RESIDENT BOOT CAMP ATS 2021

Ventilator Management

ATS Virtual Bootcamp 2021

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ATS RBC Wiki Site – Get your primer here

Username: faculty
Password: bootcamp
Click on 2021 RBC Attendee Site

SCAN ME

https://wiki.thoracic.org

The assumption today -

- Safe space to learn
- We’re all learning together
- Your answer may be wrong, but I guarantee you weren’t the only one thinking what you said.
- We all learn better if we interact with each other, so if you don’t volunteer to answer our questions, we might call on you.
  - We’re not mean. We’re not picking on you.
  - Most of the people on this call have no idea who you are . . .
  - We want you to participate and learn.
  - It’s fine to participate without being called on.

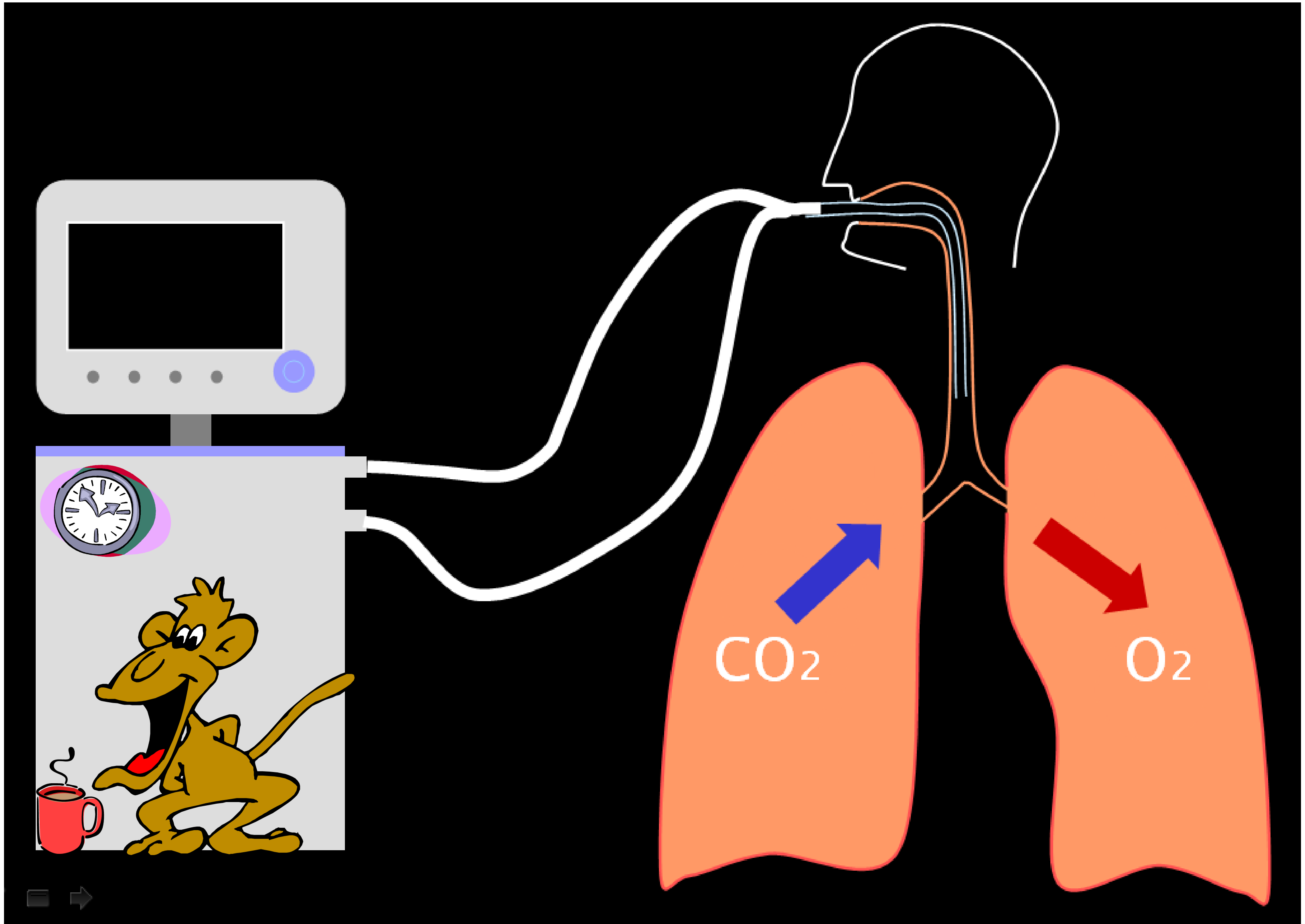
Some Basics

Ren Ashton, MD

Control Variables

Inside every vent,
is a . . .

Union **monkey**,
Who will do whatever you tell him to do, but you have to worry about the rest.



The Equation of Motion

$$P_{vent} = P_{elastic} + P_{resistive}$$
$$P_{vent} = \text{Elastance x Volume + Resistance x Flow}$$

- You can tell the monkey to manage either side of the equation, but you have to worry about the other side.
  - If monkey does pressure → control variable is pressure ("pressure control mode")
    - Alarms will tell you when volumes or flows are too low
  - If monkey does volume/flow → control variable is volume ("volume control mode")
    - Alarms will tell you when pressures are too high

The respiratory cycle on a ventilator:

- What signals the start of inspiration?

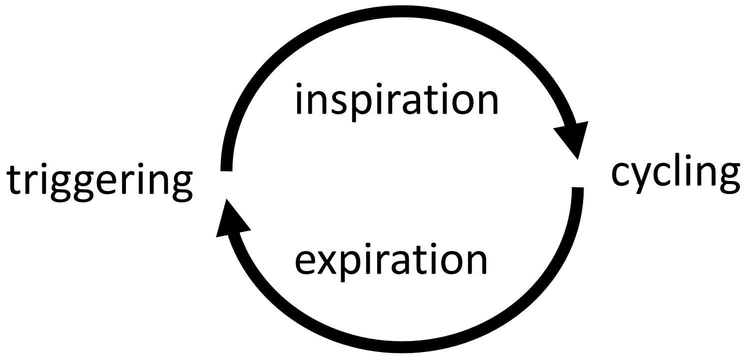
  (Also called “**triggering**”)

  - Preset time since last breath
  - Patient-generated pressure drop
  - Patient-generated inward air flow

- What signals the end of inspiration?

  (also called “**cycling**”)

  - Preset time since triggering
  - Preset volume target reached
  - Preset flow target reached



Breath Types

- Mandatory breaths
  - Breaths are either triggered, cycled or both by machine
- Spontaneous breaths
  - Breaths are both triggered and cycled by patient

- CMV = continuous mandatory breaths
- IMV = intermittent mandatory breaths
- CSV = continuous spontaneous breaths

To look forward to:
Targeting schemes – what makes modes with the same control variable and breath type distinct from each other . . .

