SPECIALIZED VENTILATION STRATEGIES
DALHOUSIE SHS

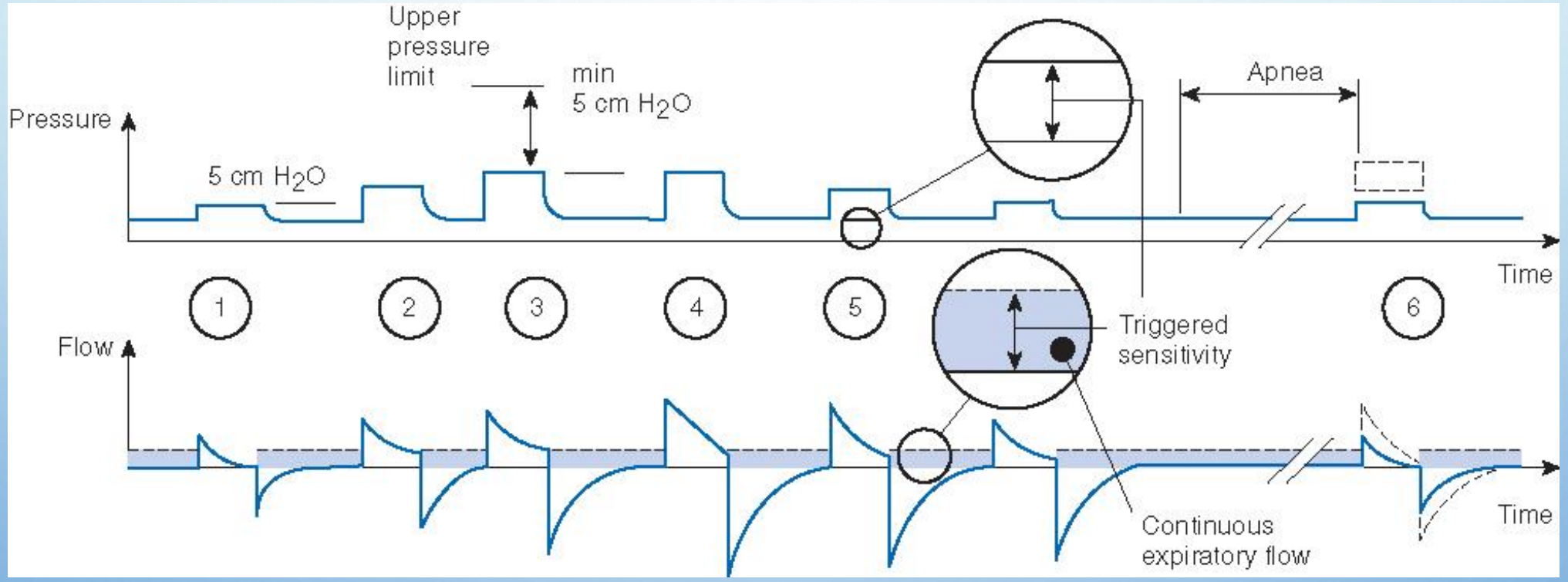
LEARNING OBJECTIVES

1. Discuss Volume Support, Automode, Average Volume-Assured Pressure Support and Proportional Assist Ventilation.
2. Discuss the benefits and disadvantages of airway pressure-release ventilation (APRV).
3. Provide examples of how the Edi waveform can be of value in monitoring patients who are critically ill.
4. Discuss the various factors that can cause a low Edi signal and a high Edi signal.
5. Describe the safety back-up features and alarms available with NAVA.
6. Name the pulmonary pathologic conditions in which heliox therapy may be beneficial.

Volume Support Ventilation

- Pressure support with a volume target (similar to PRVC)
- Pressure breath, patient triggered, volume targeted and flow cycled
- Ventilator adjusts pressure over several breaths to achieve targeted volume

Volume-Support Ventilation



AUTOMODE

- Ventilator switches between mandatory and spontaneous
- Volume Control ⇆ Volume Support
- Pressure Control ⇆ Pressure Support
- PRVC ⇆ Volume Support
- On the Servo I

Average Volume-Assured Pressure Support (AVAPS)

- Adaptive pressure control on ventilators for NIV
- Maintains targeted tidal volume by adjusting inspiratory pressure within set limits
- Averages tidal volume over time not breath to breath
- Gradual change in pressure over several minutes

SmartCare®/PS

- Automated weaning system
- Measures selected respiratory variables, adapts ventilator output to individual patient needs by using predetermined algorithms and automatically conducting spontaneous breathing trials (SBTs) when predetermined thresholds are met.
- End-tidal CO_2 required

Proportional Assist Ventilation (PAV)

