Respiratory Care
Mechanical Ventilation

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Welcome from Respiratory Care

- The Respiratory Care Department operates on a modified decentralizing concept with highly credentialed & licensed Respiratory Practitioners
- Therapists are assigned to a specific unit that increases job performance, satisfaction and responsibility
- We pride ourselves on our practice and adhere to Credo behaviors
- We encourage interaction with medical staff for the betterment of the patient

- From the emergency room, the intensive care units, to the floor, our therapists are needed and encouraged to participate in all phases of the patients' care and education

- Patients requiring mechanical ventilation are maintained in areas where the scope of service permits, including an intensive care, step down, or palliative care unit.

- Vanderbilt’s Standard Operating Policy on Mechanical Ventilation
  - Only the following Members of the healthcare team may make parameter changes
    - Anesthesiologists; Critical Care Faculty; Critical Care Fellows; Pediatric / Neonatal Critical Care Advanced Nurse Practitioners; and Respiratory Care Practitioners (RCPs).

https://vanderbilt.policytech.com/dotNet/documents/?docid=10949

VANDERBILT UNIVERSITY
MEDICAL CENTER

Standard Operating Procedure

Mechanical Ventilation	Category	Clinical
	Effective Date	April 2017
	Approval Date	April 2017
	Supersedes	November 2012

Applicable to: ☒ Adult Enterprise ☒ Pediatric Enterprise ☐ Behavioral Health Enterprise ☐ VUMC
☒ Other: MD, house staff, APRN/PA, RN, Respiratory Care Practitioner

I. **Purpose:**

To provide guidelines for safe and optimal mechanical ventilation.

II. **Specific Information:**

A. Patients requiring mechanical ventilation are maintained in areas where the scope of service permits, including an intensive care, stepdown, or palliative care unit.

B. The following members of the healthcare team may make parameter changes to mechanical ventilators:

1. Anesthesiologists;
2. Critical Care Faculty;
3. Critical Care Fellows;
4. Pediatric/Neonatal Critical Care Advanced Practice Providers (APP); and
5. Respiratory Care Practitioners (RCP).

C. All parameter changes require a provider order or are made based on approved protocols.

D. See Appendix for procedural detail.

VIII. **References:**

VUMC Policy Manual. (2017). Retrieved from https://vanderbilt.policytech.com.

Clinical Policy Manual:
Clinical Practice Guidelines - Adult, Children, and Neonates
Transport of the Critically Ill Patient
Restraint/Seclusion Management [restraints]
Transferring and Transporting of Inpatients at Children's Hospital
Ventilator-Associated Pneumonia; Guidelines to Reduce – Pediatrics

Safety Policy Manual:
Electrical Equipment

Mosby Nursing Skills. (2017). Retrieved from
http://app44.webinservice.com/NursingSkills/Home.aspx
- Suctioning: Endotracheal and tracheostomy tube
- Endotracheal Tube: Skin and oral care

The Joint Commission, Comprehensive Accreditation and Certification Manual. (2017). Retrieved via Eskind Digital Library
http://library.vanderbilt.edu/biomedical/search.php?letter=j#tab-search-databases, then search Joint Commission.
Provision of Care, Treatment, and Services Standard PC.01.02.01
Leadership Standard LD.04.04.07

The Society for Healthcare Epidemiology of America, Strategies to Prevent Ventilator-Associated Pneumonia in Acute Care Hospitals. (2012). Retrieved from
http://www.jstor.org/stable/10.1086/593984

Key Points

- If you page a respiratory therapist with a concern and they tell you to make any kind of setting change at all

  DO NOT DO IT!!
- Therapists are available 24x7 and should make an appearance at the bedside when you call.

Key Points

- All parameter changes require a provider order or are made based on approved protocols.

- RN's may implement changes for oxygen concentration with a provider's order or when weaning based on pulse oximetry measurements.

Key Point - REMEMBER

If there appears to be a major issue, such as rapid oxygen saturation drops or a possible equipment error, disconnect the patient from the ventilator, **connect the resuscitator bag and provide manual breaths** until the respiratory therapist arrives to correct the situation.