Knob-ology

Puritan Bennett 840

- Find the input areas
- Find the output areas on
- Learn how to highlight a parameter and change the setting
    - Most vents now have touch screens and a system with control knob/accept
- Learn how to display waveforms and which ones are most useful
- Learn how to perform inspiratory and expiratory holds

Maquet Servo-i

Carefusion Avea

BREAK OUT SESSION START NOW

CASE 1: ARDS

CASE 1

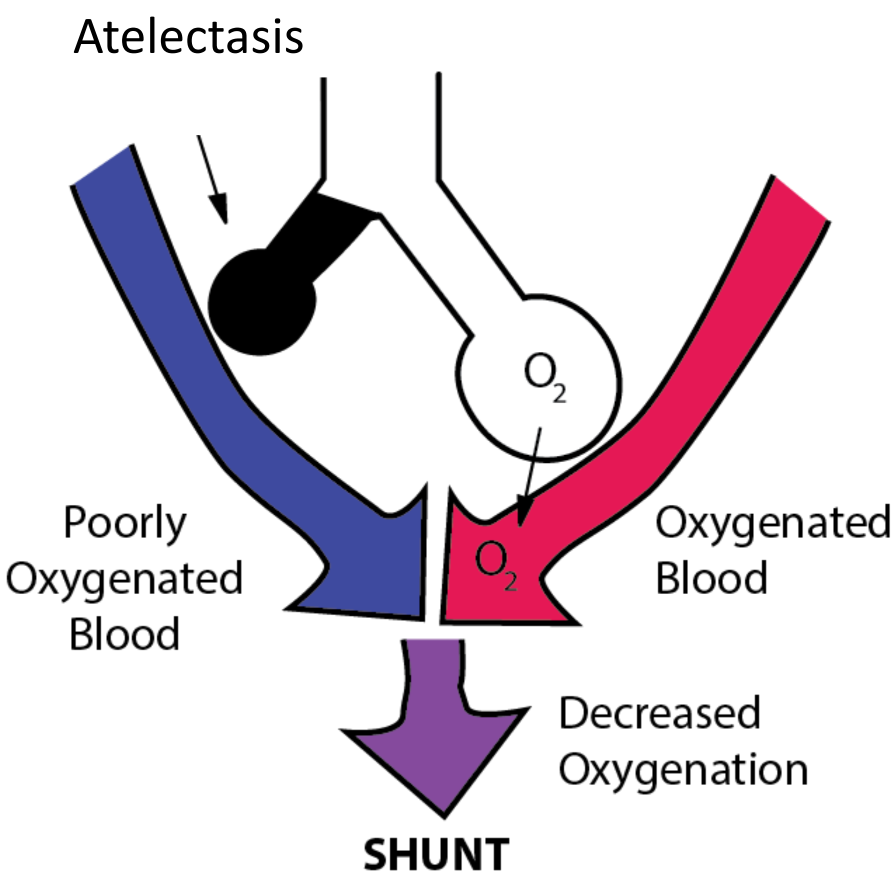

MAQUET
Volume Control
Automode
Admit patient
Nebulizer
Status
06-17 08:31
40 cmH2O
Ppeak (cmH2O)
33
60
Pmean (cmH2O)
10
PEEP (cmH2O)
5
150 l/min BTPS
RR (b/min)
20
36
5
O2 (%)
41
45
35
-150
I:E
1:2.3
500 ml BTPS
MVe (l/min)
9.7
14.0
4.0
VTi (ml)
493
VTe (ml)
459
Additional settings
O2 conc.
40
%
21
100
PEEP
5
cmH2O
0
50
Resp. Rate
20
b/min
4
100
Tidal Volume
500
ml
100
2000
Additional values

You receive a blood gas

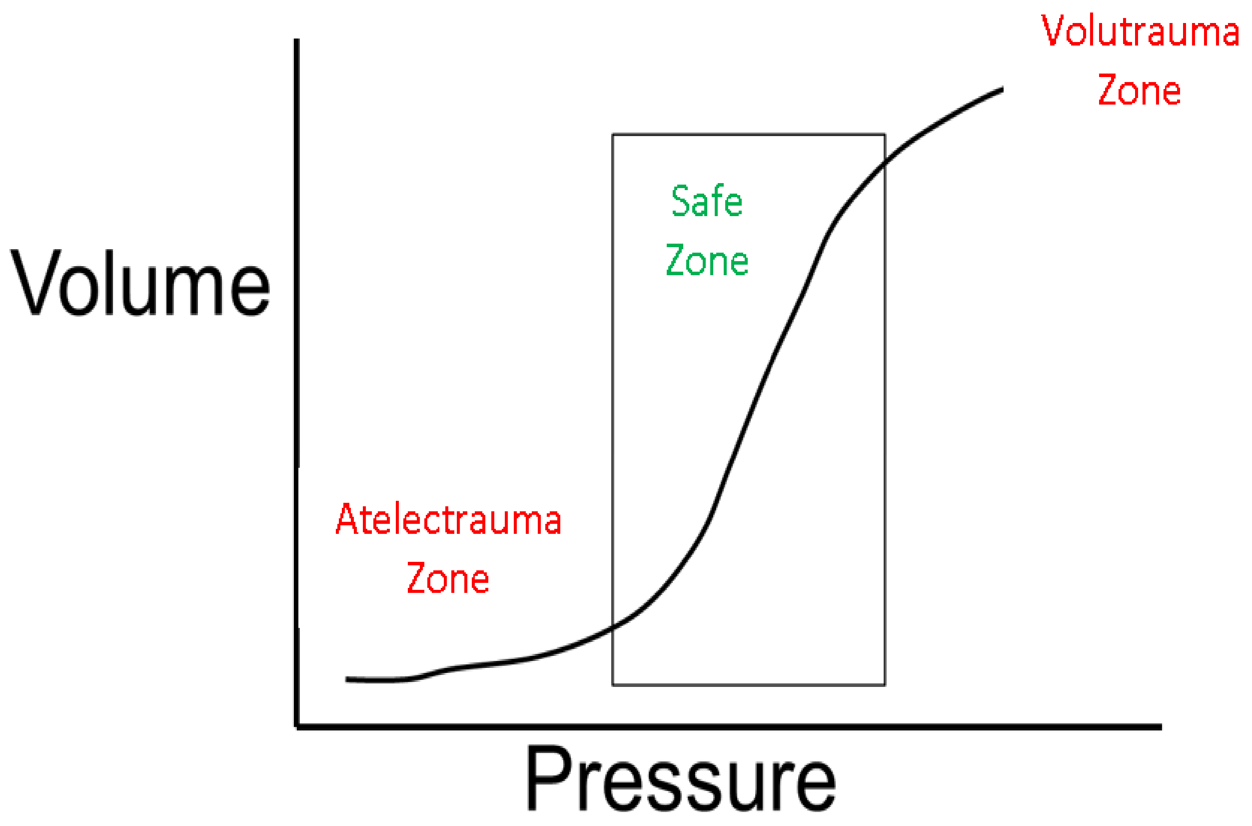
- pH 7.32
- PaCO2 65 mmHg
- PaO2 50 mmHg

Should we make any changes to the ventilator?

Why does PEEP help improve PaO2?



Another secret about PEEP



Which one should we adjust (PEEP or FiO2)?