- Pressure, flow, and volume delivery are proportional to the patient's spontaneous effort
- Amount of pressure the ventilator produces depends on two factors:
    1. The amount of inspiratory flow and volume demanded by the patient's effort
    2. The degree of amplification selected by the clinician (which determines the extent of ventilator response to patient effort)
- PAV is a positive feedback system

PAV

- RT sets proportional assist up to 80% of total effort
- Ventilator determines: p_{aw}, flow, V_T, I_T based on
  - Patient effort, elastance, and resistance
- Patient affects everything because only set parameter is that ventilator will perform a fixed proportion of work
- The proportion of patients developing asynchrony was greater with PSV than with PAV

Neurally Adjusted Ventilatory Assist (NAVA)

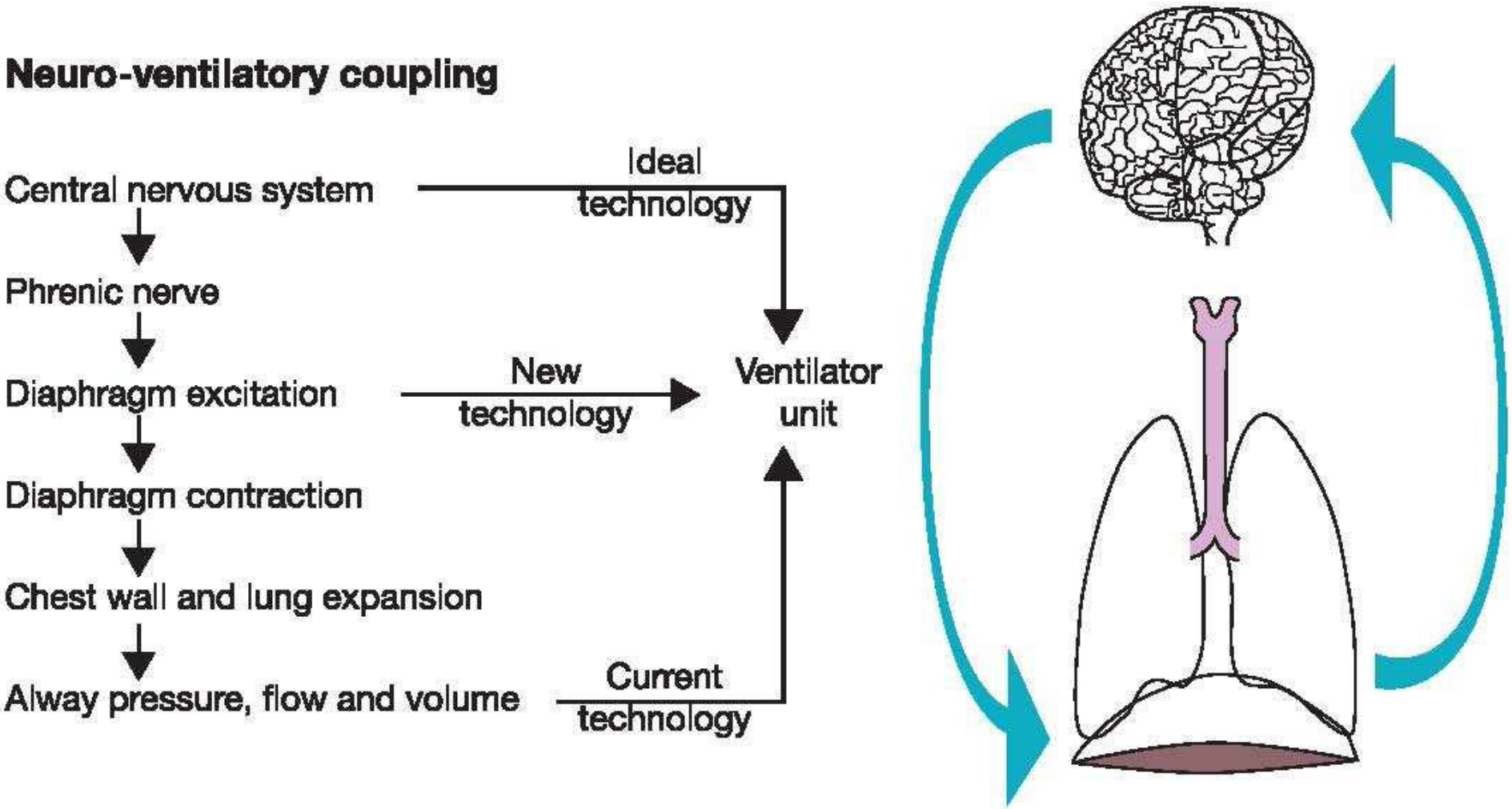
- Patient-initiated mode of ventilation
- Ventilator is controlled by the patient's neural respiratory drive
- NAVA delivers ventilatory support:
  - In synchrony with the patient's neural respiratory drive
  - In proportion to the patient's neural respiratory drive

