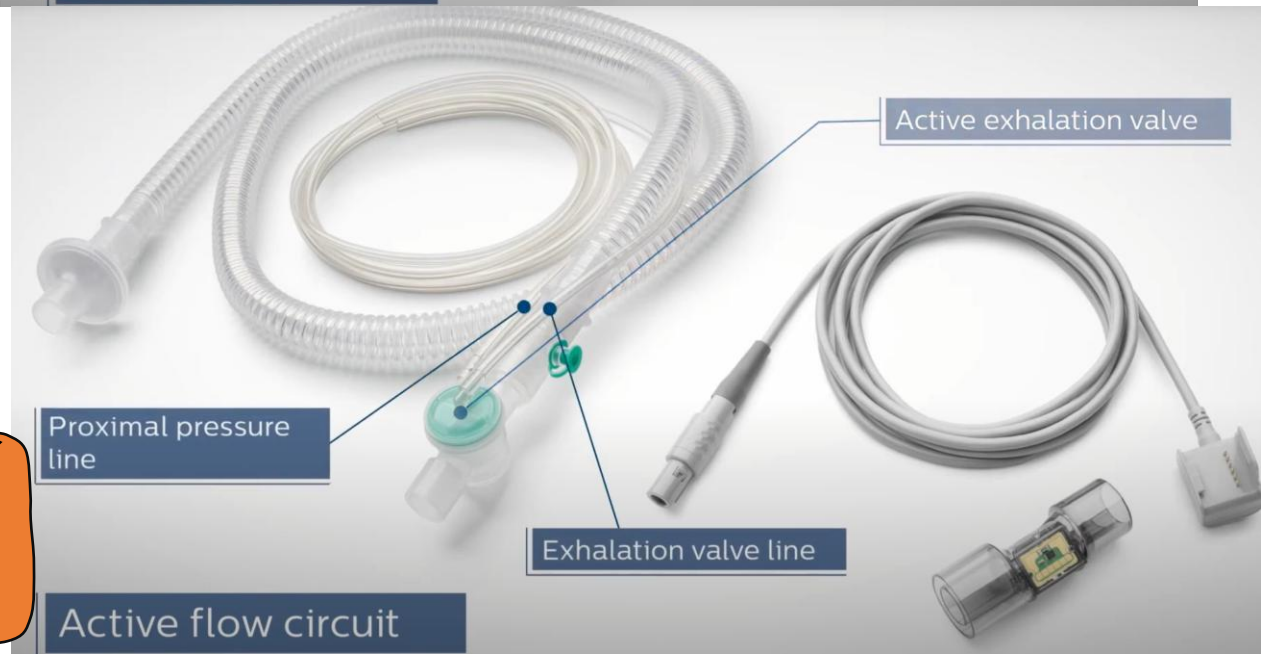
Circuit Dual limb

장점	단점
• CO_2 재호흡이 거의 없음: 호기 가스가 별도의 호기 limb 로 빠져나감 • 모니터링 정확도 높음: 호기 일회 호흡량, 분당 환기량, 순응도/저항 계산 등이 신뢰도 높음 • PEEP/trigger 안정적 : 호기 밸브를 인공호흡기가 직접 정밀하게 제어	• 회로가 무겁고 복잡함 • 이동시 불편함.

Single limb

- 구조 단순 회로가 가볍고 간편함.
- 비용이 dual limb 보다 저렴
- CO_2 가 배출 될 수 있는 Exhalation Valve(호기 밸브) leak port 나 active valve 가 필요함.
- 호기 밸브의 위치와 종류에 따라 CO_2 Rebreathing 위험이 **상당히 높음**





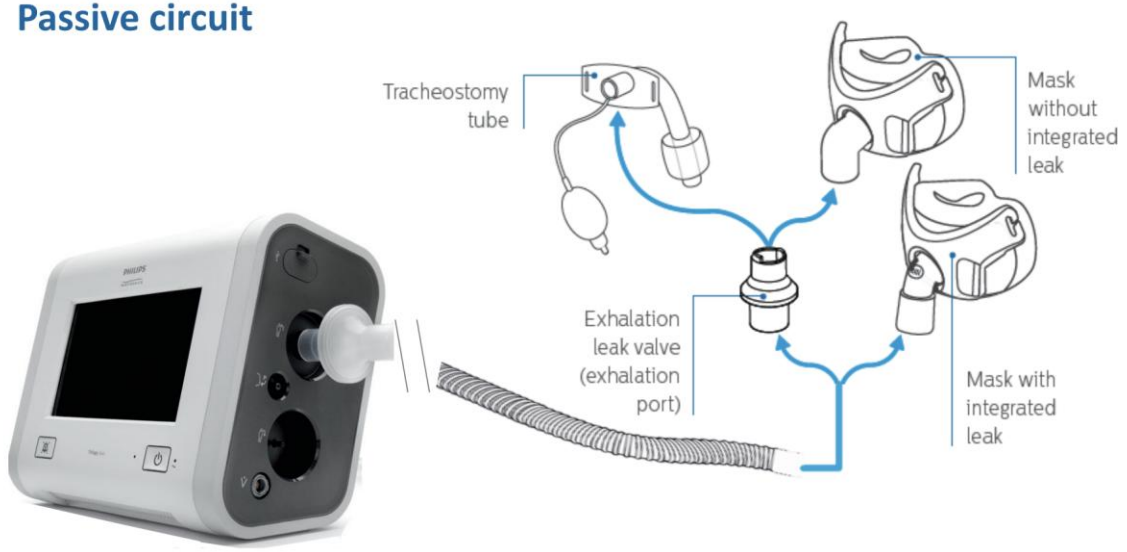
특별한 문제 없으면 passive circuit만 알고 있으면 된다.
Active 같은 경우에는 exhalation valve가 있다는 것이 차이

Single limb

- **A passive circuit**
  - A calibrated intentional leak placed proximal to the patient
- **An active circuit**
  - A true expiratory valve that directs all of the expired air out of the circuit

Passive circuit 에서는 반드시 EPAP 을 4cmH_2O 이상!!

Passive circuit



Active PAP circuit

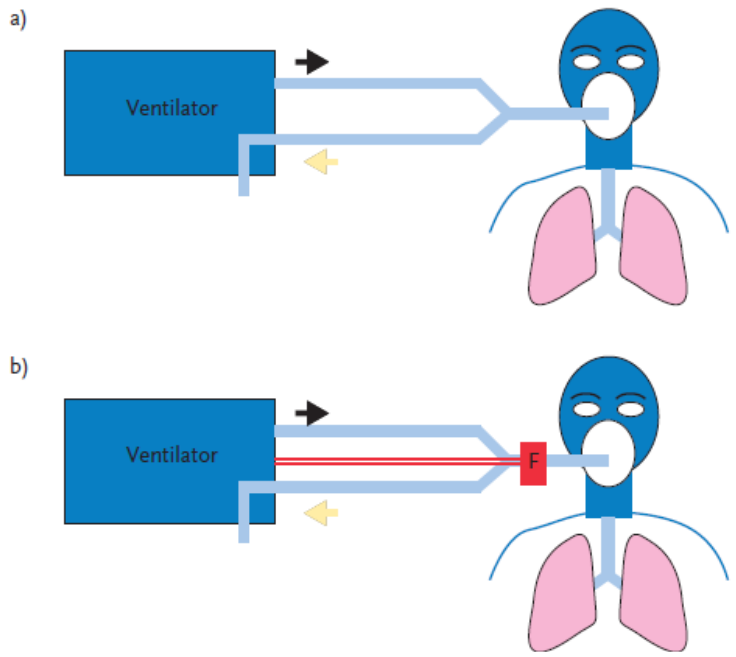
A. Connect the bacteria filter on the circuit to the inspiratory port.