NIH NHLBI ARDS Clinical Network
Mechanical Ventilation Protocol Summary

SCAN ME

Lower PEEP/higher FiO2

FiO_2	0.3	0.4	0.4	0.5	0.5	0.6	0.7	0.7
PEEP	5	5	8	8	10	10	10	12

FiO_2	0.7	0.8	0.9	0.9	0.9	1.0
PEEP	14	14	14	16	18	18-24

Higher PEEP/lower FiO2

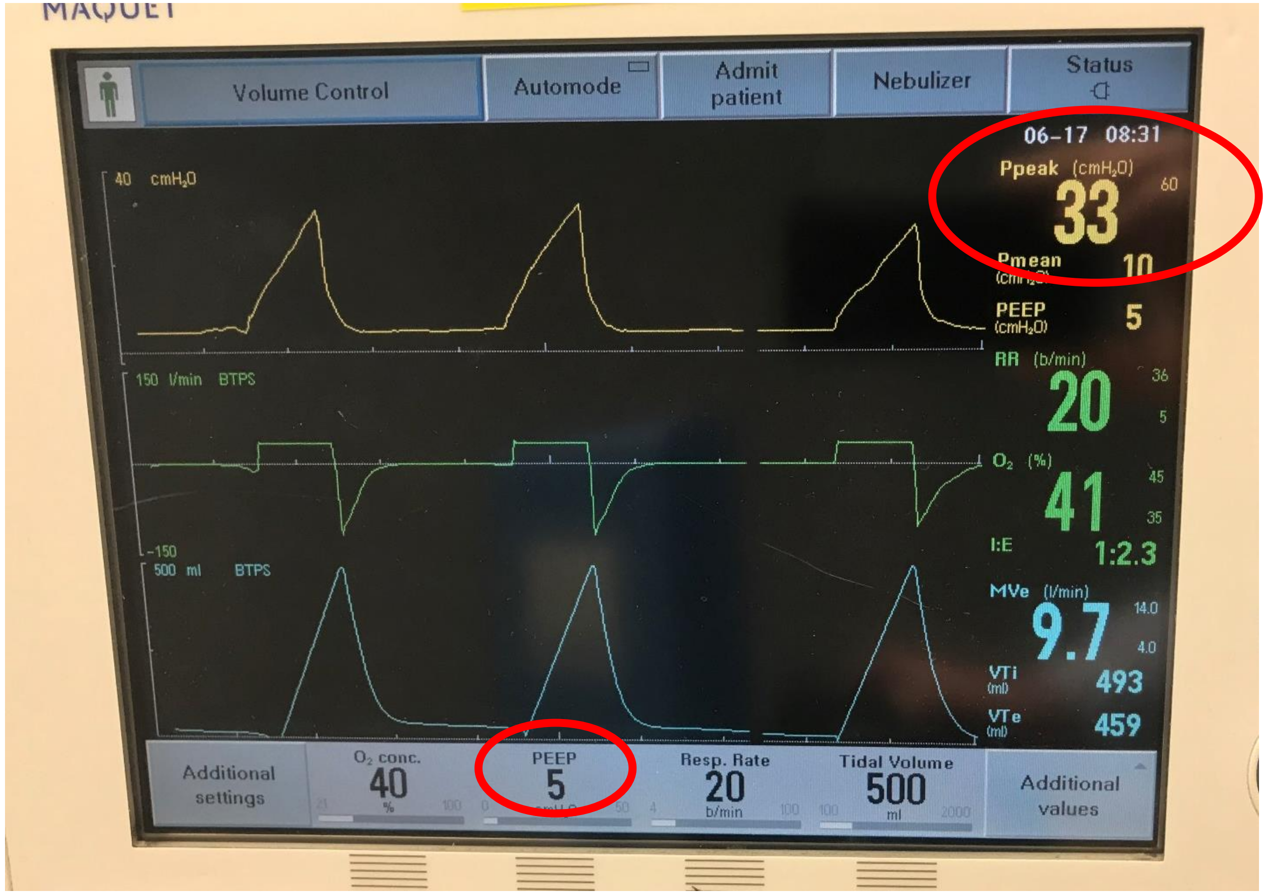
FiO_2	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.5
PEEP	5	8	10	12	14	14	16	16

FiO_2	0.5	0.5-0.8	0.8	0.9	1.0	1.0
PEEP	18	20	22	22	22	24

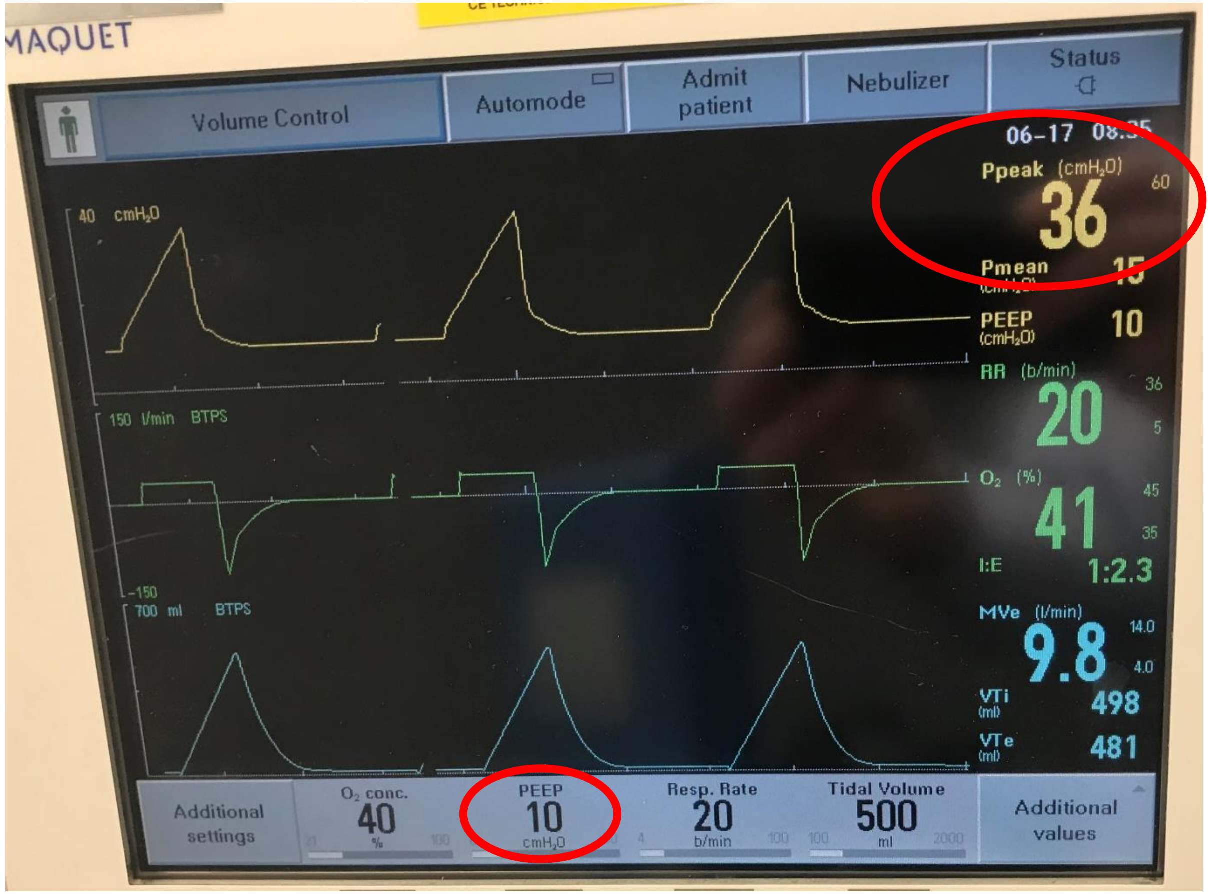
Recap

- Use PEEP and FIO2 to adjust the PaO2

After adjusting the PEEP, what has changed?