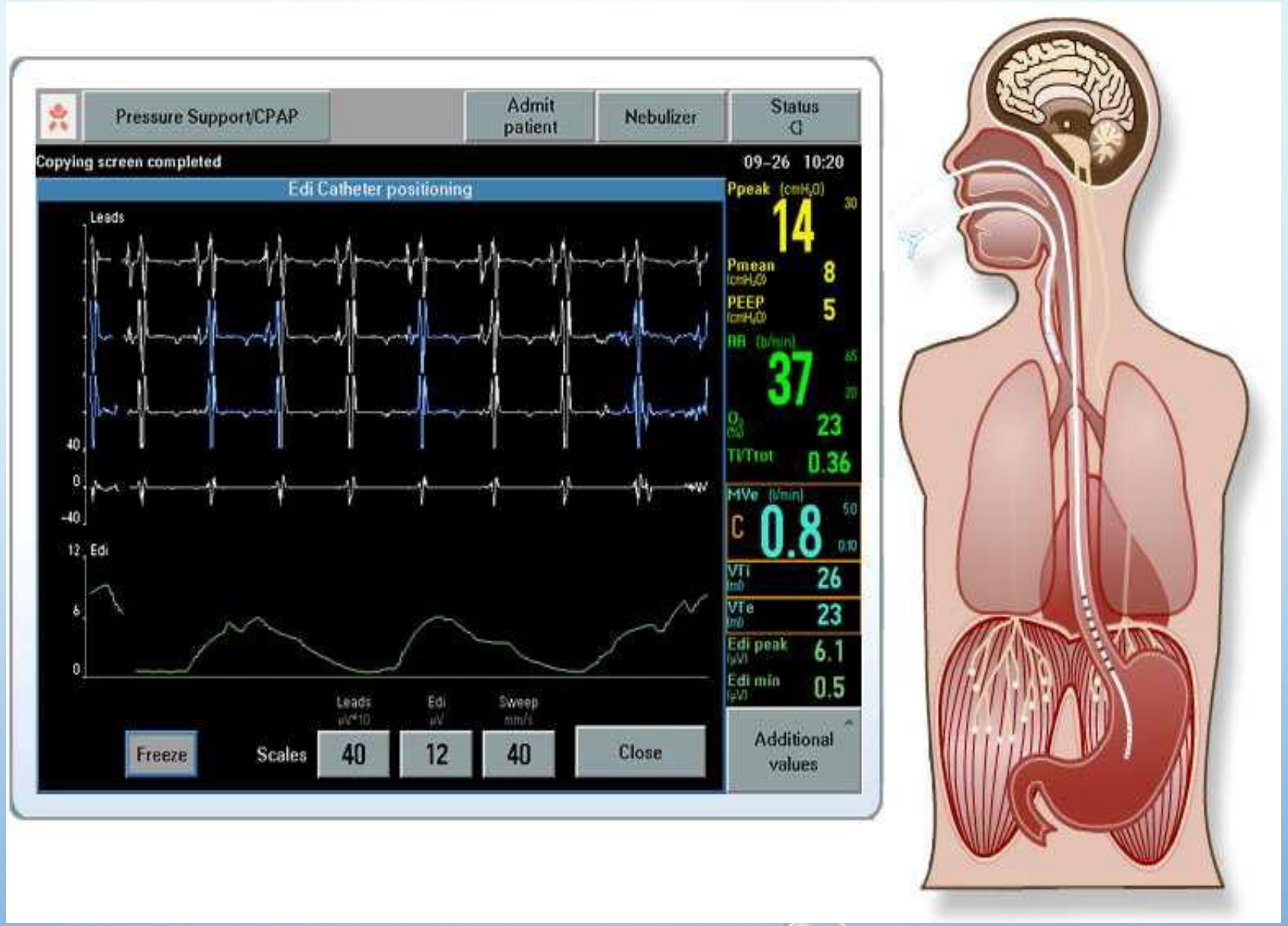
Note: only available on Servo-I

NAVA

- NAVA is essentially the same as PAV except that PAV responds to changes in airway pressure and flow, whereas NAVA responds to changes in diaphragmatic EMG activity
- Parameter set is the number of cm H_2O applied per microvolt of diaphragmatic EMG activity
- The most important advantage of PAV and NAVA over traditional modes of ventilation is improved synchrony