Basic Ventilator Management

- Understanding your ventilator circuit
  - Inspiratory Side
  - Expiratory Side
  - Filtration
  - Humidification System
    - Can be a heated wire circuit
    - May have a heated humidifier
    - Common is a Heat Moister Exchanger (HME)

Basic Ventilator Settings

- Tidal Volume (VT)
  - Amount of inspiratory volume delivered per breath
- Respiratory Rate
  - Mandatory breaths per minute – regardless of patient effort
- Pressure Support
  - Augments inspiratory (VT) – Goal to reduce work of breathing
- Oxygen (O2) Concentration
  - Remember Room air is 21%
- Positive End Expiratory Pressure (PEEP)
- Patient Measured Pressures
  - Peak Inspiratory Effort

Oxygenation Management

- 1st – When indicated if the patient's O2 Saturation falls below 90% an O2 Breath Button – will give 100% for 2 Minutes
- Assess patient for signs/symptoms of distress – check circuit, check connection; are there any alarms?
- Think about airway maintenance:
  - Require suction? What are my pressures?
  - What are my breath sounds? Changed?

Ventilator Alarms

- Circuit Disconnect – troubleshoot
- High Peak Pressure
  - Increased mucus or coughing
  - Kink in circuit
  - Patient biting the ET tube
  - Clogged HMR
  - Change in patient condition –e.g. pneumothorax
    - Large Airway Problem
    - Compliance Problem

Ventilator Alarms

- Low Tidal Volume
  - Could there be a cuff leak?
  - Lose connection
  - ET Tube placement? Has it moved?
- High Rate
  - Patient agitation or fighting mode of ventilation
- Apnea
  - No spontaneous effort in CPAP/PS Mode

CONTROL MODES

- Volume Control
- Pressure Control
- Pressure Regulated Volume Control

SIMV = Synchronized Intermittent Mandatory Ventilation

- Where a regular series of breaths are scheduled but the ventilator senses patient effort and reschedules mandatory breaths based on the calculated need of the patient.
- This mode is used for patients that are moving toward Pressure Support/Continuous Positive Airway Pressure (PS/CPAP) Mode

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Volume Control

VOLUME CONTROL

- There is a set tidal volume
- There is a set respiratory rate
- There is a set PEEP
- There is a set FI02