Initial Settings



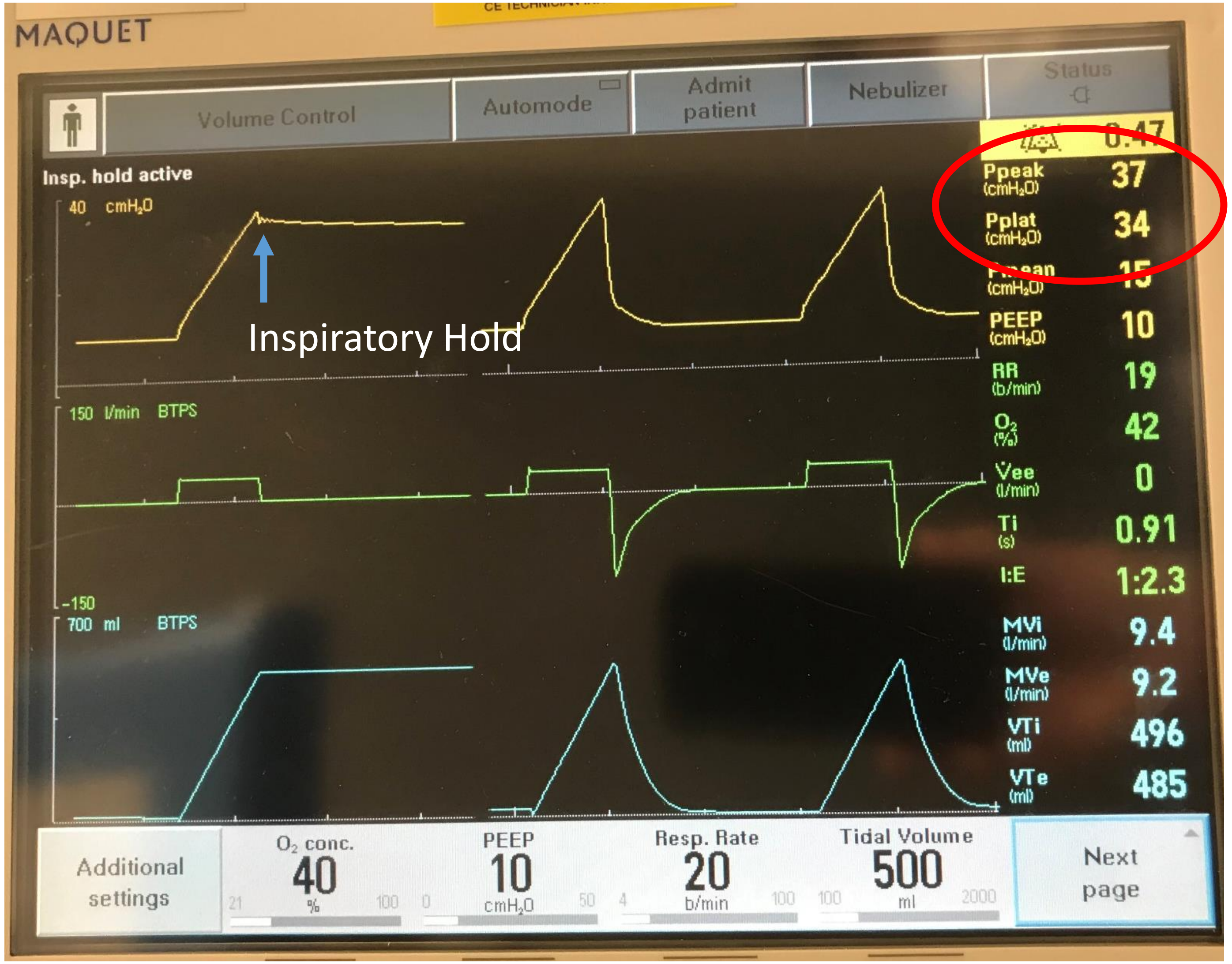
Current Settings

How do we evaluate what is causing the high peak pressures?

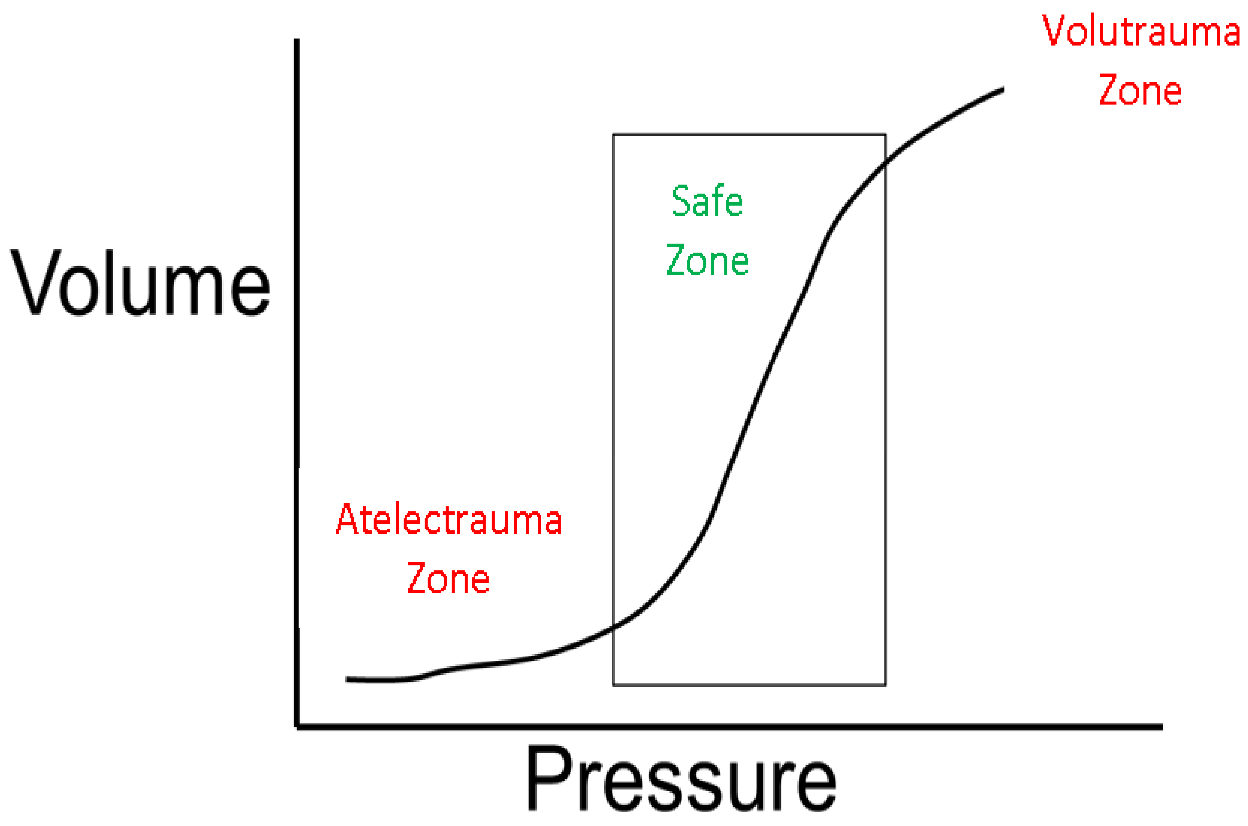
$$P_{vent} = P_{elastic} + P_{resistive}$$

$$P_{vent} = (\text{Elastance} * \text{Volume}) + \cancel{(\text{Resistance} * \text{Flow})}$$