Neuro-ventilatory coupling



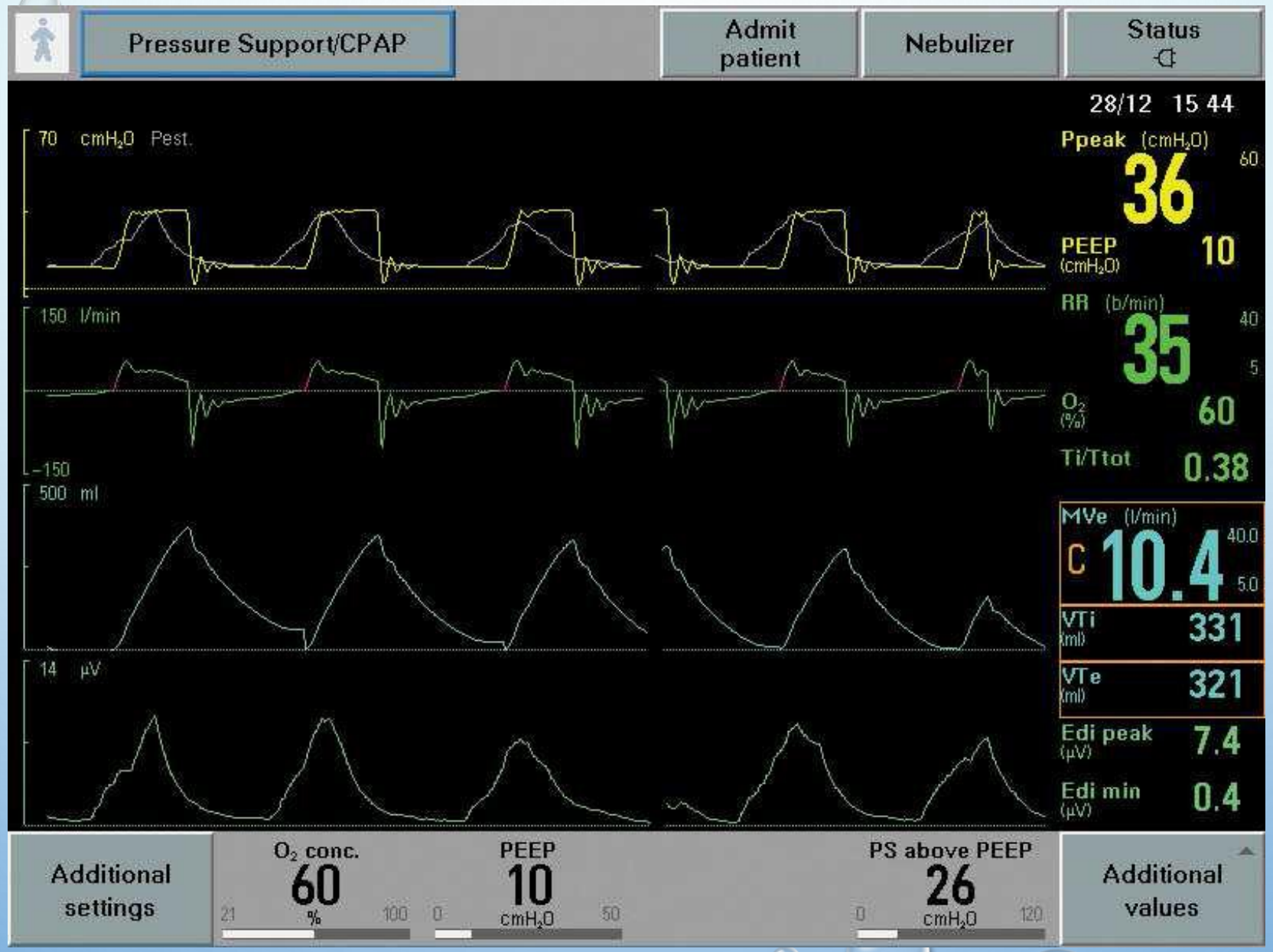

Pressure Support/CPAP
Admit patient
Nebulizer
Status
Copying screen completed
09-26 10:20
Edi Catheter positioning
Leads
40
0
-40
12
Edi
6
0
Ppeak (cmH2O)
14
30
Pmean (cmH2O)
8
PEEP (cmH2O)
5
RR (b/min)
37
65
20
O2 (%)
23
TI/Ttot
0.36
MVe (l/min)
C
0.8
5.0
0.10
VTi (ml)
26
VTe (ml)
23
Edi peak (µV)
6.1
Edi min (µV)
0.5
Leads µV*10
Edi µV
Sweep mm/s
Freeze
Scales
40
12
40
Close
Additional values