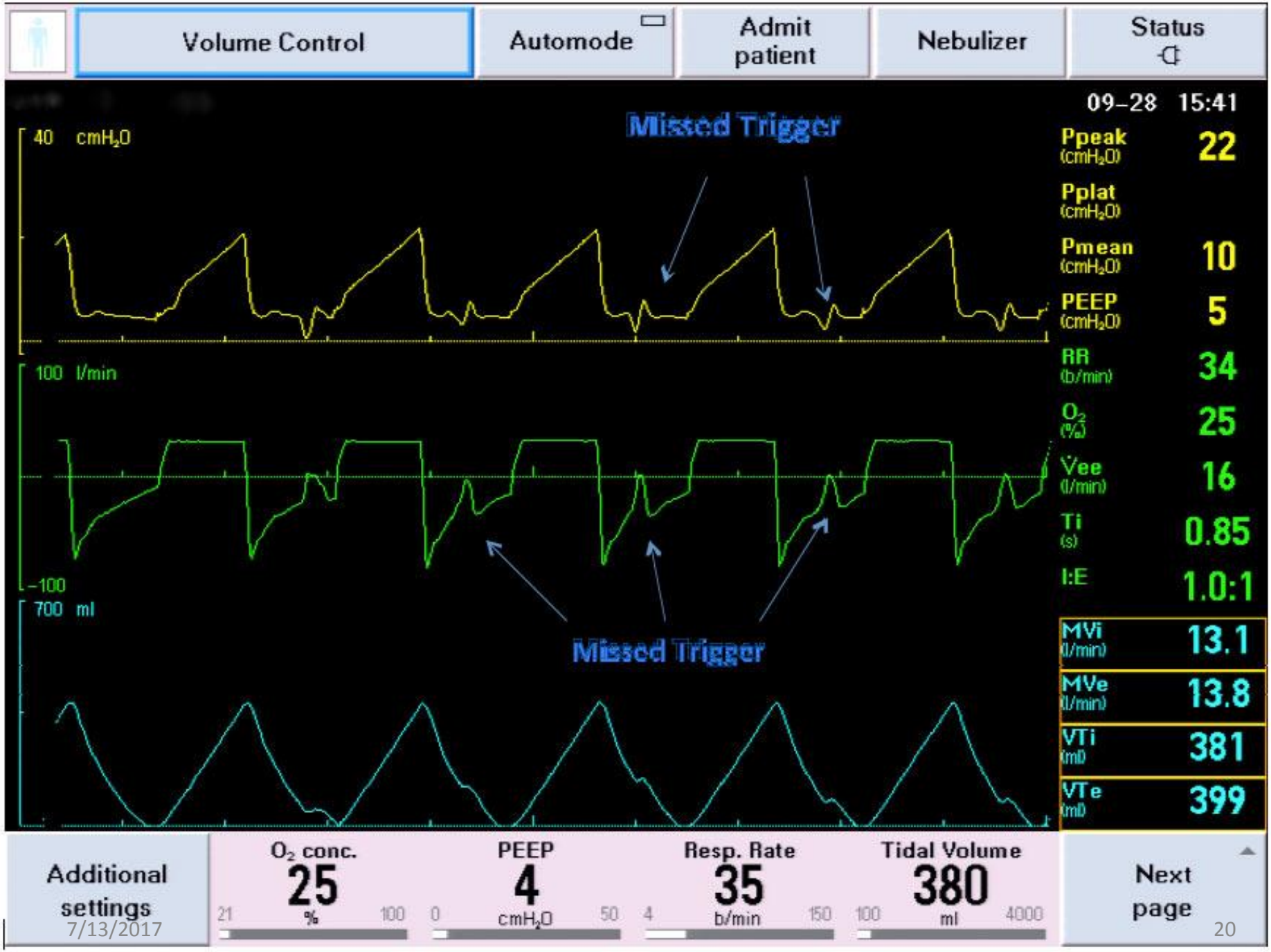
VOLUME CONTROL SAMPLE SETTINGS

Tidal Volume	500 ml
Resp. Rate	12 bpm
PEEP	5 c.m. H_2O
FI02	40 %

VOLUME CONTROL CONT.

In this mode the inspiratory pressure needed to deliver the set tidal volume is variable.