B. Connect the proximal pressure line (wider diameter than active exhalation valve line) to the proximal pressure port.

C. Connect the active exhalation valve pressure line to the active exhalation valve line connection.

Circuit

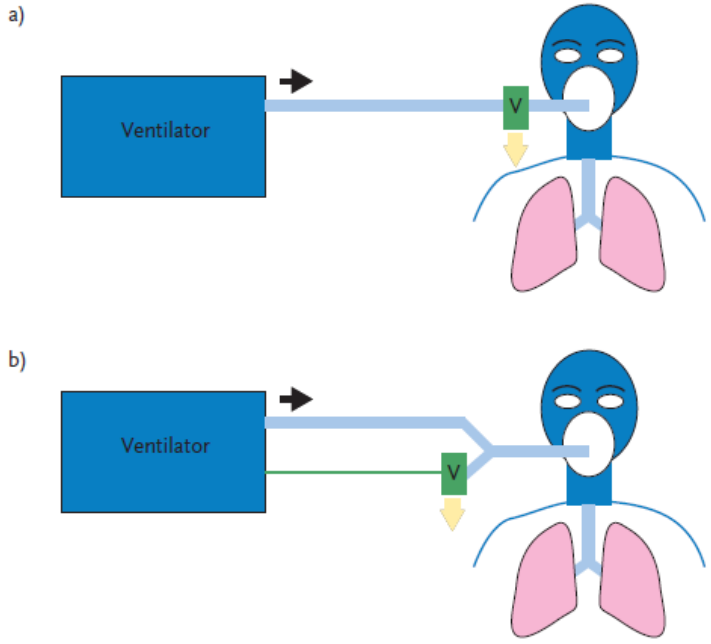
Dual limb circuit



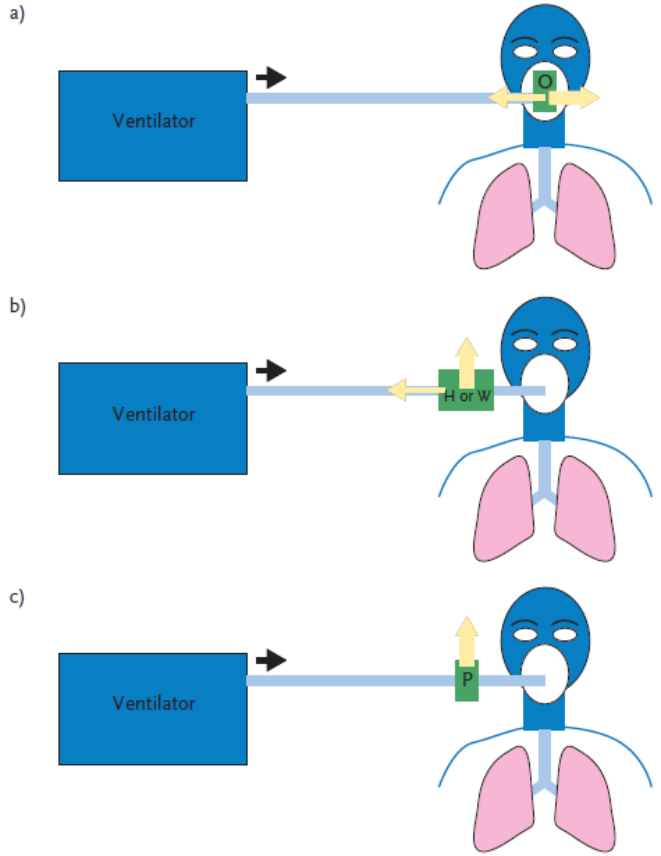
Single limb circuit

CO_2 rebreathing

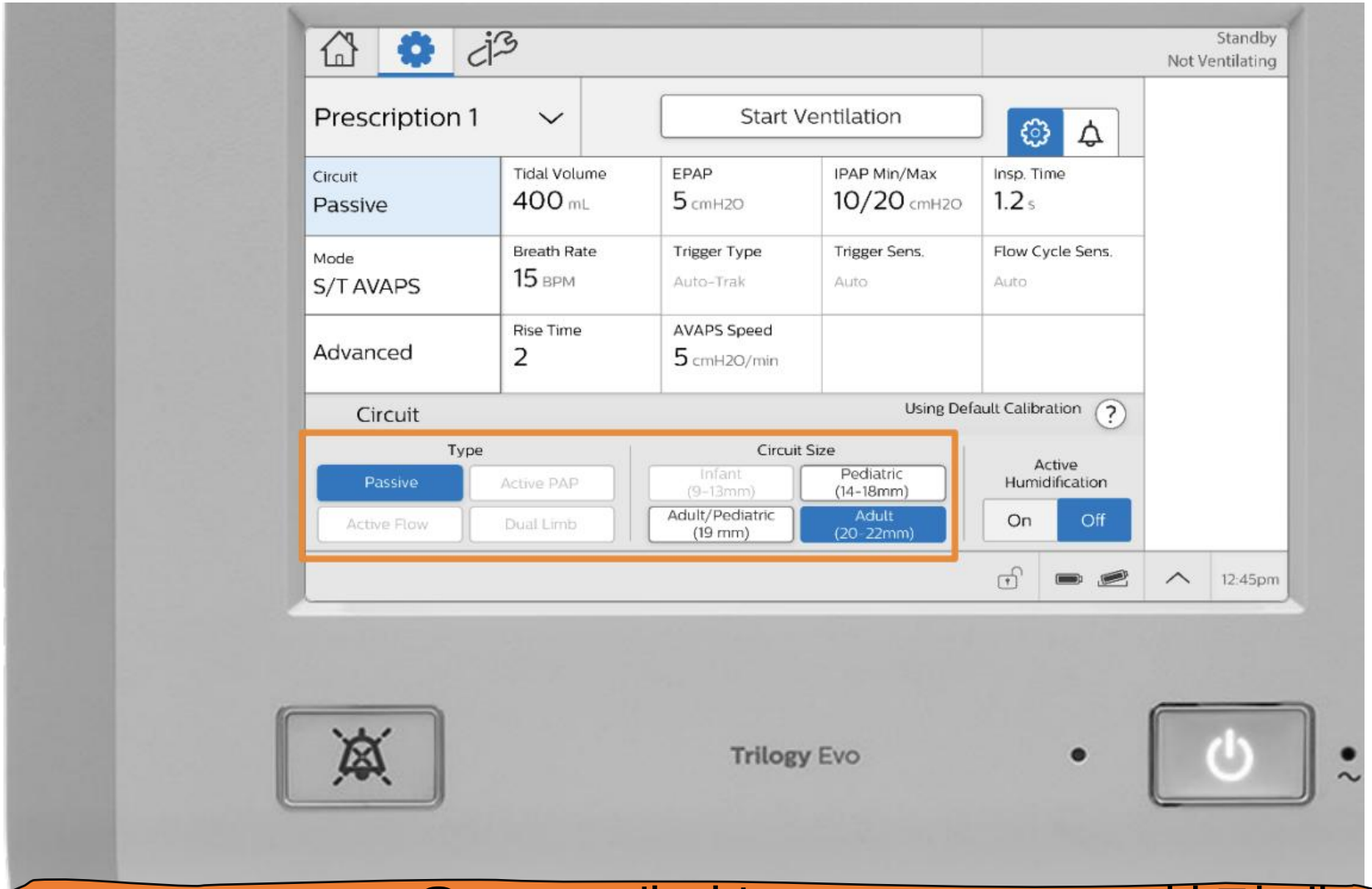
with a nonrebreathing expiratory valve (non-vented)



without a "true" non-rebreathing valve (vented)



Circuits

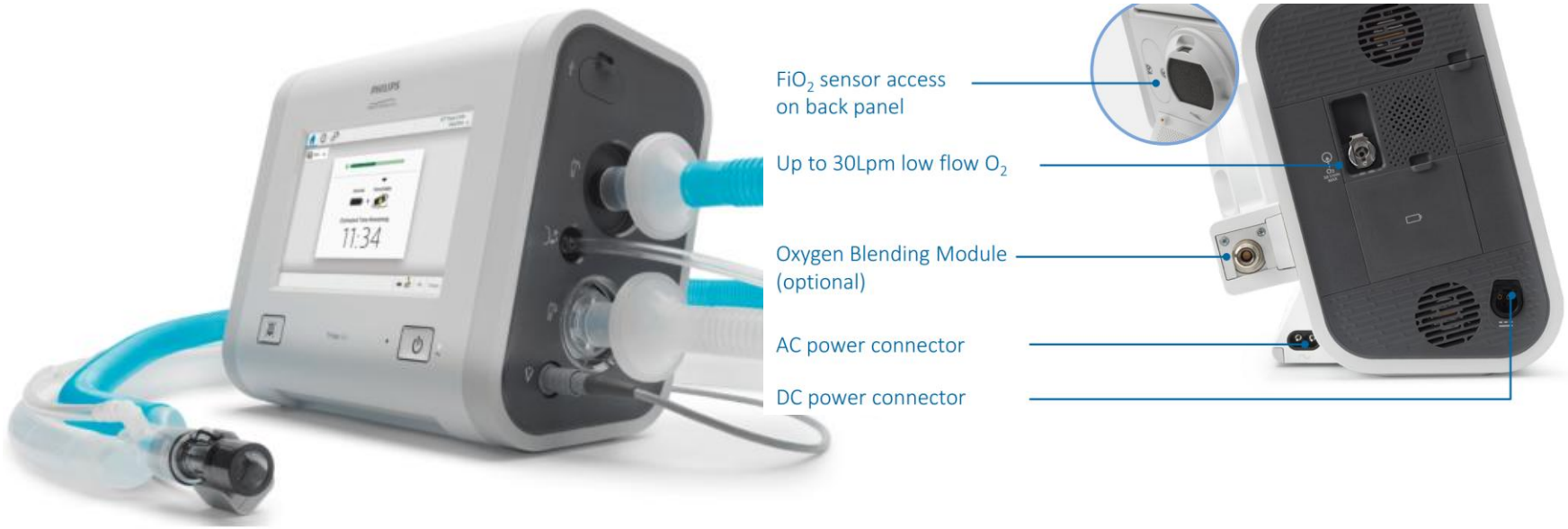


Circuit setting은 EVO에서는 Prescription 화면에서 진행을 한다.

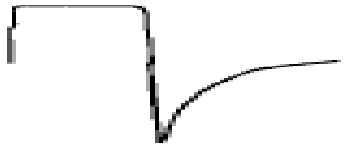
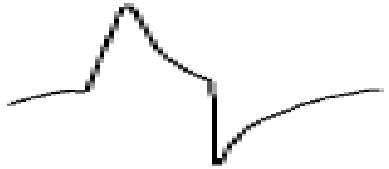
Philips home ventilation work shop slide

Ventilator setting

Mode
Inspiratory Pressure
Expiratory Pressure
Rate
Inspiratory Time
TiMin / TiMax
Trigger
Ramp = Rise time
Cycle
Alarm settings



Mandatory: Ventilator-initiated, time-cycled
Assist-Control: Patient-initiated, time-cycled
Spontaneous: Patient-initiated, patient-cycled

	Volume-targeted ventilation (VTV)	Pressure-targeted ventilation (PTV)
Pressure curve pattern		
Flow curve pattern		
Type of ventilator assistance delivered	Fixed volume in spite of changing resistance (R) and compliance (C)	Fixed pressure. Tidal volume may vary with changes in C and R
Controlled variable	Maintains a constant inspiratory preset flow	Maintains a constant inspiratory preset pressure
Breath-to-breath adjustments	**Not possible: ventilator delivers a fixed assistance**	**Possible: flow and volume can be varied in a breath-to-breath basis**
Possibility to guarantee a fixed delivered tidal volume	**Yes (if no leaks)**	**No**
Peak airway pressure	Not limited*	Limited (useful in patients at risk of barotrauma or gastric distension
Leak compensation	**Poor, leaks may significantly reduce delivered volume and induce hypoventilation**	**Good for mild to moderate leaks**

Thorax 2011;66:170e178.