NAVA
Admit patient
Nebulizer
Status
08–10 13 19
25 cmH2O
40 l/min
-40
150 ml
12 µV
Ppeak (cmH2O)
13
40
Pmean (cmH2O) 8
PEEP (cmH2O) 5
RR (b/min)
35
70
20
O2 (%) 28
Ti/Ttot 0.39
MVe (l/min)
C 2.9
6.5
1.0
VTi (ml) 77
VTe (ml) 86
etCO2 (%) 4.8
Edi peak (µV) 5.5
Edi min (µV) 0.3
Additional settings
O2 conc. 28 % 21 100
PEEP 5 cmH2O 0 50
NAVA level 1.3 cmH2O/µV 0.0 30.0
Additional values

NAVA

Using the edi to titrate and fine tune conventional ventilation

- Adjustment of trigger
- Adjustment of cycle off criteria
- Adjustment of inspiratory time


Pressure Support/CPAP
Admit patient
Nebulizer
Status
28/12 15 44
70 cmH2O Pest.
150 l/min
-150
500 ml
14 µV
Ppeak (cmH2O)
36
60
PEEP (cmH2O)
10
RR (b/min)
35
40
5
O2 (%)
60
Ti/Ttot
0.38
MVe (l/min)
C 10.4
40.0
5.0
VTi (ml)
331
VTe (ml)
321
Edi peak (µV)
7.4
Edi min (µV)
0.4
Additional settings
O2 conc.
60
%
21
100
PEEP
10
cmH2O
0
50
PS above PEEP
26
cmH2O
0
120
Additional values

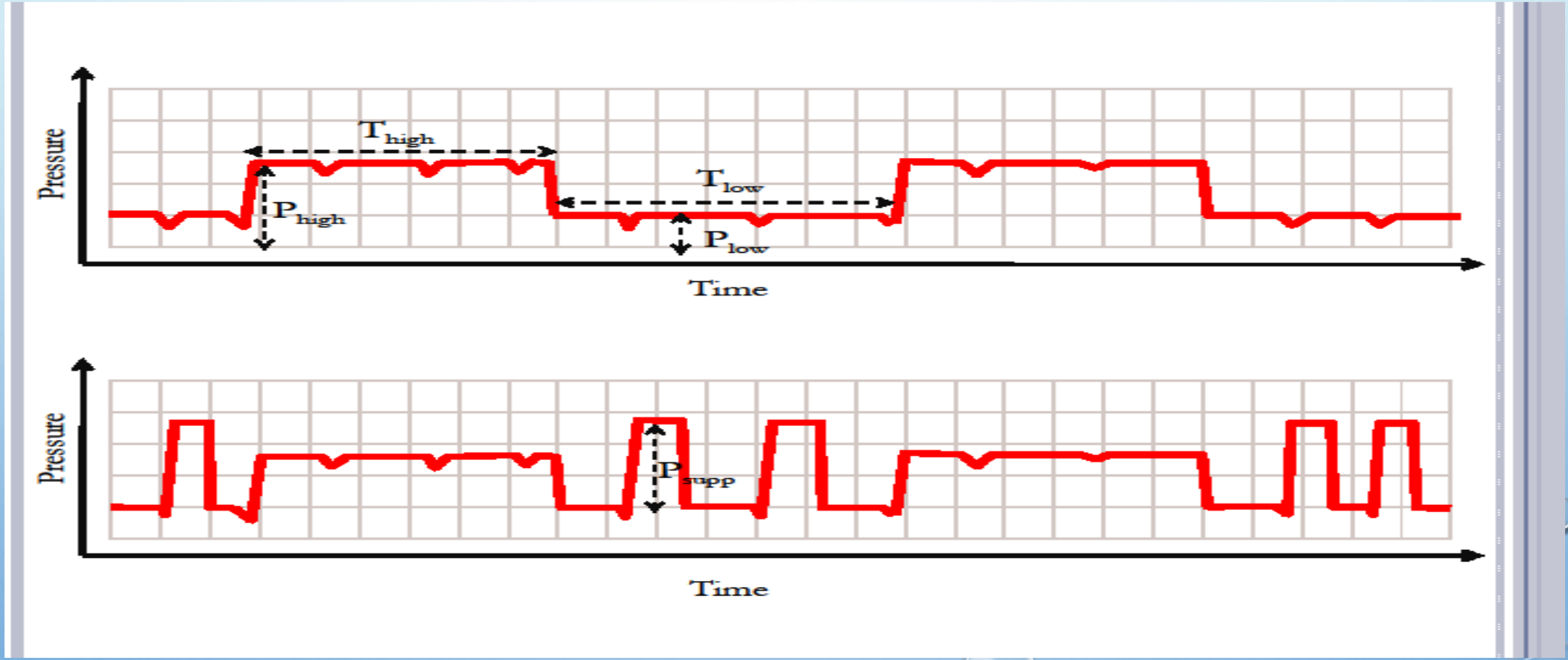
AUTOMATIC TUBE COMPENSATION (ATC)