Plateau Pressure – No flow; measures lung elastance

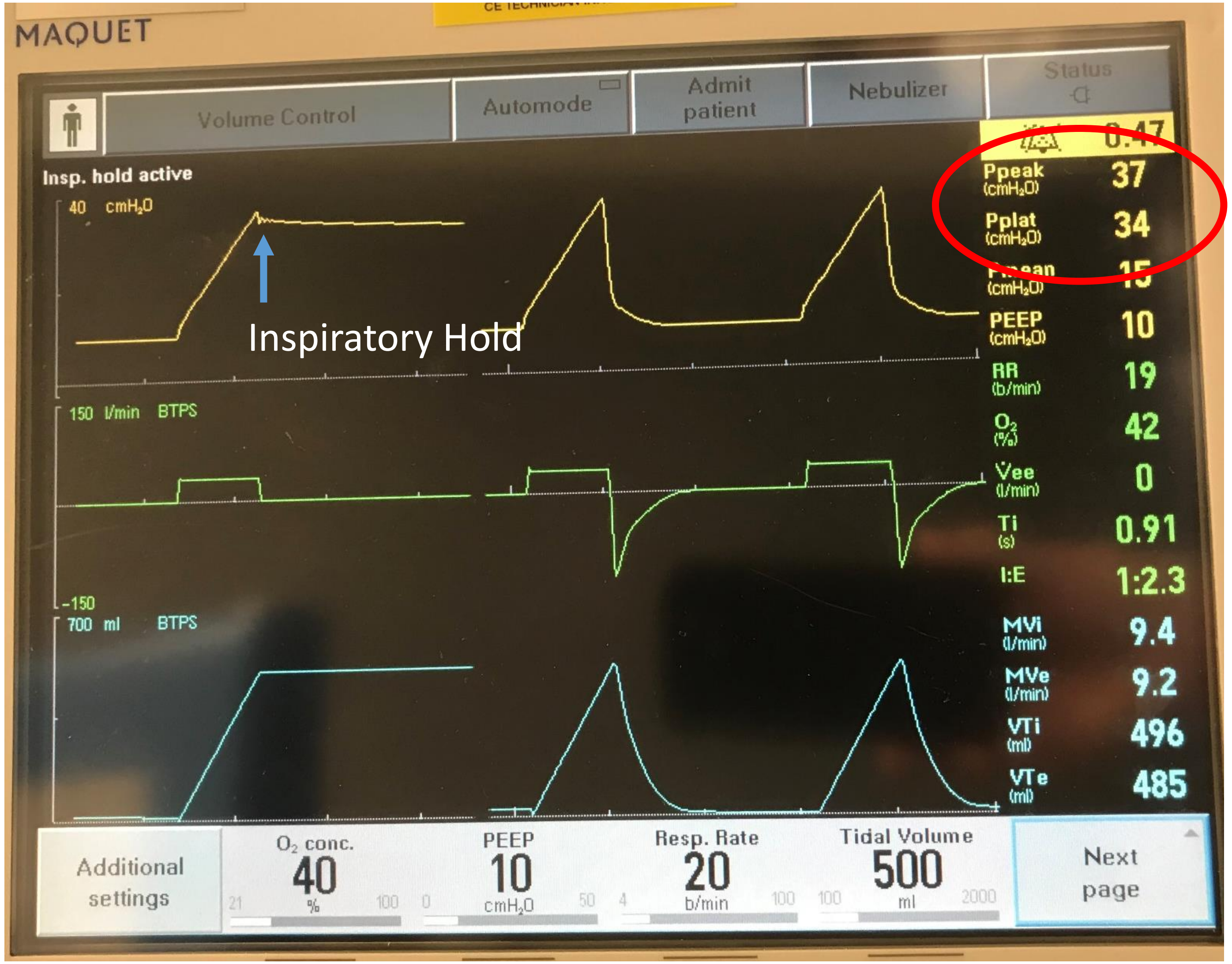


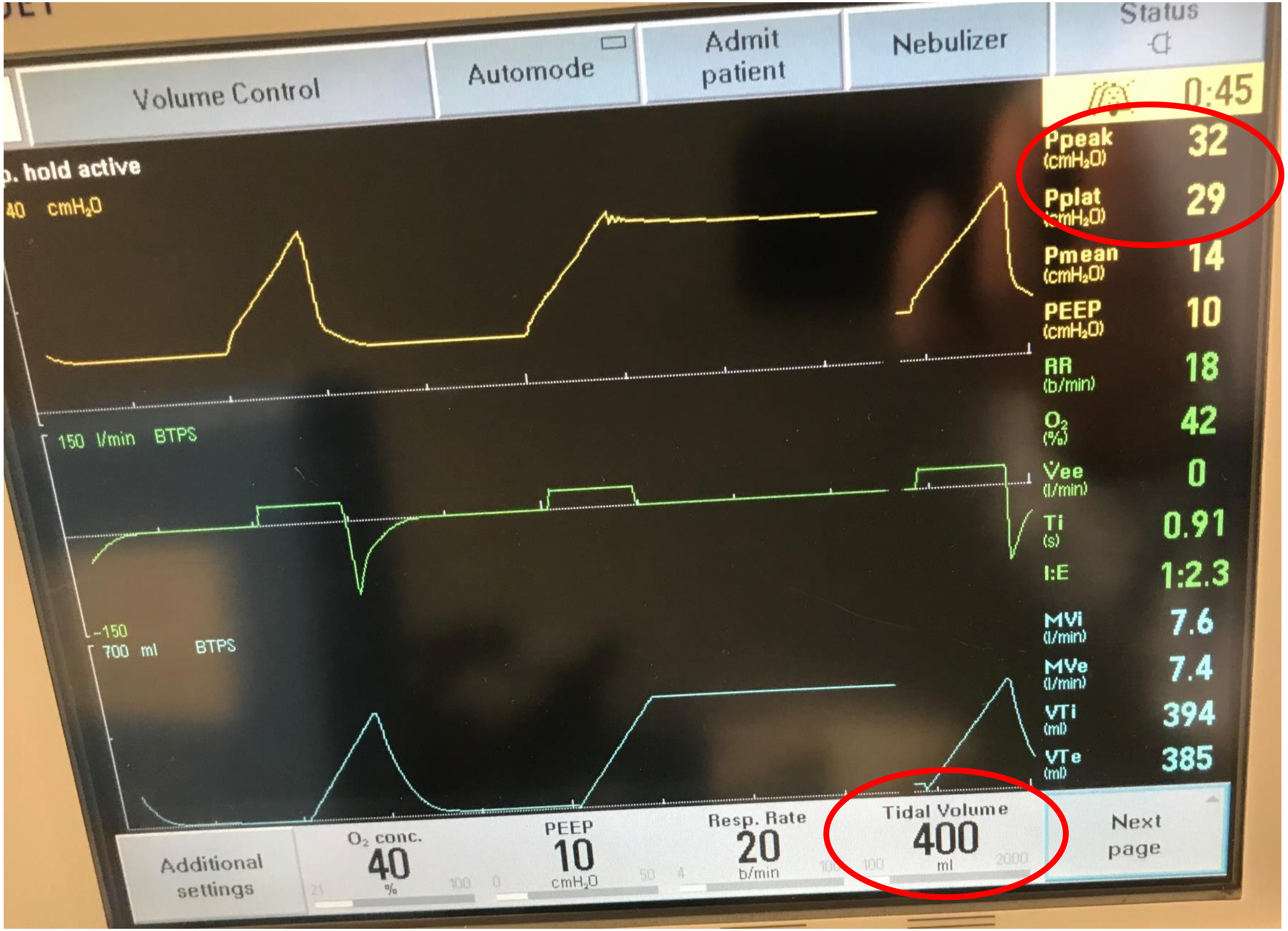
Back to the Pressure Volume Curve



What can we change to lower the plateau pressure?