Triggers

- Auto-Track
  - combination of multiple flow triggering algorithms
  - automatically set to synchronize
  - **passive circuits only**
- Sensitive Auto-Trak
  - more sensitive version of Auto-Trak
  - **passive circuits only**
- Flow trigger
  - initiates a breath when the patient's inspiratory effort creates a flow equal to or greater than the trigger sensitivity setting
  - **lower number is more sensitive**
  - passive, active PAP, active flow, or dual limb circuits
- Ventilator trigger
  - time-based, defined by the Breath Rate setting

Mode	Breath type	Trigger Source	Inspiration	Cycle	Exhalation
Control modes					
A/C-PC	Assist –Control	Patient	PEEP +Pressure control	Inspiratory time	PEEP
	Mandatory	Ventilator			
A/C-VC	Assist –Control	Patient	Tidal volume	Inspiratory time	PEEP
	Mandatory	Ventilator			
Spontaneous Modes					
CPAP	Spontaneous	Patient	CPAP	Patient	CPAP
PSV	Spontaneous	Patient	PEEP + Pressure control	Patient	PEEP
Mixed Modes					
S/T	Spontaneous	Patient	IPAP	Patient	EPAP
	Mandatory	Ventilator		Inspiratory time	
SIMV-PC	Spontaneous	Patient	PEEP + Pressure support	Patient	PEEP
	Assist-Control	Patient	PEEP + Pressure control	Inspiratory time	
	Mandatory	Ventilator			
SIMV-VC	Spontaneous	Patient	PEEP + Pressure support	Patient	PEEP
	Assist-Control	Patient	Tidal Volume	Inspiratory time	
	Mandatory	Ventilator			

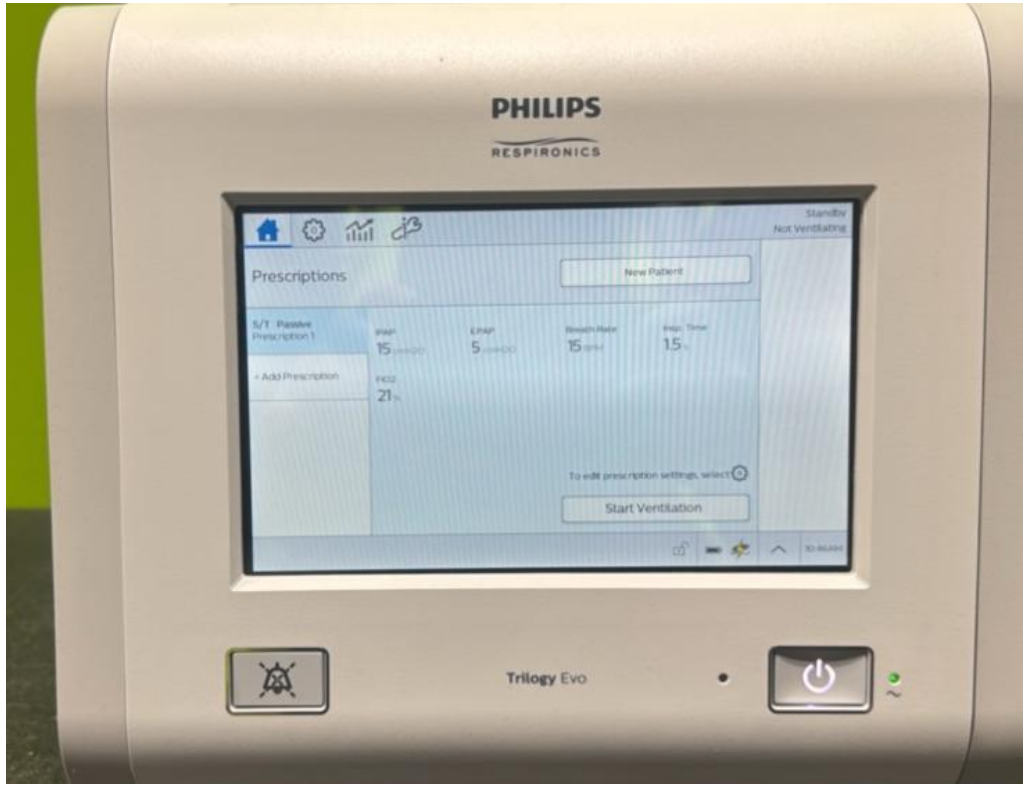
1. Pressure-targeted ventilators are the devices of choice for acute NIV (Grade B).

Good practice points

- Both pressure support (PS) and pressure control modes are effective.
- Only ventilators designed specifically to deliver NIV should be used

Pressure Targeted Ventilation Mode in Trilogy
CPAP
Pressure support (PSV)
Spontaneous/Timed(ST)
Timed(T)
Pressure Control(PC)
PC-SIMV

모르면 S/T 쓰면 된다....



BiPAP: EPAP/IPAP/PS

EPAP ≠PS

EPAP = PEEP

IPAP-EPAP = PS

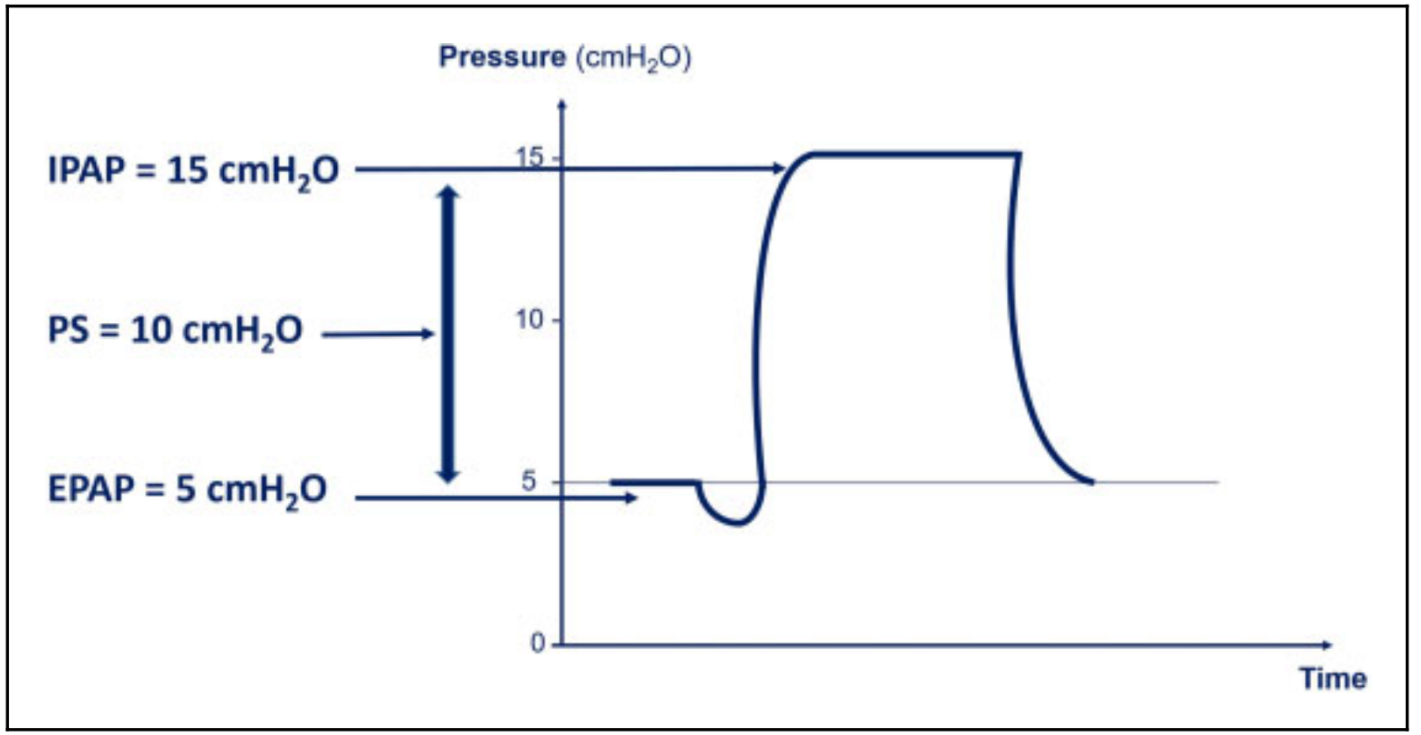
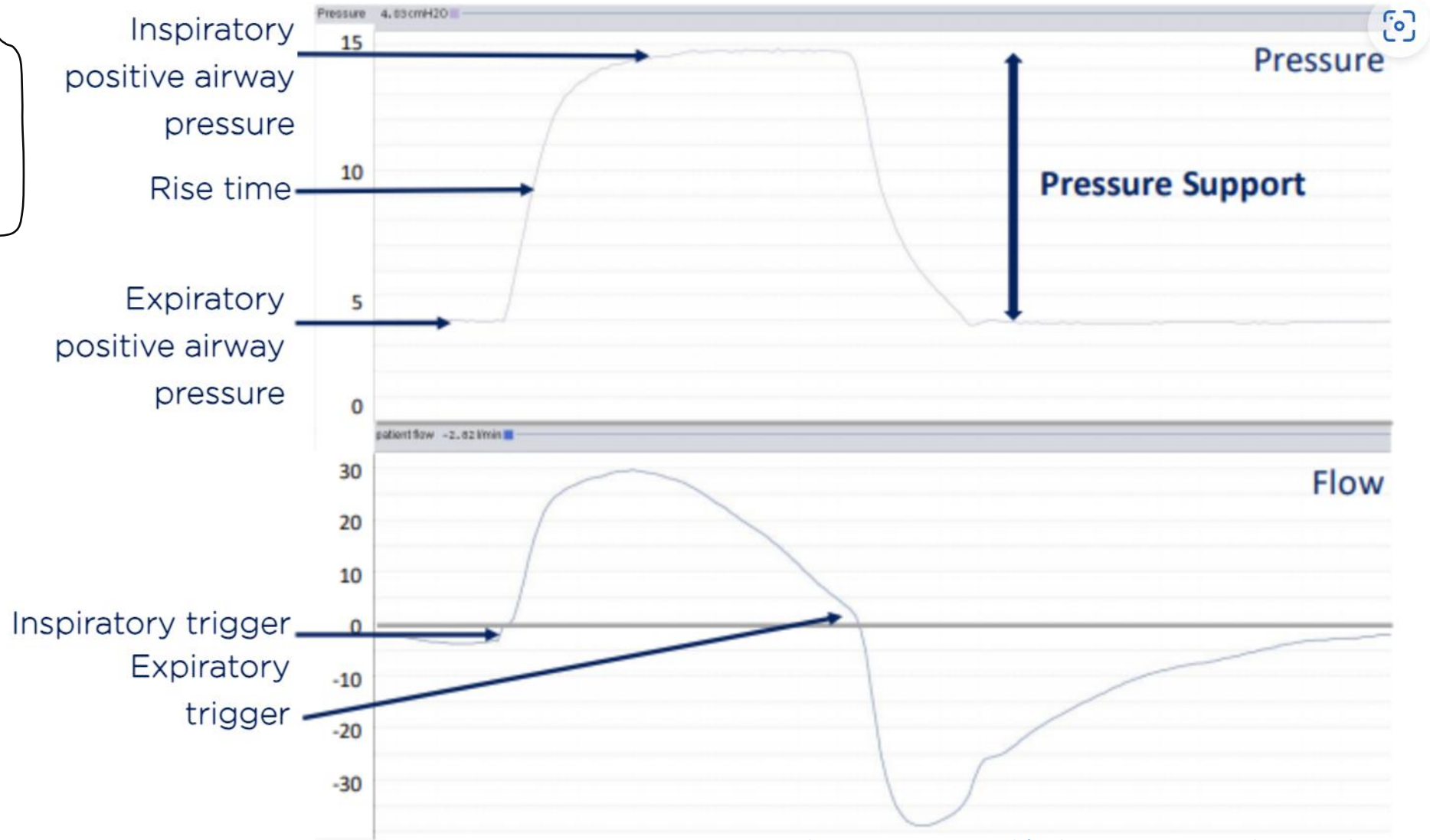