- Calculates R_{aw} associated with the artificial airway
- Attempts to adjust P_{aw} to keep tracheal pressure constant at baseline pressure
- Goal to eliminate imposed WOB
  - ATC% adjustable to compensate from as low as 10% to 100% of imposed work

Bi-level and Bivent characteristics

- Allow spontaneous breaths superimposed on a set number of “pressure controlled” ventilator cycles
- Reduce peak airway pressures
- “Open” circuit / enhanced synchrony between patient effort and machine response
- Patients can spontaneously breath at either pressure levels
- Settings:
  - Pinsp and pexp (phigh and plow)
  - Thigh and tlow

Bi-level

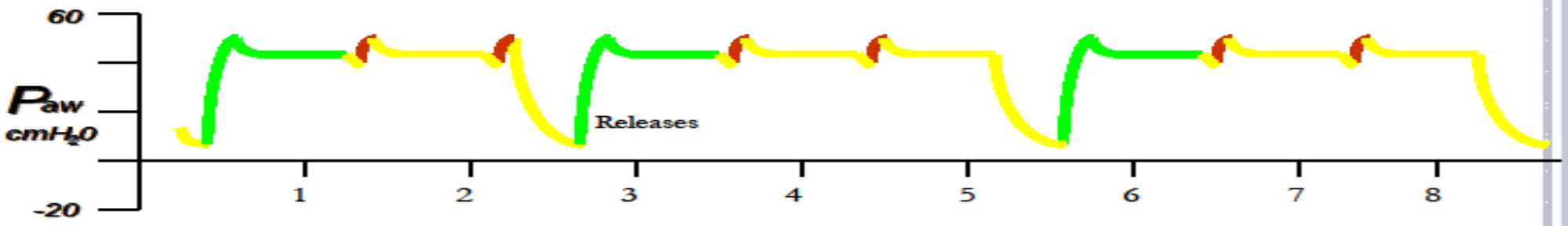


APRV: Airway Pressure Release Ventilation

- A form of bilevel but utilizes a very short expiratory time for pressure release
- APRV should imply a severe I:E ratio
- Partial to full ventilatory support
- All spontaneous breathing is done at upper pressure limit
- In a paralyzed or heavily sedated patient, APRV is essentially, pressure controlled inverse ratio ventilation
- Used in patients with ARDS, refractory hypoxemia due to collapsed alveoli, atelectasis