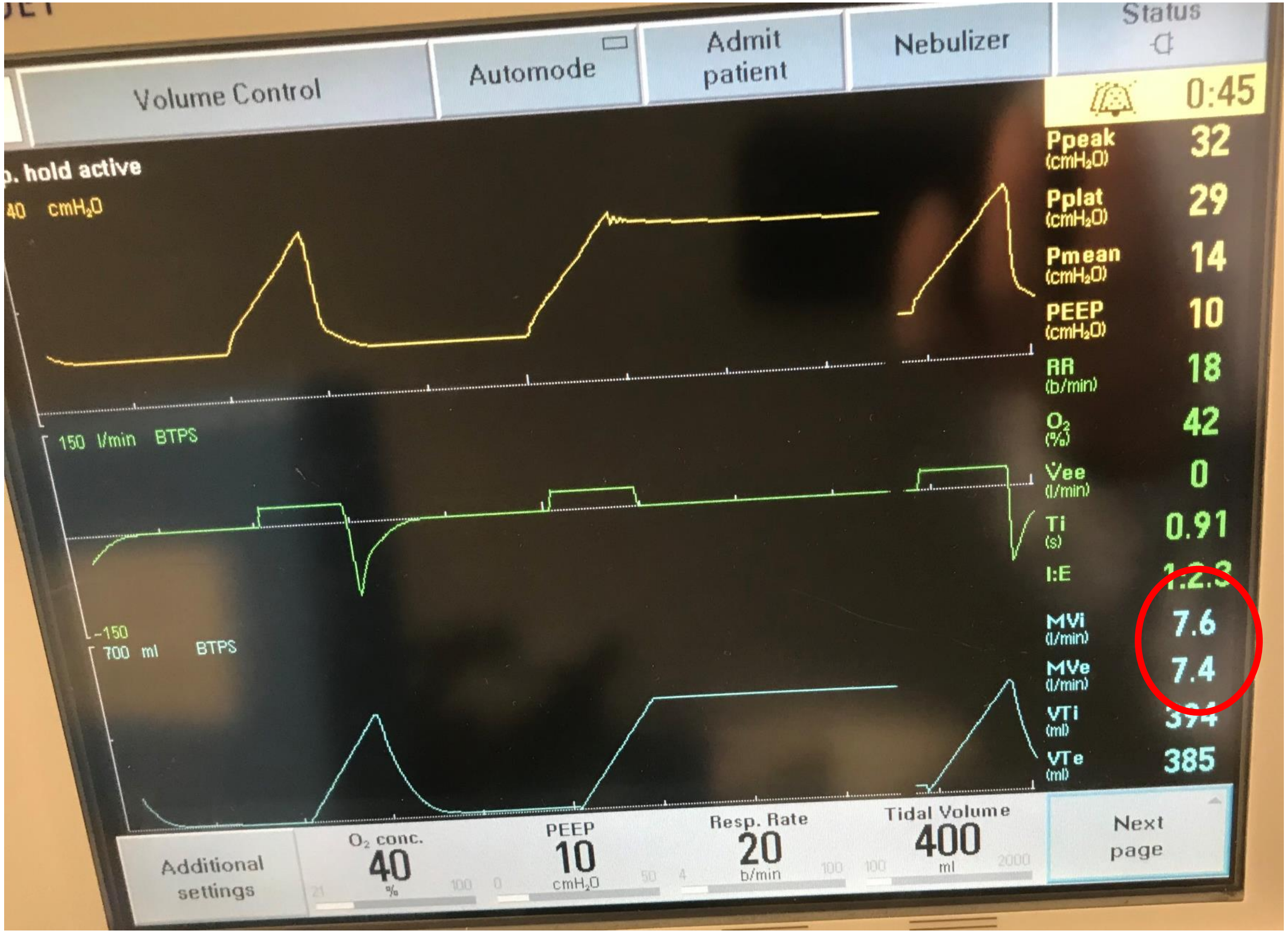
$$P_{vent} = \text{Elastance} * \text{Volume} + \cancel{\text{Resistance} * \text{Flow}}$$