Figure 1. Confusion between inspiratory IPAP and PS settings. The initial drop in pressure before the pressure increase from EPAP to IPAP represents the patient's effort to trigger the mechanical breath. IPAP: inspiratory positive airway pressure; PS: pressure support; EPAP: expiratory positive airway pressure.

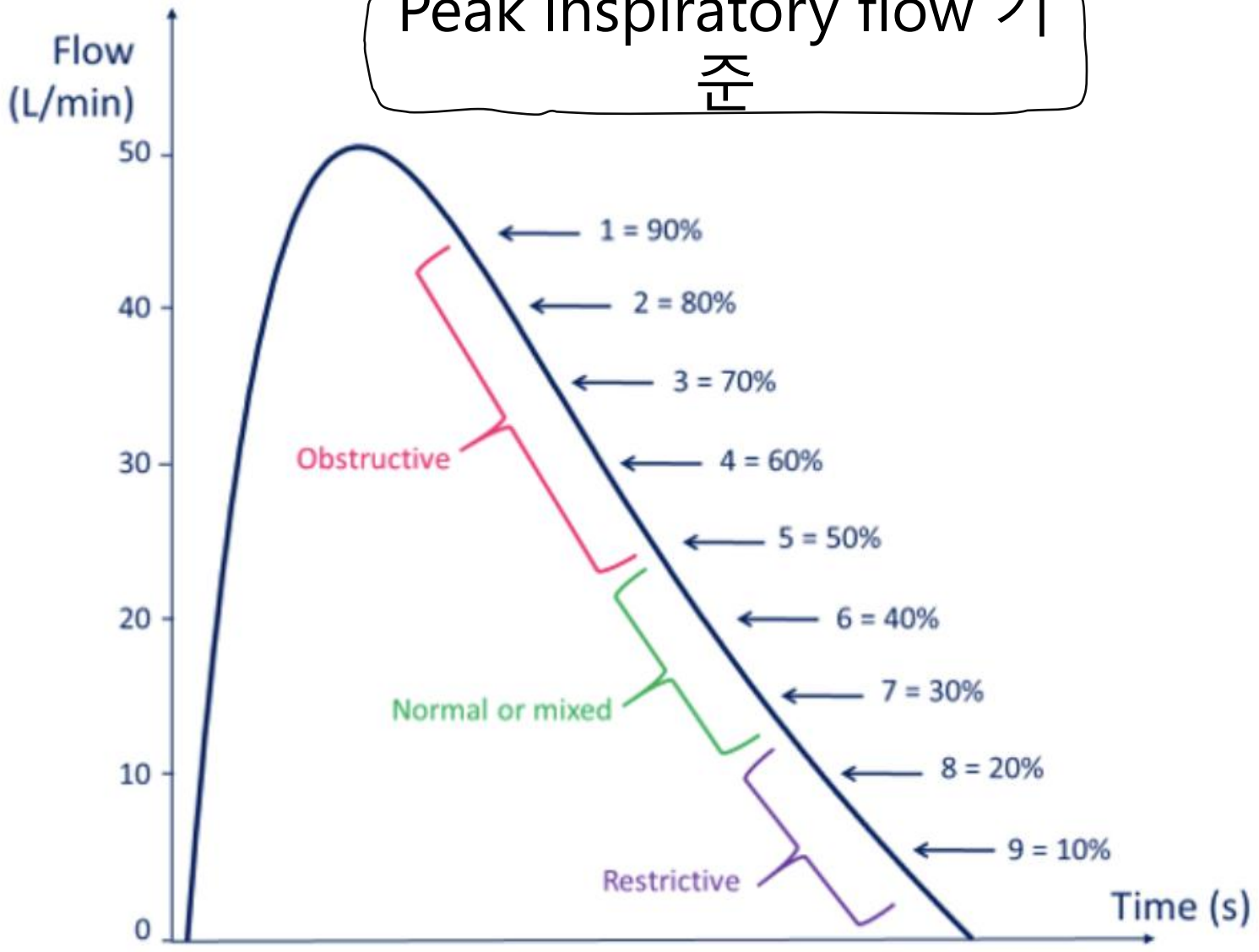
Basic Terminology

각각의 setting이 어떤 것을 조절하는지 알아야한다.



General initiation protocol for long-term NIV - Education by Breas

Peak inspiratory flow 기준

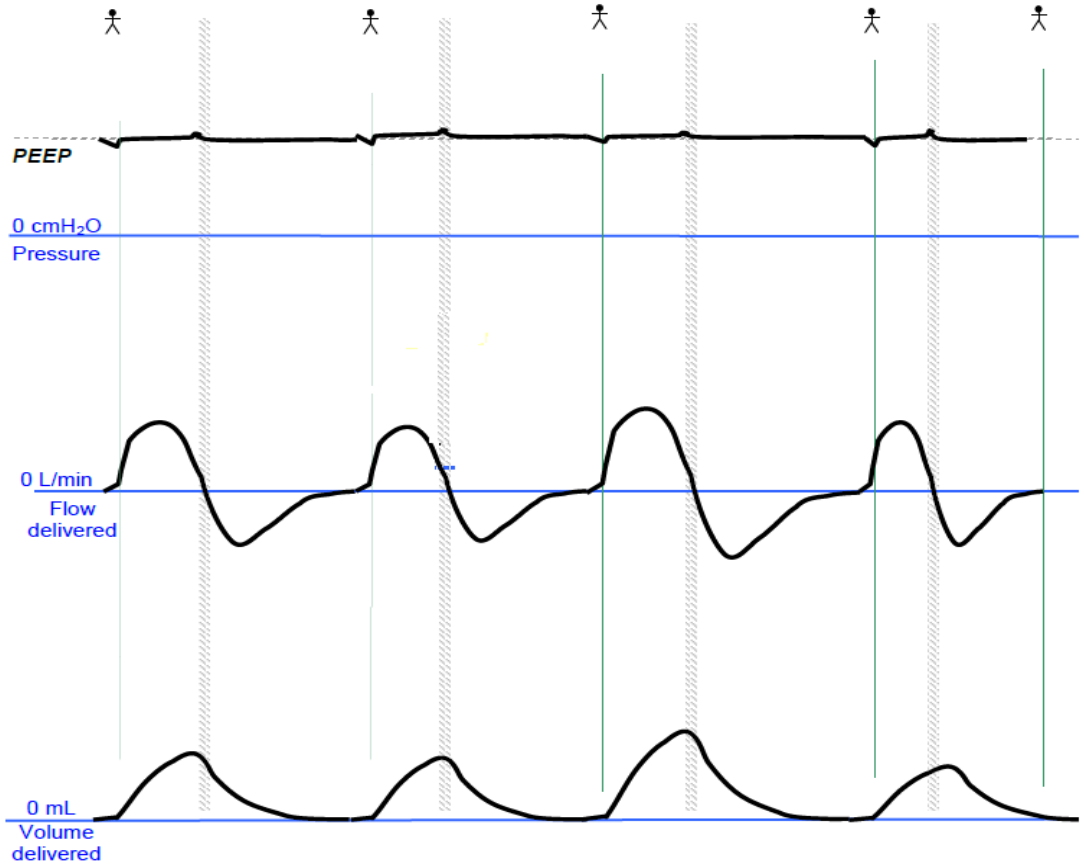


Flow Cycle Sensitivity

CPAP mode

- CPAP is a fixed positive pressure throughout the respiratory cycle.
- All breaths in this mode are spontaneous breaths.