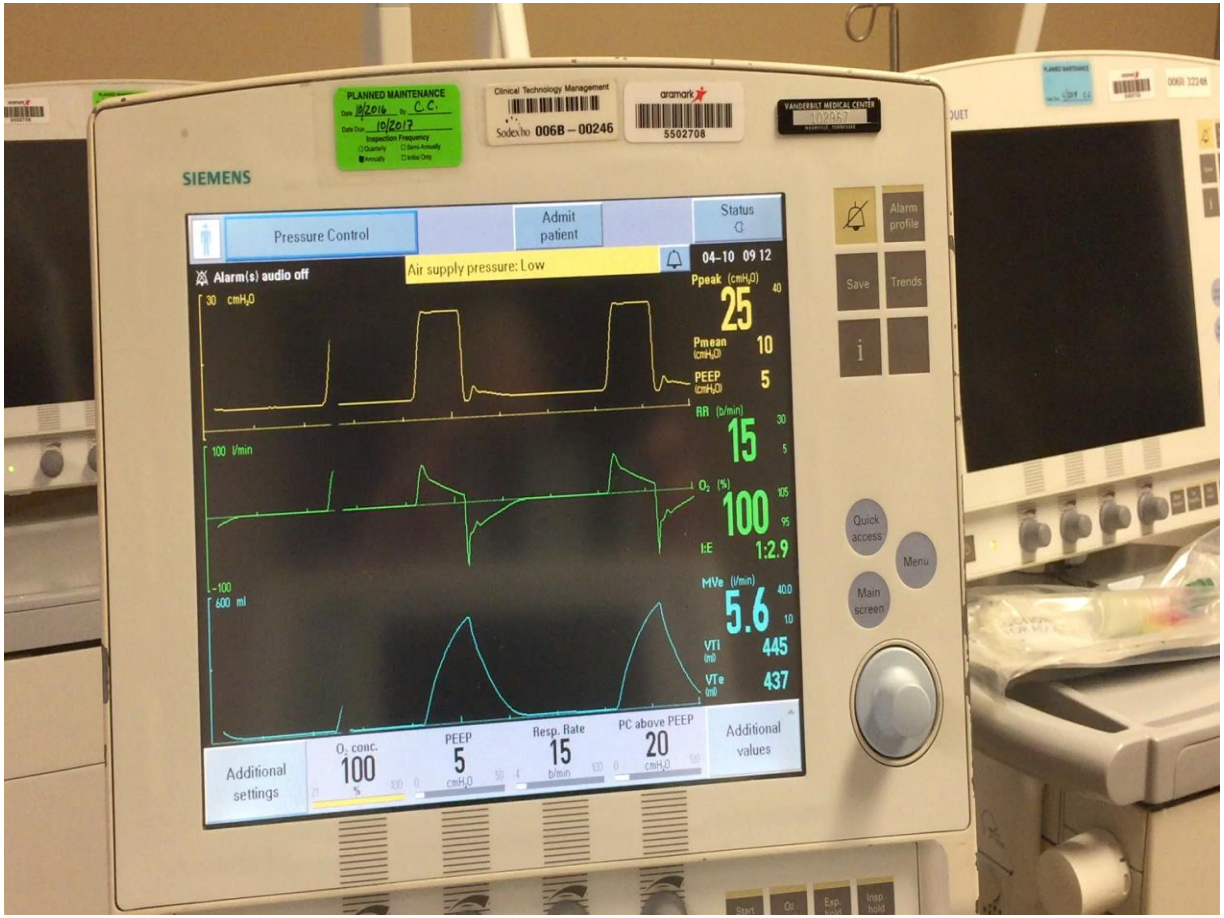
The patient can breath above the set rate, but every breath will be a controlled breath so the patient will receive 500 ml with each breath.


Volume Control
Automode
Admit patient
Nebulizer
Status
09–28 15:41
Missed Trigger
40 cmH2O
100 l/min
–100
700 ml
Missed Trigger
Ppeak (cmH2O) 22
Pplat (cmH2O)
Pmean (cmH2O) 10
PEEP (cmH2O) 5
RR (b/min) 34
O2 (%) 25
Vee (l/min) 16
Ti (s) 0.85
I:E 1.0:1
MVi (l/min) 13.1
MVe (l/min) 13.8
VTi (ml) 381
VTe (ml) 399
Additional settings
O2 conc. 25 % 21 100
PEEP 4 cmH2O 0 50
Resp. Rate 35 b/min 4 150
Tidal Volume 380 ml 100 4000
Next page

PRESSURE CONTROL

- There is a set inspiratory pressure
- There is a set respiratory rate
- There is a set PEEP
- There is a set FI02

Pressure Control



PRESSURE CONTROL SAMPLE SETTINGS

Pressure Control	20 c.m. H_20
Resp. Rate	12 bpm
PEEP	5 c.m. H_20
FI02	40 %

PRESSURE CONTROL CONT.

In this mode the inspiratory pressure will be constant and the tidal volume delivered will be variable based on lung compliance.

The patient can breath above the set rate, but every breath will be a controlled breath so the patient will receive 20 c.m. H_20 with each breath.

PRESSURE REGULATED VOLUME CONTROL

- There is a set tidal volume
- There is a set respiratory rate
- There is a set PEEP
- There is a set FI02

PRVC
(Pressure Regulated Volume Control)

PRESSURE REGULATED VOLUME CONTROL

- The machine measures how much tidal volume is being delivered to the patient. If the tidal volume is too low then the machine will increase the pressure control by 2 cm/ H_20 each breath - until the desired tidal volume is achieved.
- If the tidal volume is too high, it will decrease the pressure in the same manner.

PRESSURE REGULATED VOLUME CONTROL

The pressure will increase until either the targeted tidal volume is achieved or the pressure reaches a level of 5 cm/ H_20 below where the PIP alarm is set on the ventilator.