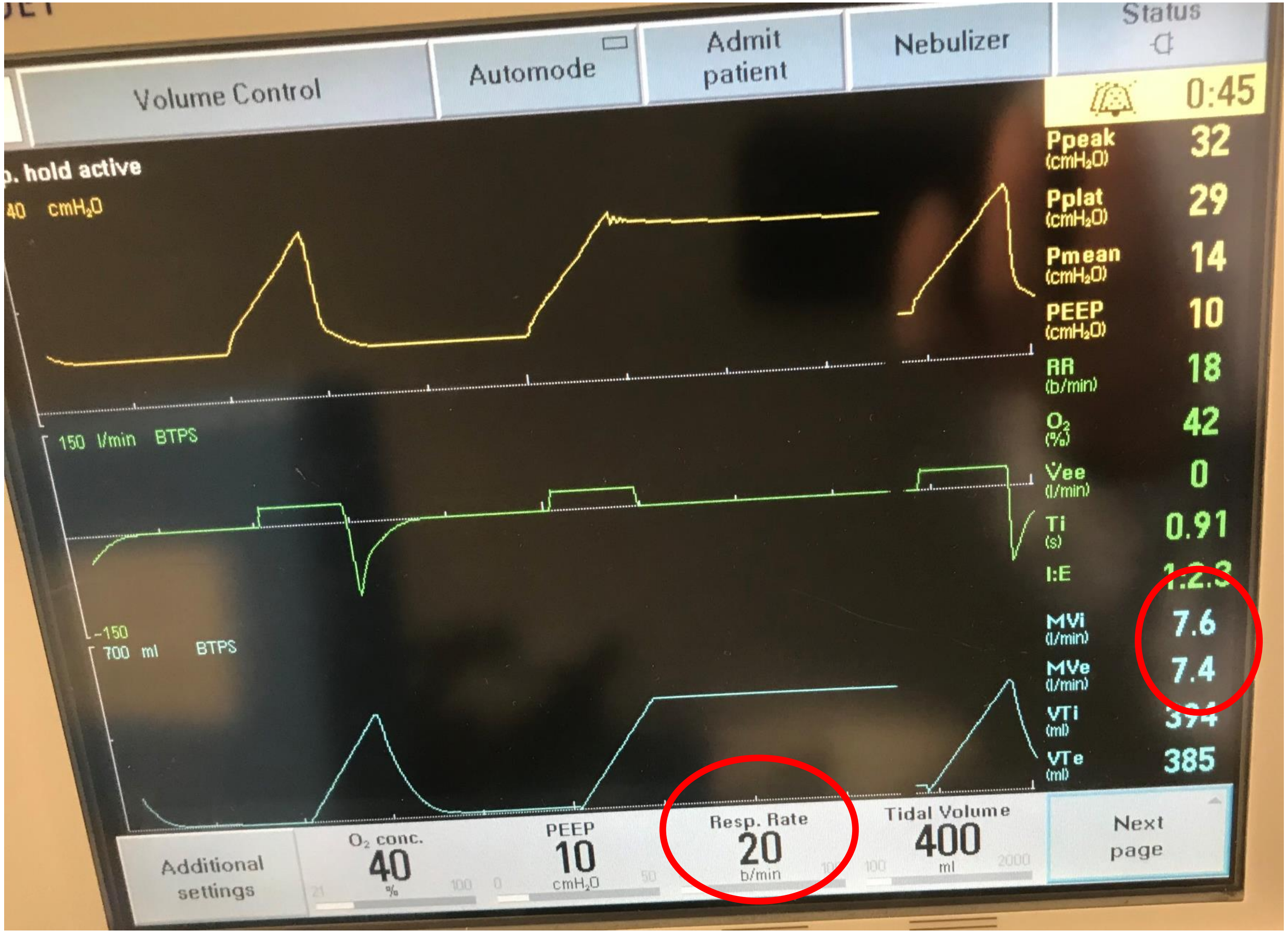


Volume Control
Automode
Admit patient
Nebulizer
Status
0:45
p. hold active
40 cmH2O
Ppeak (cmH2O) 32
Pplat (cmH2O) 29
Pmean (cmH2O) 14
PEEP (cmH2O) 10
RR (b/min) 18
O2 (%) 42
V̇ee (l/min) 0
Ti (s) 0.91
I:E 1:2.3
MVi (l/min) 7.6
MVe (l/min) 7.4
VTi (ml) 394
VTe (ml) 385
150 l/min BTPS
-150
700 ml BTPS
Additional settings
O2 conc. 40 %
PEEP 10 cmH2O
Resp. Rate 20 b/min
Tidal Volume 400 ml
Next page

With lower Vt, what might happen?



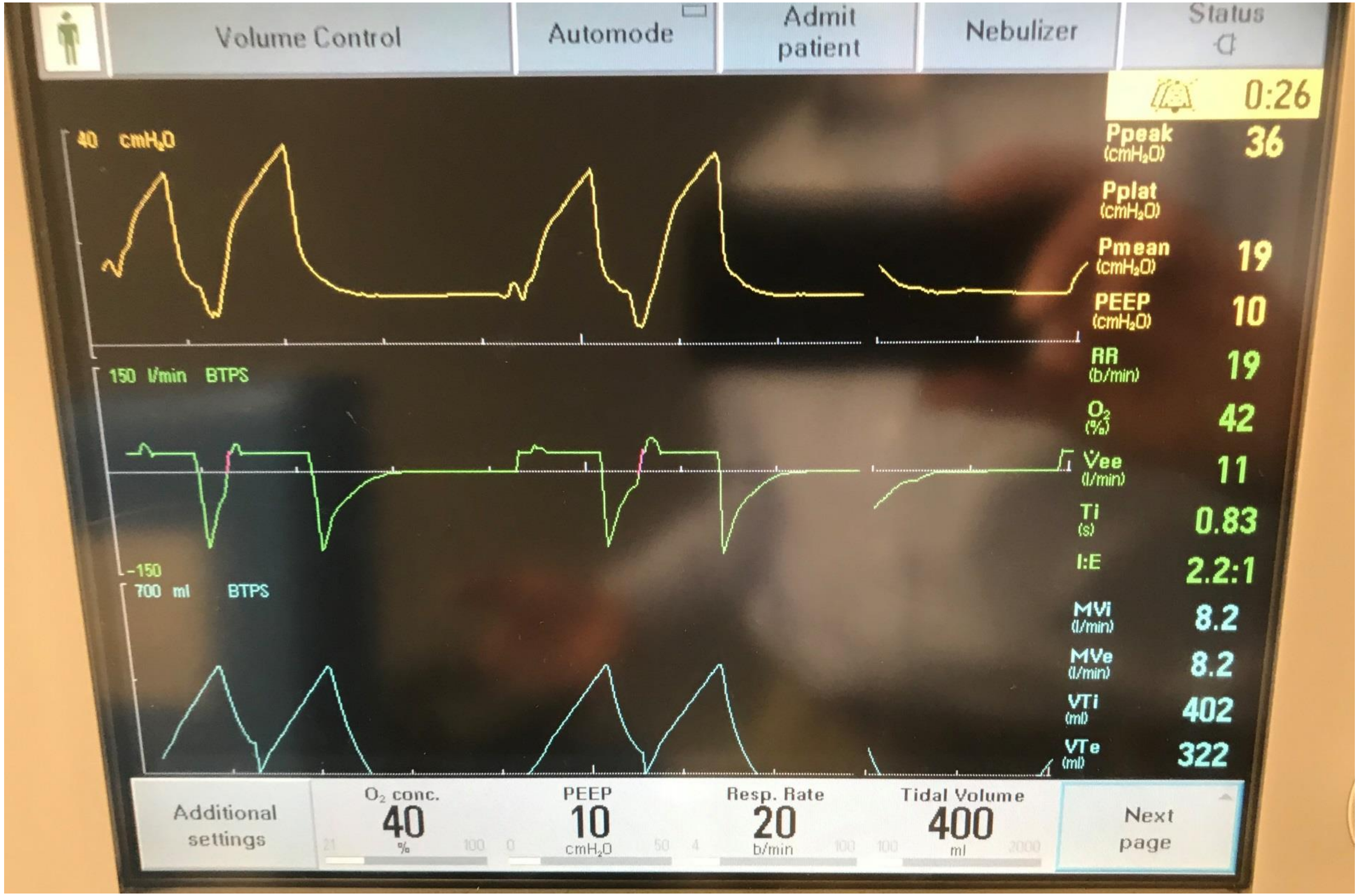
With lower Vt, what might happen?