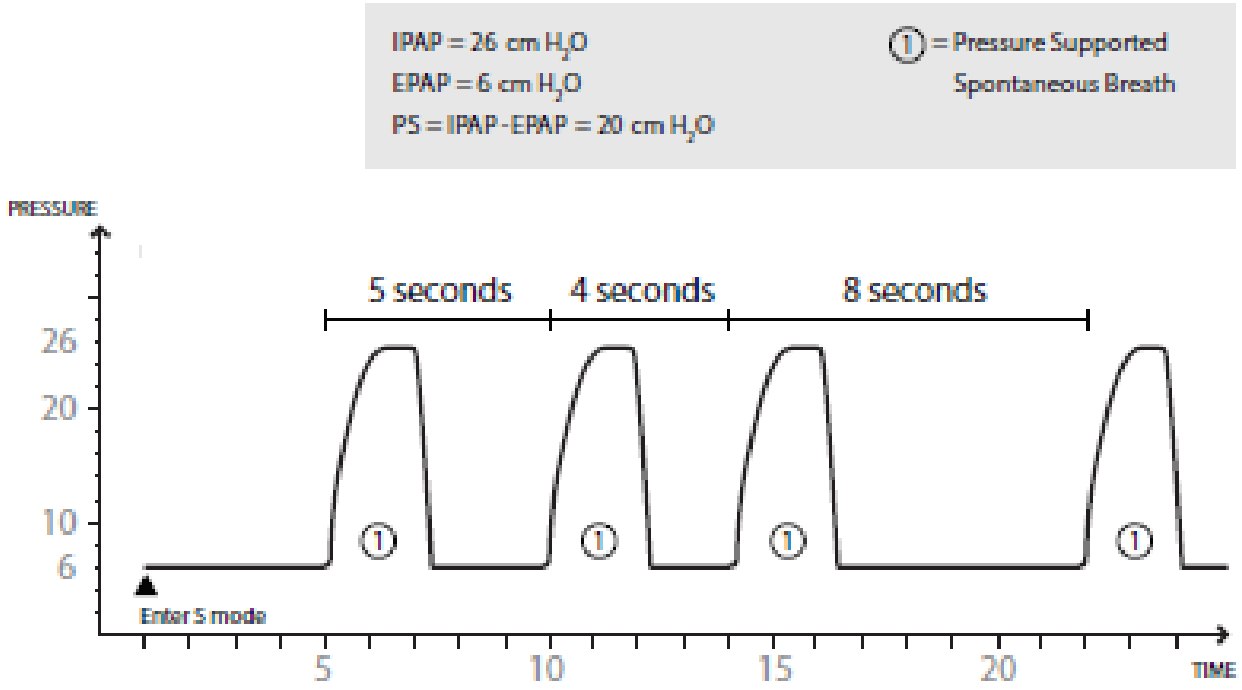
Setting	Description
CPAP	Continuous positive airway pressure range
Trigger Type	Auto-Track Sensitive Auto-Track Flow Trigger
Trigger Sensitivity	when the trigger type is Flow Trigger.



PSV mode

- PSV mode is patient-triggered, pressure-limited, and flow-cycled.
- All breaths in this mode are spontaneous breaths.

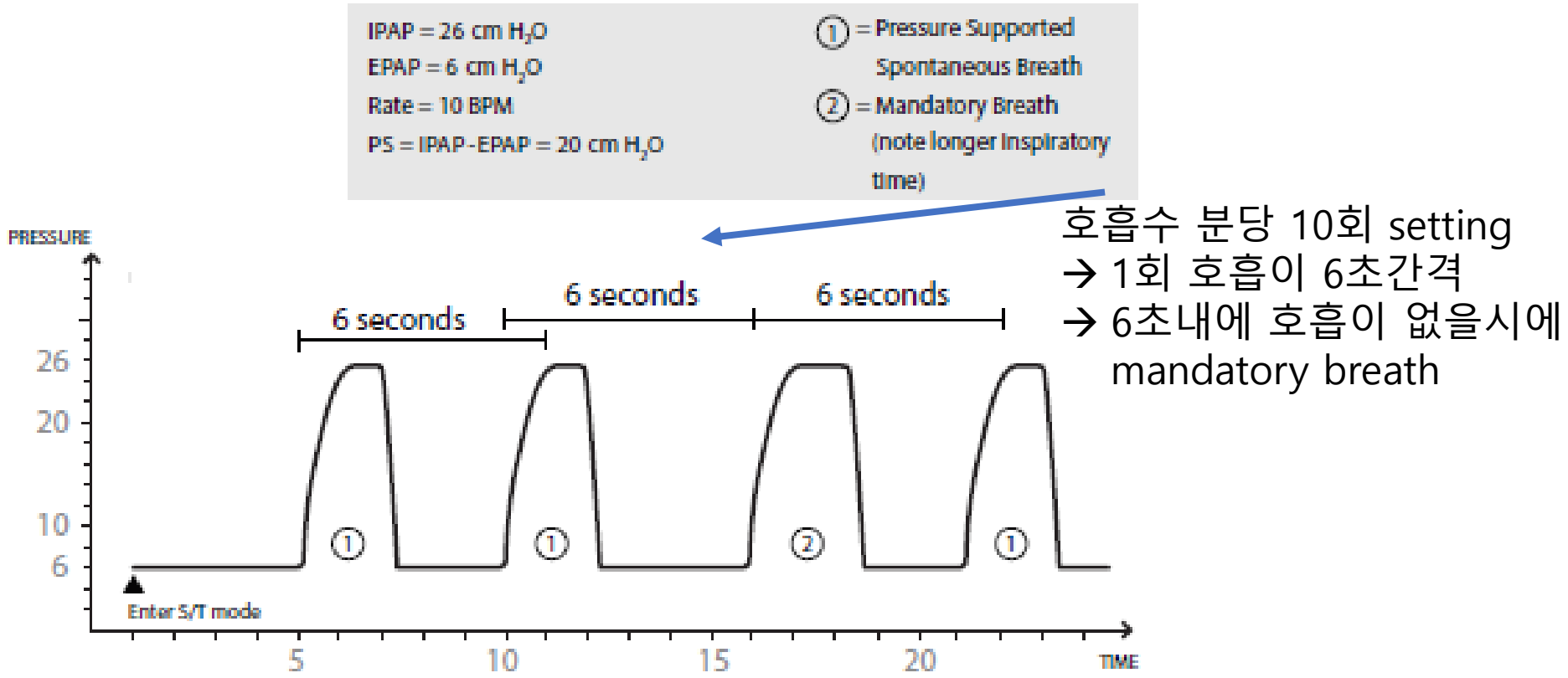
Setting	Description
Pressure Support	Continuous positive airway pressure range
PEEP	EPAP ≥4cmH2O
Rise Time	
Trigger Type	Auto-Track Sensitive Auto-Track Flow Trigger
Trigger Sensitivity	when the trigger type is Flow Trigger.
Flow Cycle Sensitivity	As flow begins to decrease during inspiration, if the patient flow is less than the flow cycle set point



Spontaneous/Timed(ST)

- patient-triggered and patient-cycled, or ventilator-triggered and ventilator-cycled.
- The duration of a spontaneous breath is determined by the patient effort. The duration of a mandatory breath is determined by the inspiratory time setting.

Setting
IPAP
EPAP
Rise Time
Breath Rate
Inspiratory time
Trigger type
Trigger Sensitivity
Flow Cycle Sensitivity

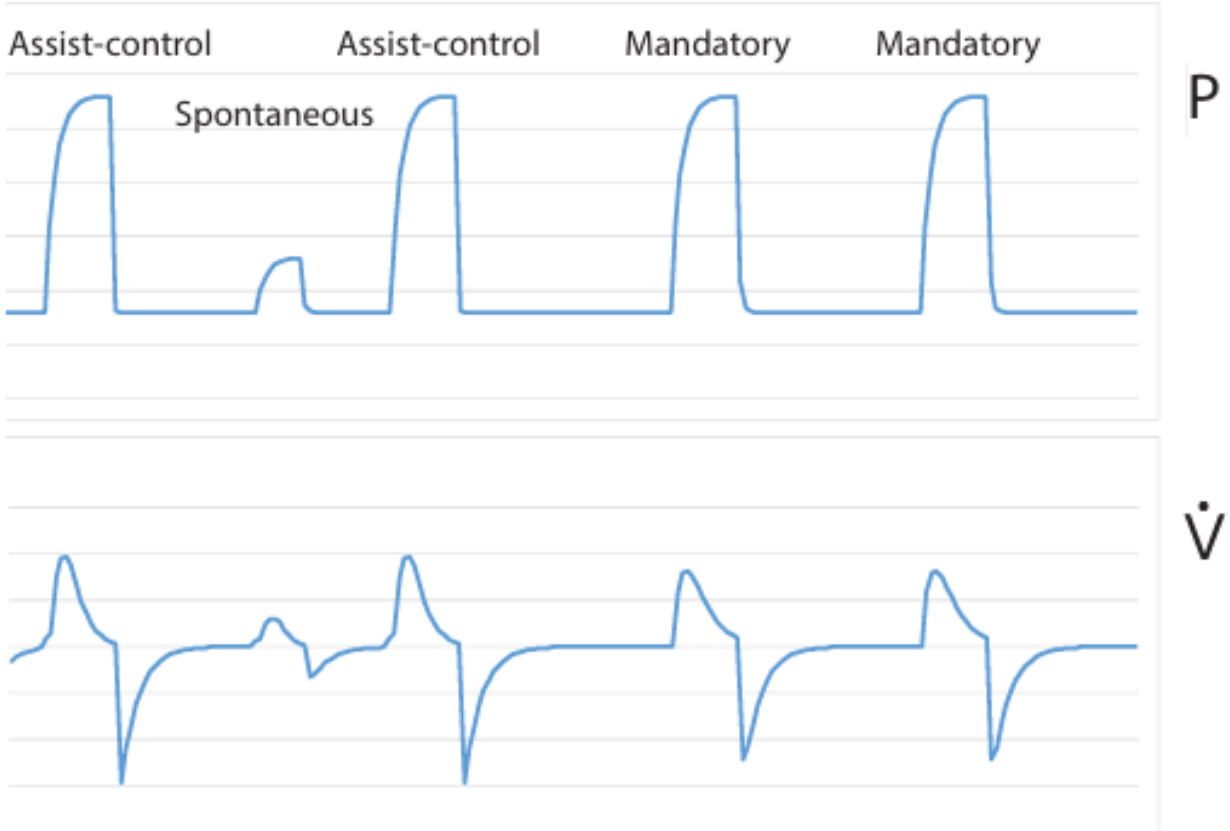


호흡수 분당 10회 setting
→ 1회 호흡이 6초간격
→ 6초내에 호흡이 없을시에 mandatory breath

SIMV-PC

- a mixture of mandatory, assist-control and spontaneous breaths.
- guarantees one mandatory breath in each cycle. Spontaneous breaths can be delivered with pressure support.