APRV

Airway Pressure Release Ventilation



APRV

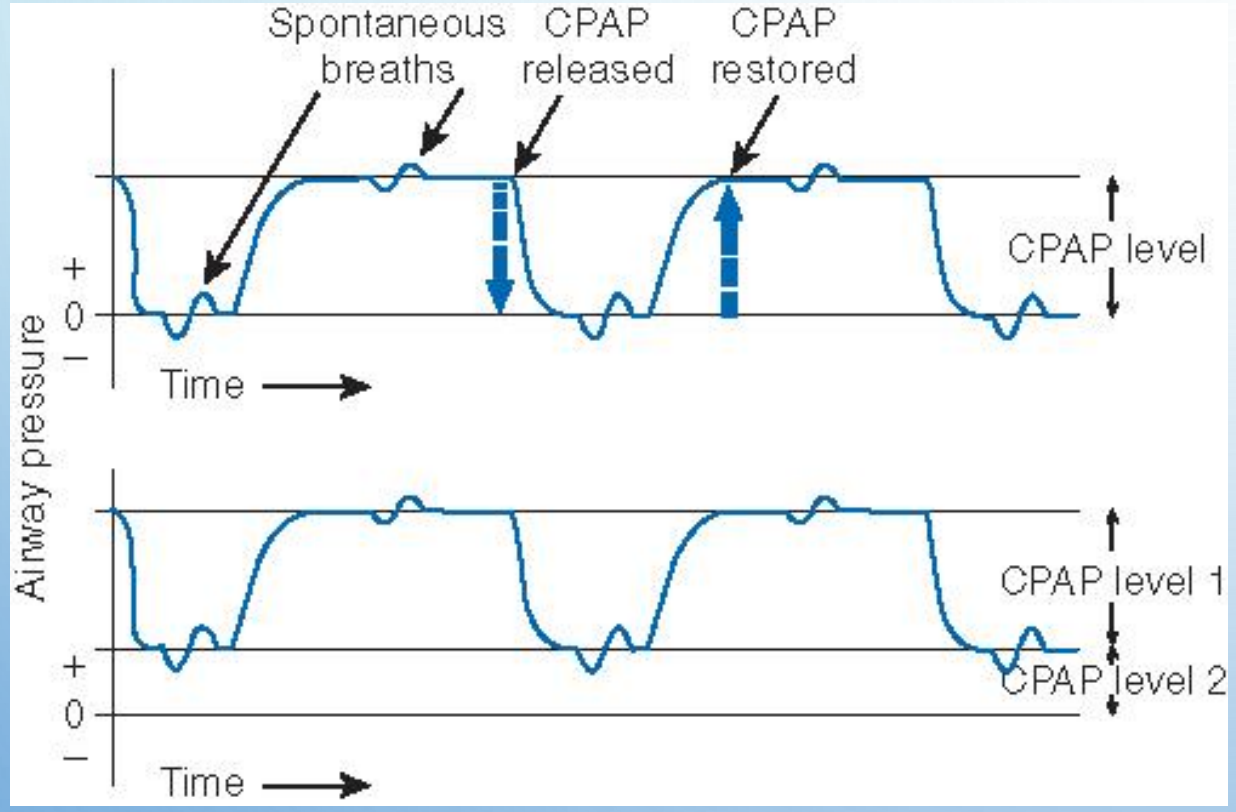
ADVANTAGES

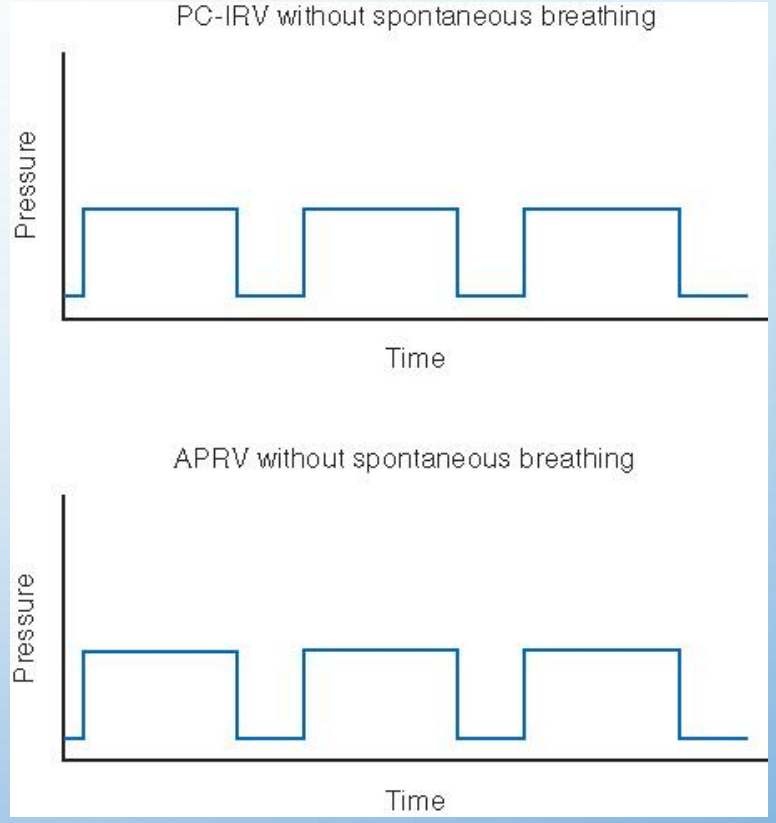
- Preserves spontaneous ventilation
- Improves patient-ventilator synchrony if spontaneous breathing is present
- Improves oxygenation by stabilizing collapsed alveoli
- Allows patients to breath spontaneously while continuing lung recruitment
- Lowers PIP
- May decrease physiologic deadspace