PRESSURE REGULATED VOLUME CONTROL CONT.

- The difference between this mode and volume control is that the first breath delivered, and only the first breath, is a volume controlled breath.
- The machine measures how much pressure it takes to achieve this tidal volume and then it uses this pressure to deliver pressure control breaths for the duration of this mode.

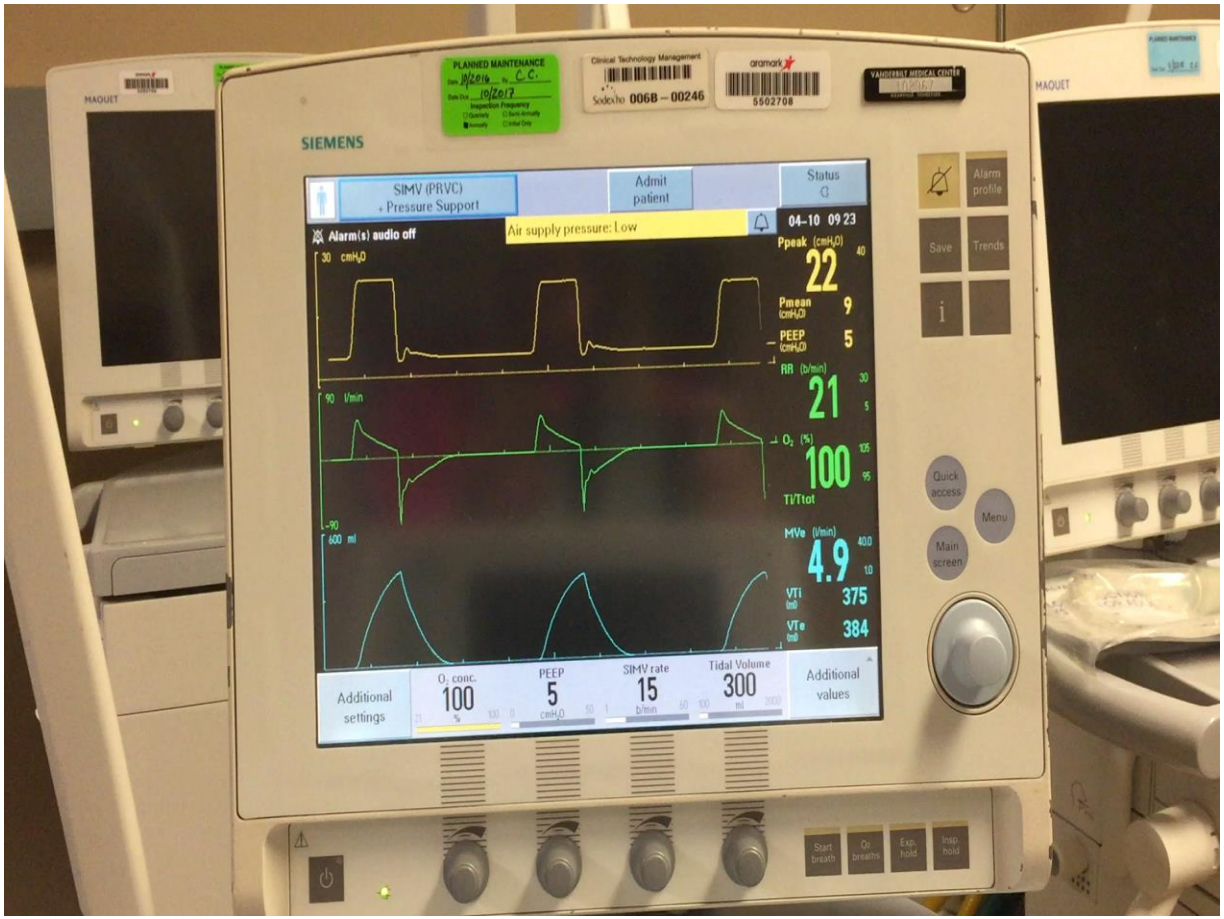
PRESSURE REGULATED VOLUME CONTROL SAMPLE SETTINGS

- Tidal Volume 500 c.m. H_20
- Resp. Rate 12 bpm
- PEEP 5 c.m. H_20
- FI02 40 %

PRESSURE REGULATED VOLUME CONTROL CONT.