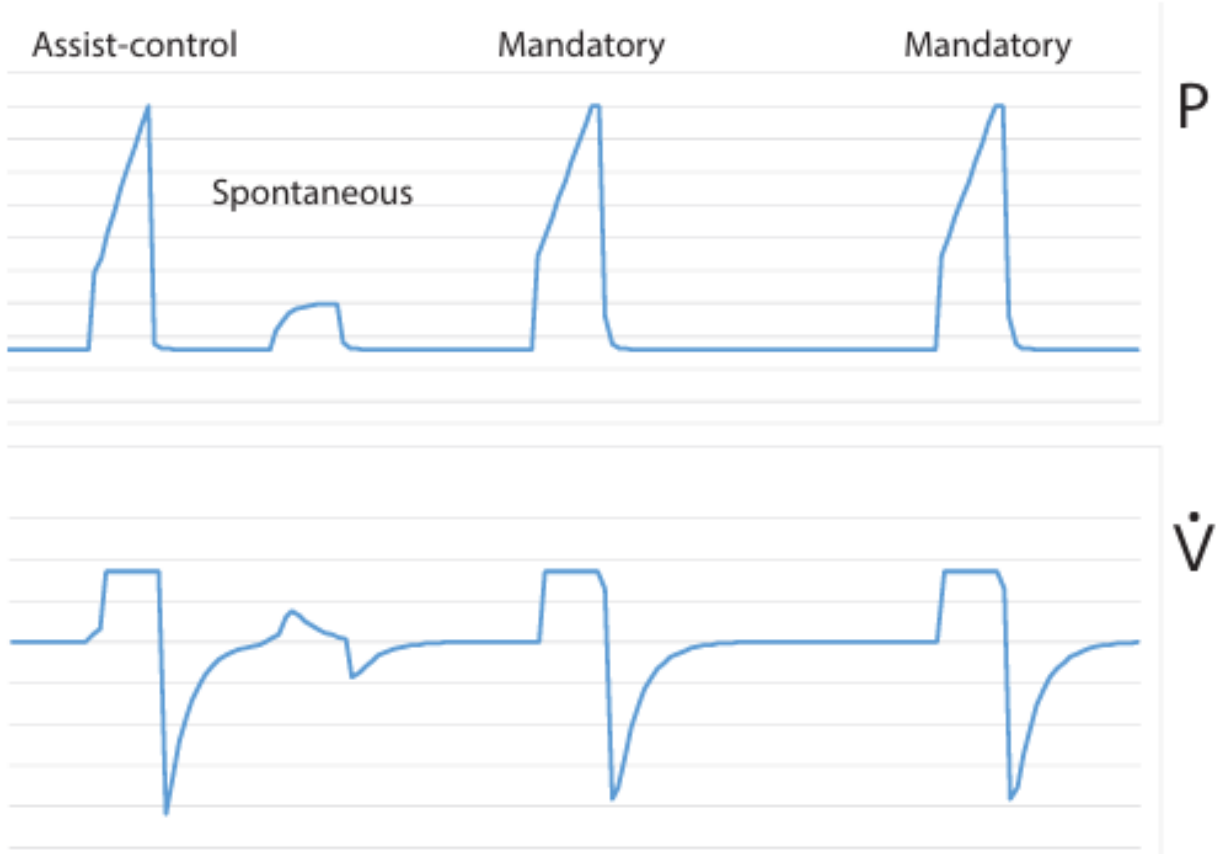
Setting
Pressure control
Pressure support
PEEP
Inspiratory time
Rise time
Breath rate
Trigger type
Trigger Sensitivity
Flow Cycle Sensitivity



SIMV-VC

- a mixture of mandatory, assist-control and spontaneous breaths.
- guarantees one mandatory breath in each cycle. Spontaneous breaths can be delivered with pressure support.

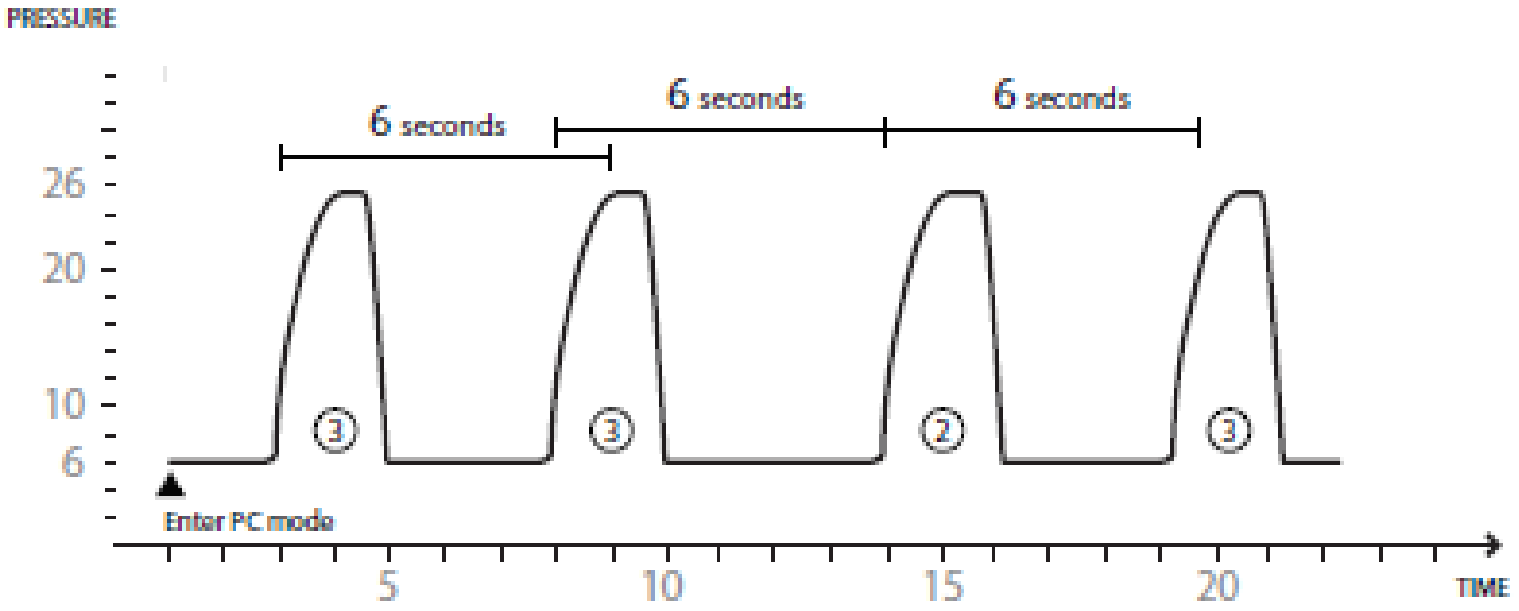
Setting
Tidal volume
Pressure support
PEEP
Inspiratory time
Rise time
Breath rate
Flow pattern
Trigger type
Trigger Sensitivity
Flow Cycle Sensitivity



Pressure Control(PC)