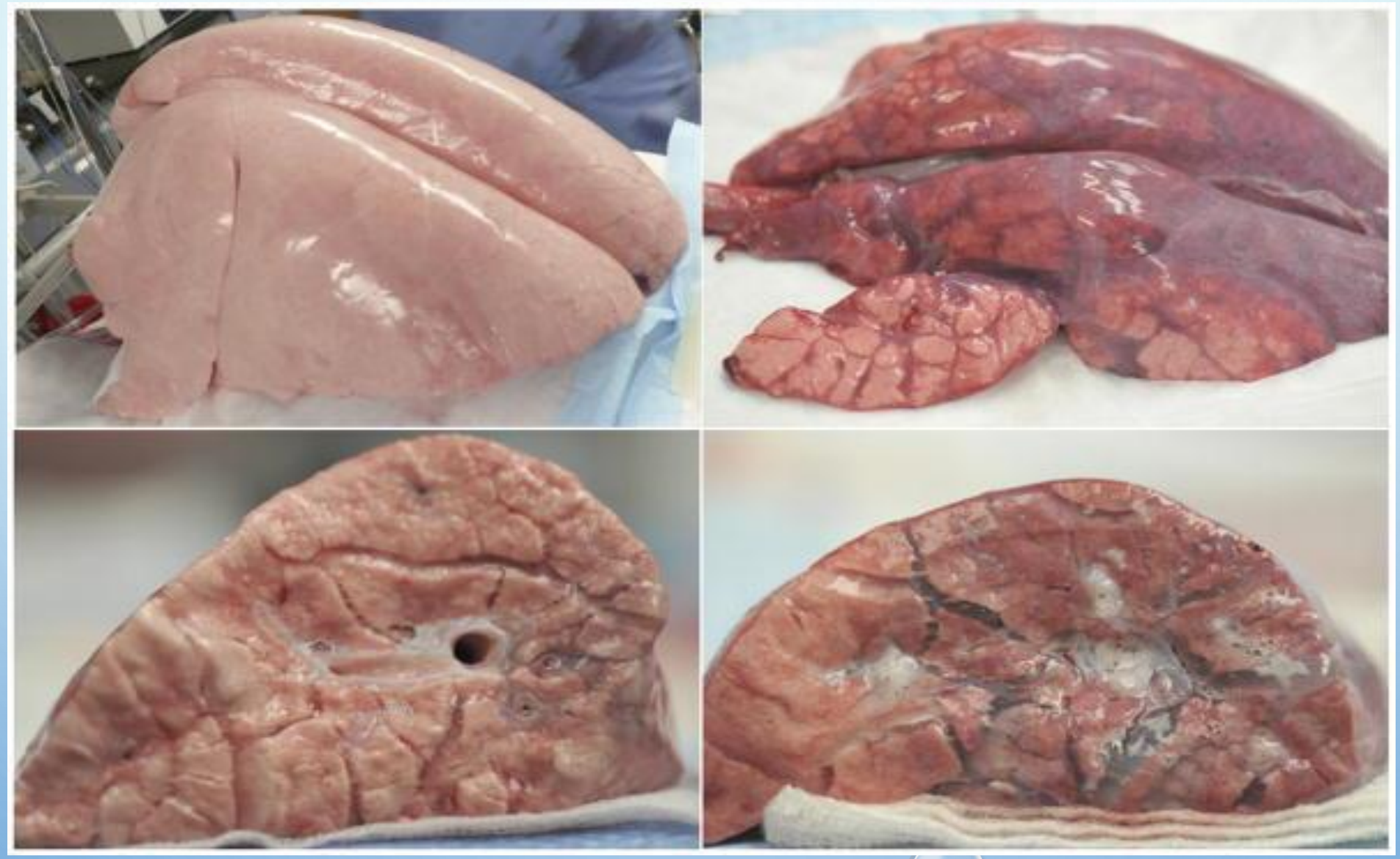
DISADVANTAGES

- Variable VT
- Could be harmful to patients with high expiratory resistance (i.E., COPD or asthma)
- Auto-peep is usually present
- Caution should be used with hemodynamically unstable patients
- Asynchrony can occur if spontaneous breaths are out of sync with release time
- Requires the presence of an “active exhalation valve”

Airway Pressure-Release Ventilation







APRV

- Initial settings
- Conventional ventilator mode can serve as a guide
  - ➢ High pressure
  - ➢ Low pressure
  - ➢ High time
  - ➢ Low time
- $T_{high} + T_{low} = TCT$; 60/TCT = *frequency*

APRV

- Adjusting ventilation
  - Ventilation and $paco_2$ are both determined by the release time and V_T exchange during T_{low} and by the patient's spontaneous ventilation
- Adjusting oxygenation
  - Generally be improved by increasing P_{high} or F_IO_2
  - Prone positioning
- Discontinuing ventilation and oxygenation
  - Begin once the patient's lung condition has improved

APRV

Technique for reducing support:

- Adjust p_{high} and t_{high}
- P_{high} should be reduced 2 to 3 cm H_2O at a time and t_{high} lengthened in 0.5- to 2.0-second increments
- P_{high} is slowly decreased until it meets p_{low}
- P_{high} and p_{low} pressures are intended to meet at the desired baseline

APRV VIDEO

- APRV DEMO

HELIOX THERAPY

- Effect is based on its low density
  - ➢Reduces turbulent flow in obstructed airways and decreases respiratory muscle load and dyspnea
- Because helium is an inert gas, it will not react with human tissue or with pharmaceutical agents
- Servo I ventilator