The patient can breath above the set rate, but every breath will be a controlled breath so the patient will receive 500 ml with each breath.

SIMV PRVC + Pressure Support



SYNCRHONIZED INTERMITTENT MANDATORY VENTILATION

- AKA: SIMV
- Probably the most common mode of ventilation used at Vanderbilt.
- When the patient breaths above the set respiratory rate, instead of the breath being controlled it will now be “supportive”
- This mode is more commonly used for “weaning” the patient from the vent.

SIMV CONTINUED

Basically there will be two types of breaths being delivered:

- Controlled breaths
- Pressure Supported breaths

SIMV CONTINUED

The controlled breaths can either be Pressure Control, Volume Control, or Pressure Regulated Volume Control

So you will commonly here the mode as:

- SIMV Volume Control
- SIMV Pressure Control
- SIMV PRVC

SIMV CONTINUED

If you have a set respiratory rate of 12 and the patient is breathing 16 times a minute, 12 breaths will be controlled and 4 will be pressure supported breaths.

SIMV CONTINUED

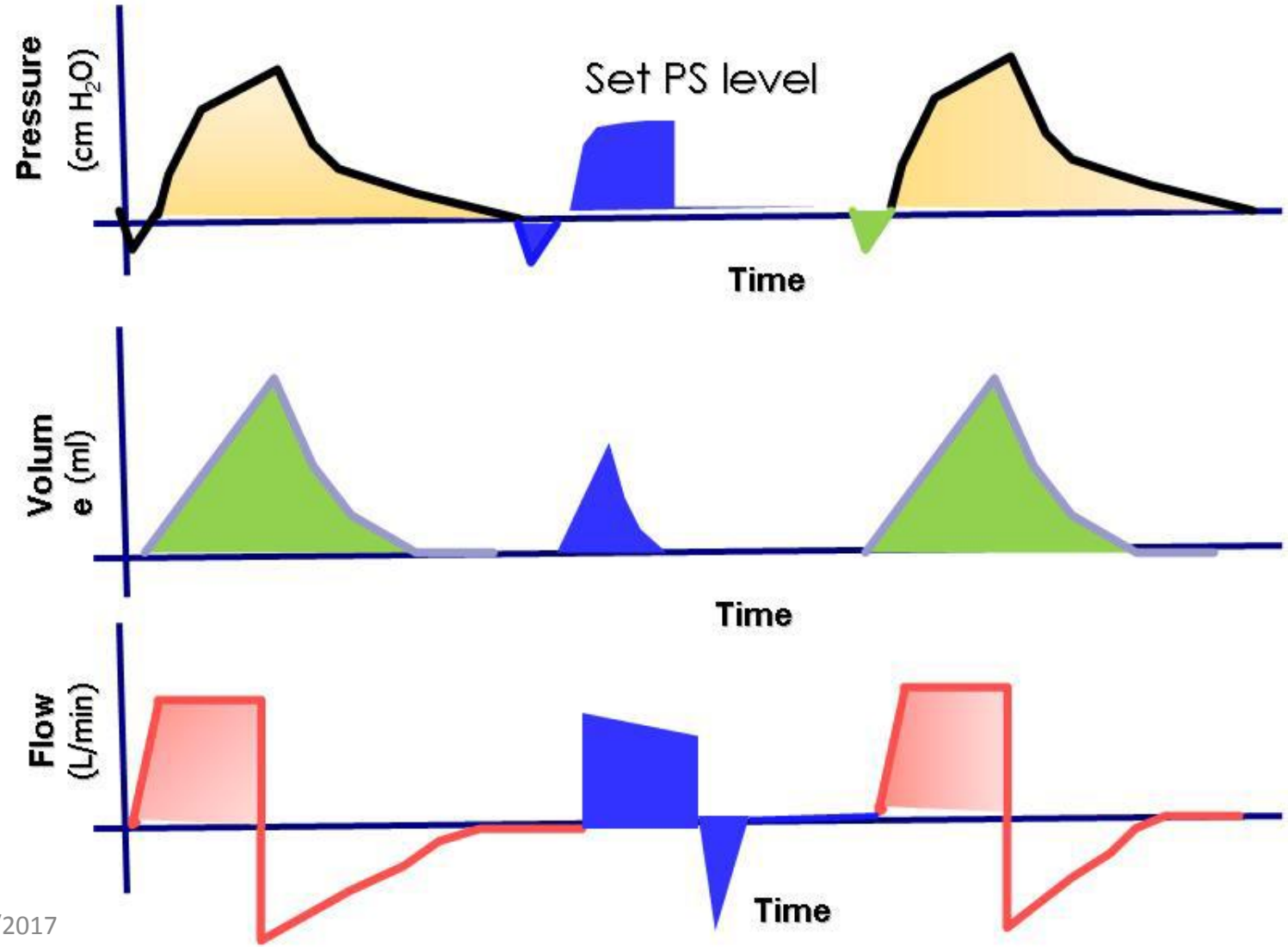
Pressure Support is a setting on the ventilator. It is a pressure setting and just helps the patient with their work of breathing on their spontaneous breaths.