IPAP = 26 cm H_2O
EPAP = 6 cm H_2O
Rate = 10 BPM
PS = IPAP-EPAP = 20 cm H_2O

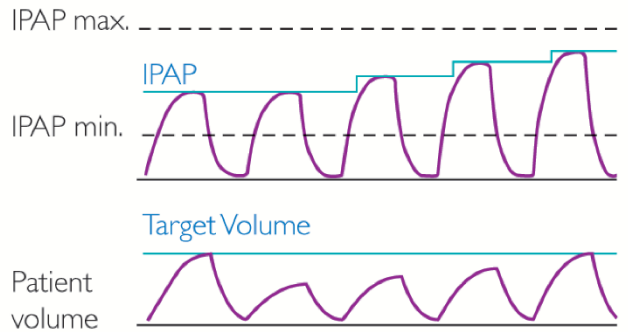
② = Mandatory Breath
③ = Assist Breath



Inspiration time(Ti) 설정을 제외하고는 ST모드와 동일

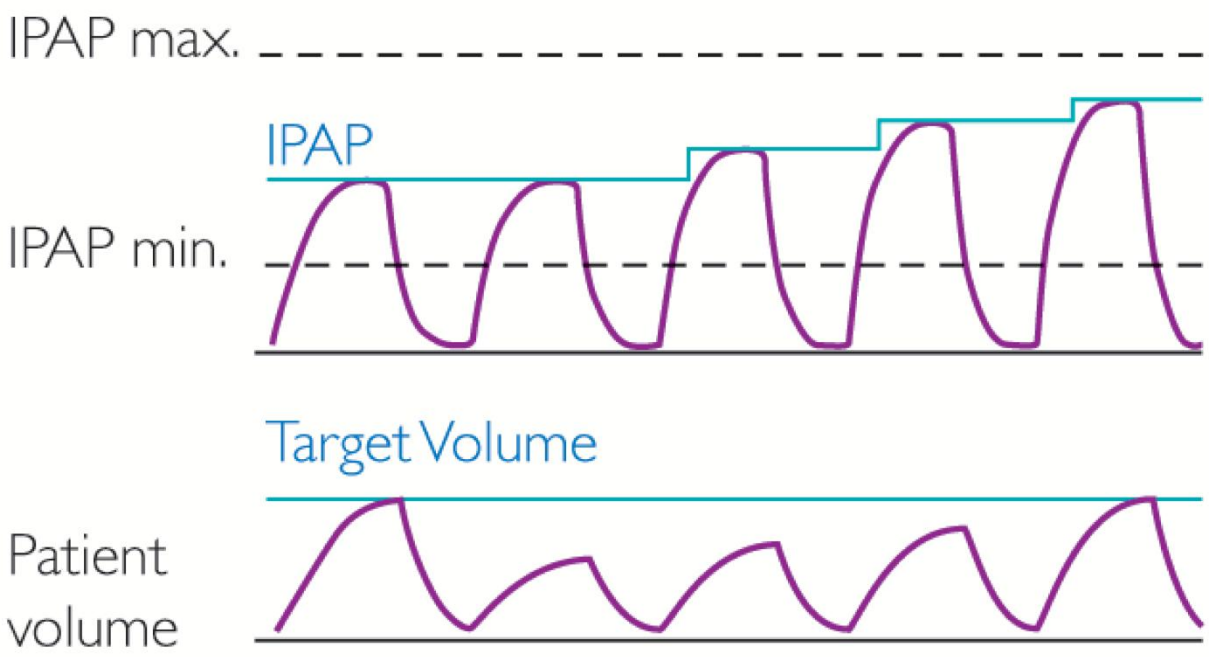
AVAPS (Average volume-assured pressure support)

- Automatically adapts pressure support to patient needs to guarantee an average tidal volume
- Function that can be activated within PSV, S/T, PC pressure modes.
- **Automatically titrates pressure support**
  - **Changes in body position**
  - **Sleep stage**
  - **Changes in respiratory mechanics**
- Delivers average tidal volume
  - Throughout course of the night
  - Long-term progression = protects/defends resting lung volume
- AVAPS produces results comparable to sleep lab titration of PSV
  - CO_2 reduction
  - Health-related quality of life
  - Sleep quality



Thorax. 2012 Aug;67(8):727-34

Initial IPAP $IPAP_{start} = Vt_{target} / 60 + EPAP$



- During the first minute, AVAPS does not change IPAP and blocks the low tidal volume alarm
- The average tidal volume is measured over a one -minute period
- AVAPS calculates the required IPAP change after each breath
- The maximum IPAP change is 1 cmH_2O/min for stable patients

AVAPS (Average volume-assured pressure support)

To turn on AVAPS, in the Prescription window, tap Mode. In the AVAPS section, tap On.

- Tidal volume
- IPAP minimum (S/T only)
- IPAP maximum (S/T only)
- PS minimum (PSV only)
- PS maximum (PSV only)
- PC minimum (A/C-PC only)
- PC maximum (A/C-PC only)
- AVAPS speed: 1-10 cm H2 O per minute, 1 cm H2 O per minute increment

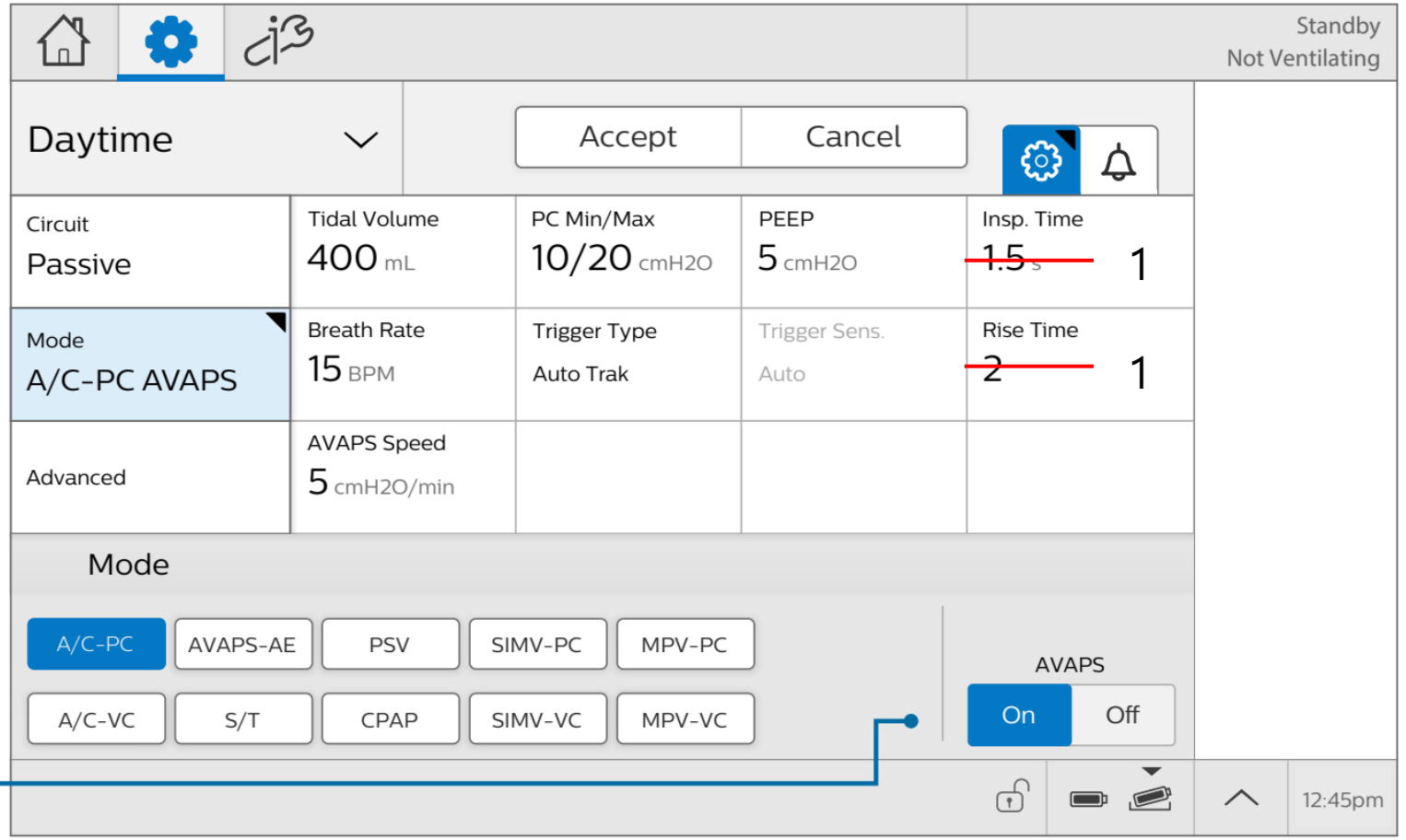
1. Set the target Tidal volume
→ 8ml/kg

2. Set IPAP Limits
→IPAP max = 20 to 50 cmH_2O
→IPAP min = EPAP + 4cmH_2O

3. Check patients arterial blood gases and Oxygen saturation

Prescription settings: mode

Rise time, insp. Time은 default 보다는 1로



Mode settings

Tap **Mode** to choose a therapy mode or to add **AVAPS**. An unsaved change indicator (◥) is visible until you tap **Accept** to save new values

AVAPS is available:

- A/C-PC
- PSV
- S/T

AVAPS setting:

- Tidal volume
- IPAP minimum (S/T only)
- IPAP maximum (S/T only)
- PS minimum (PSV only)
- PS maximum (PSV only)
- PC minimum (A/C-PC only)
- PC maximum (A/C-PC only)
- AVAPS speed

AVAPS-AE (only NIV)

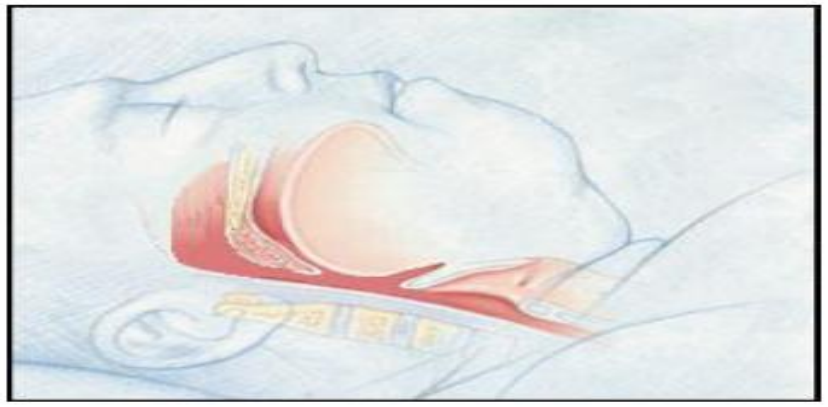
AVAPS-AE is an Auto-titration Mode of Noninvasive ventilation designed to better treat Respiratory Insufficiency patients (OHS, COPD and NMD) in the hospital and homecare environments

- Maintains targeted Tidal volume
- Auto EPAP: Maintains patent upper airway at comfortable pressure
- Auto backup rate
  - Applies an auto backup rate near a patient's resting rate

Which Patients Are Suitable For AVAPS?