As the patient becomes stronger, less and less support will be needed.

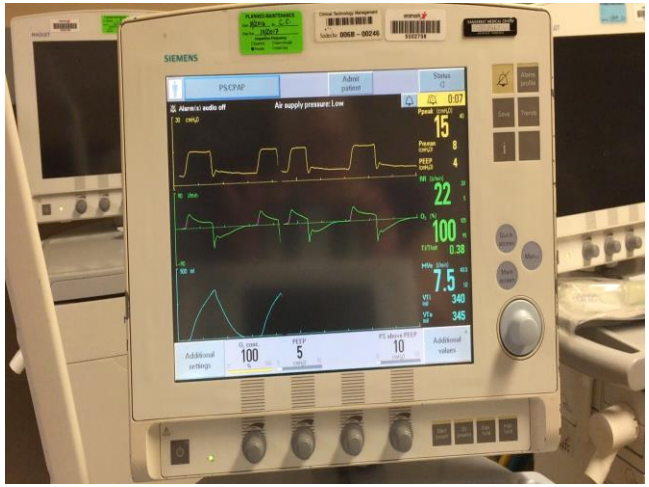
SIMV SAMPLE SETTINGS

Tidal Volume	500 c.m. H_20
Resp. Rate	12 bpm
PEEP	5 c.m. H_20
FI02	40 %
Pressure Support	10 c.m. H_2o

SIMV+ PS
(Volume-Targeted Ventilation)



PSV
Pressure Support Ventilation



Pressure Support

- Spontaneous mode of ventilation
- Patient MUST be breathing!
- PS level adjusted to achieve desired tidal volume

AIRWAY PRESSURE RELEASE VENTILATION

- APRV
  - Open lung strategy
  - Improves oxygenation
  - Counteracts pulmonary edema
  - AKA: BiVent or BiLevel
  - Thought of as a reverse I:E mode of ventilation but is more like interrupted CPAP.

INVERSE RATIO VENTILATION

- Normal I:E ratio is typically 1:2
- Reverse I:E ventilation can have the I:E ratio 2:1 or greater

AIRWAY PRESSURE RELEASE VENTILATION

- As its name suggests a release valve was designed that allows the patient to be able to take a spontaneous breath during the elongated inspiratory hold. This helps eliminate many of the risks of IRV to include the use of paralytics.
- This changes this from a traditional IRV to more of what would be considered an interrupted CPAP

TERMINOLOGY

- P HIGH
  - Inspiratory pressure-the amount of pressure that the vent will deliver during the inspiratory phase. peak inspiratory pressure will be the same as p high plus peep if peep is added
  - This is adjusted to get desired tidal volumes from the patient

- PEEP
  - Positive end expiratory pressure
  - Usually no peep is set in bi vent, we allow the patient to create their own autopeep
- T High
  - Inspiratory time
  - Normally set between 3 -4 seconds
- T Low
  - Expiratory time
  - Set low enough to create an adequate autopeep around .5 to 1 second