- Obesity hypoventilation syndrome (OHS)
- Restrictive disorders (kyphosis or pulmonary fibrosis)
- Neuromuscular disorders and SDB
- Severe COPD with chronic respiratory failure

AVAPS is NOT recommended for patients with periodic breathing



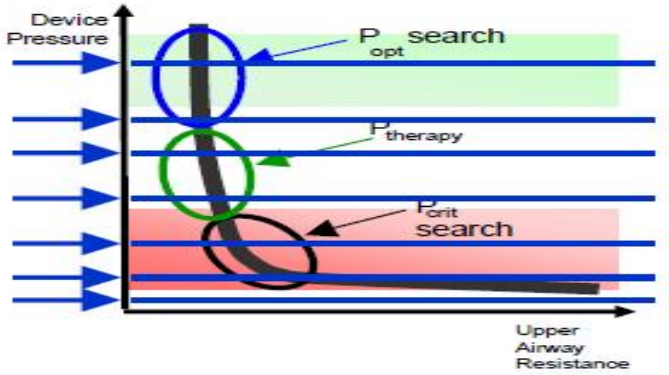
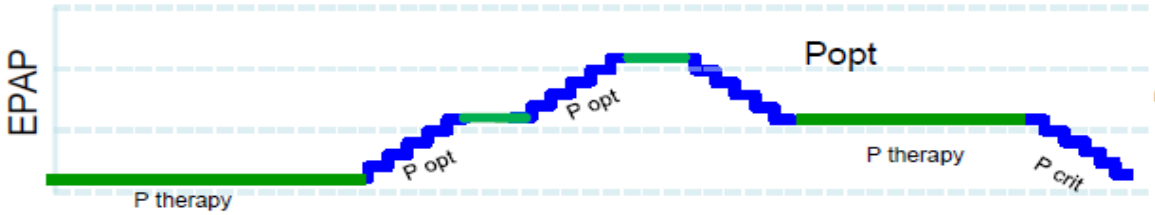
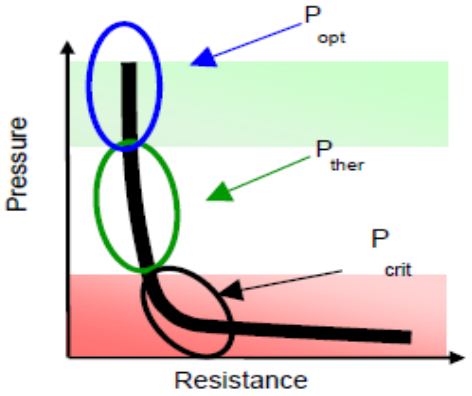


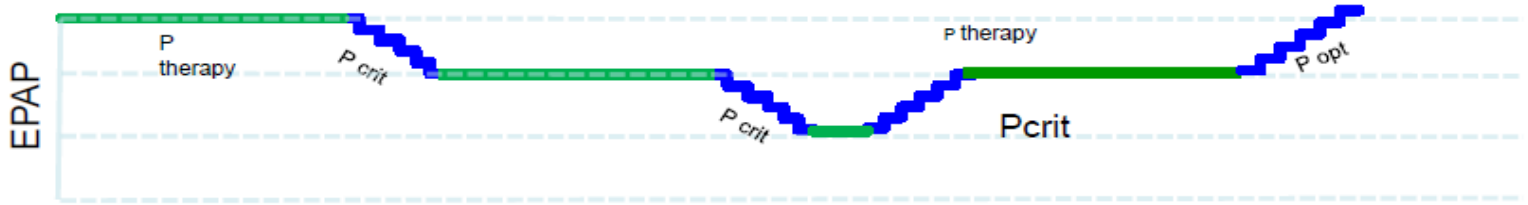
Illustration courtesy of Krames Medical Illustration.

Popt – Optimal Pressure Search (High Pressure Search)





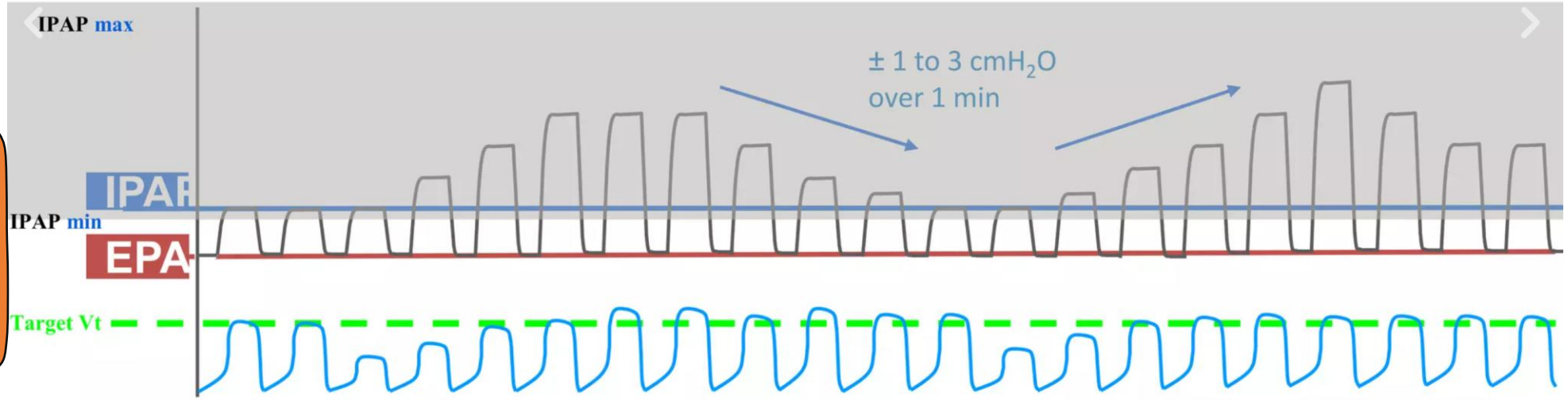
Critical Pressure Searches (Low Pressure Search)



AVAPS ≠ AVAPS-AE(Average Volume Assured Pressure Support - Auto EPAP)

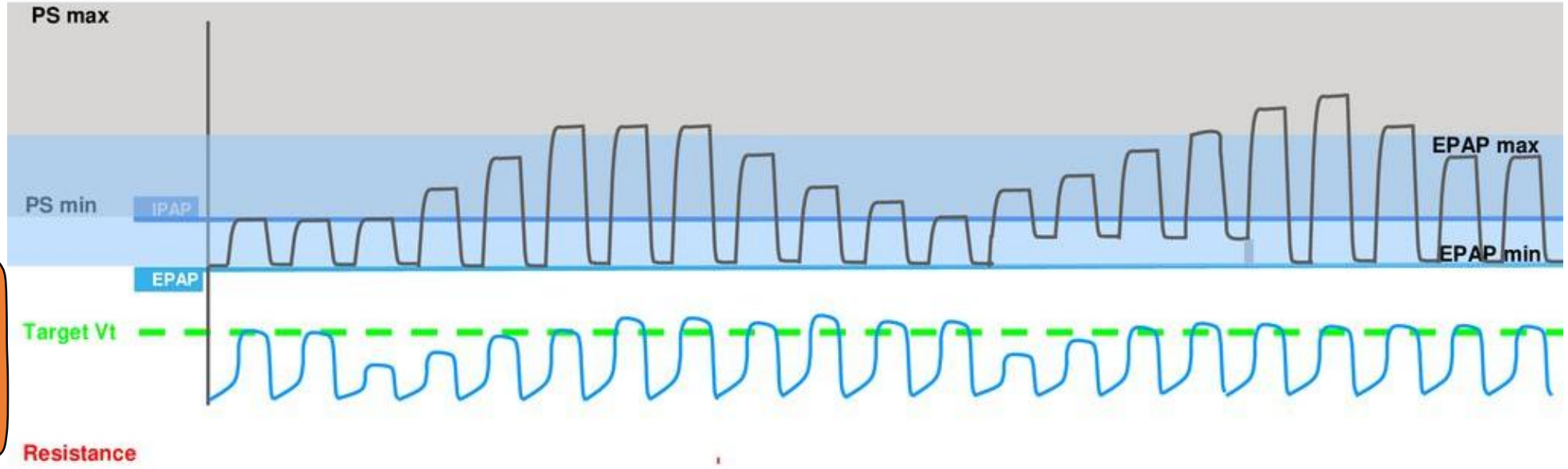
AVAPS

AVAPS는
EPAP 고정 tidal volume을 setting해주면서 IPAP 조절



AVAPS-AE

AVAPS-AE는
기존 AVAPS에 EPAP도 조절



Trilogy AVAPS-AE Settings Guide

AVAPS: Suggested tidal volume based on height and ideal weight.									
Height	**59”**	**61”**	**63”**	**65”**	**67”**	**69”**	**71”**	**73”**	**75”**
Ideal Weight	**52.0 Kg**	**55.5 Kg**	**59.0 Kg**	**62.5 Kg**	**66.5 Kg**	**70.5 Kg**	**74.5 Kg**	**78.5 Kg**	**83.0 Kg**
5 cc/kg Vt	260ml	280ml	300ml	310ml	330ml	350ml	370ml	39ml	420ml
6 cc/kg Vt	310ml	330ml	350ml	380ml	400ml	420ml	450ml	470ml	500ml
8 cc/kg Vt	420ml	440ml	470ml	500ml	530ml	560ml	600ml	630ml	660ml
10 cc/kg Vt	520ml	550ml	590ml	620ml	660ml	700ml	700ml	780ml	830ml

AVAPS-AE: Suggested settings.			
Diagnosis	**COPD with OSA**	**COPD without OSA**	**OHS**
Max Pressure	30	20	30
PS Max	16	15	22
PS Min	6	5	8
EPAP Max	14	5	15
EPAP Min	4	5	8
Breath Rate	Auto	Auto	Auto
AVAPS Rate	1	1	1
Target Vt	6-8ml/Kg	6-8ml/Kg	6-8ml/Kg

Microsoft Word - NJRA - AVAPS-AE Setting Guide.docx (squarespace.com)

Setting of AVAPS-AE during NIV

1. Start with tidal volume: → 8ml/kg
2. Max pressure : 30 cmH_2O
3. Pressure support max : 30 cmH_2O
4. Pressure support min : 12 cmH_2O
5. EPAP max: 14 cmH_2O
6. EPAP min: 4 cmH_2O
7. rate: Auto

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Thank you for attention !!!