Recap

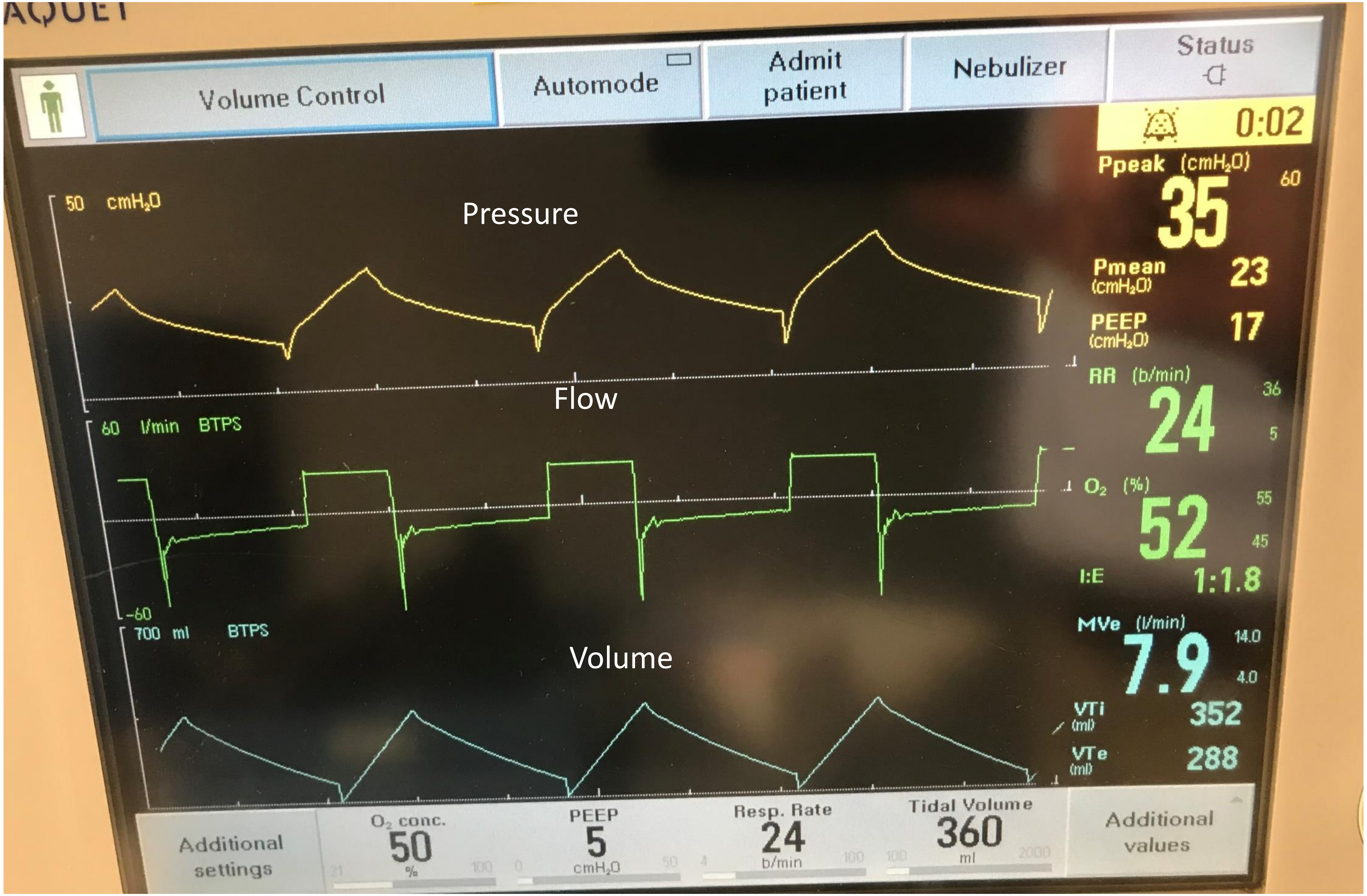
- Use PEEP and FIO2 to adjust the PaO_2
- Use PEEP and Vt to adjust the plateau pressure
- Use Vt and Rate to adjust the minute ventilation (and pCO_2)

The patient's sedation is liberated…



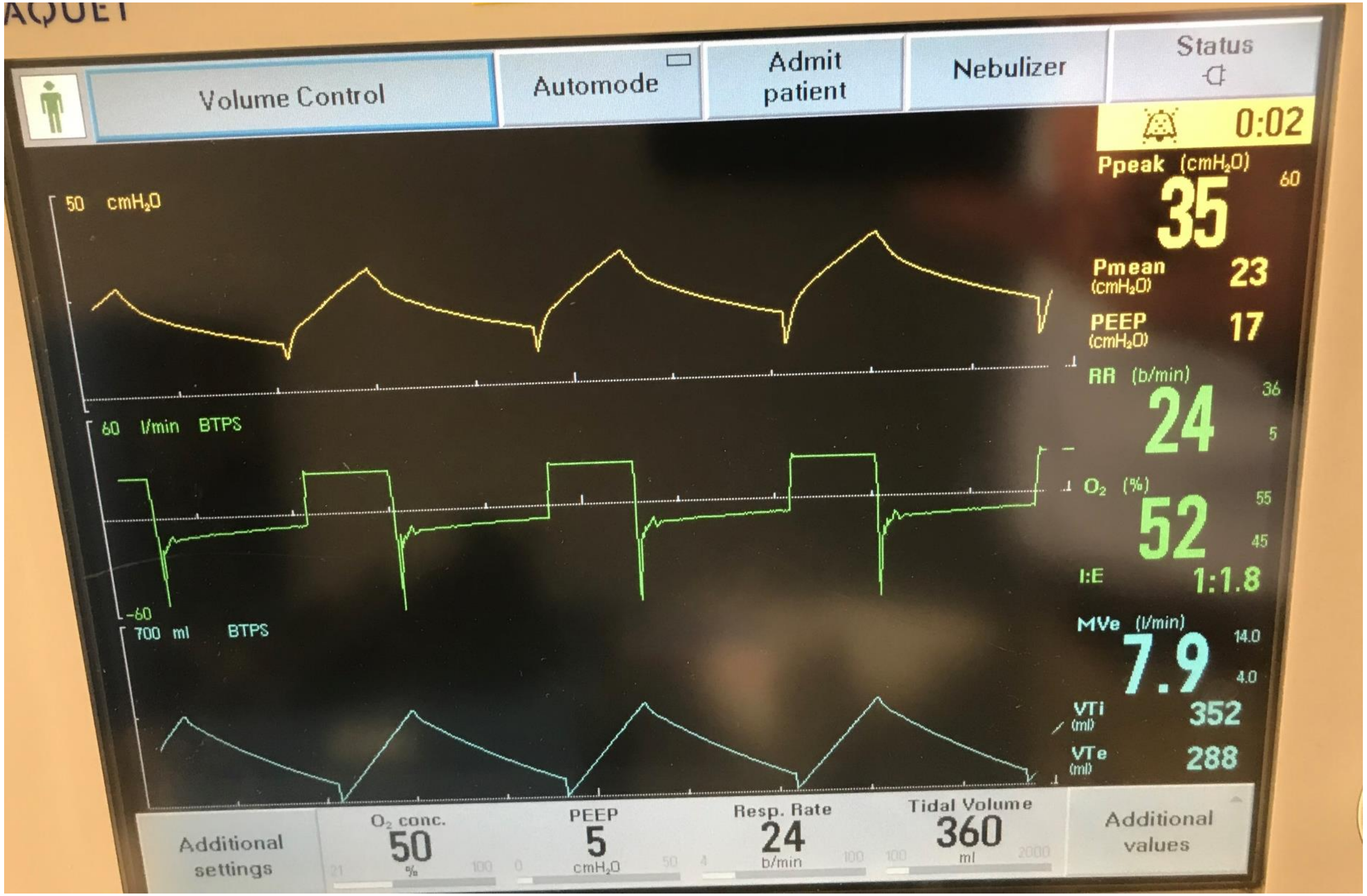
CASE 2: ASTHMA

Case 2



Volume Control
Automode
Admit patient
Nebulizer
Status
0:02
Pressure
50 cmH2O
Flow
60 l/min BTPS
-60
Volume
700 ml BTPS
Ppeak (cmH2O) 35
60
Pmean (cmH2O) 23
PEEP (cmH2O) 17
RR (b/min) 24
36
5
O2 (%) 52
55
45
I:E 1:1.8
MVe (l/min) 7.9
14.0
4.0
VTi (ml) 352
VTe (ml) 288
Additional settings
O2 conc. 50 %
PEEP 5 cmH2O
Resp. Rate 24 b/min
Tidal Volume 360 ml
Additional values

What is the problem with the vent waveform?

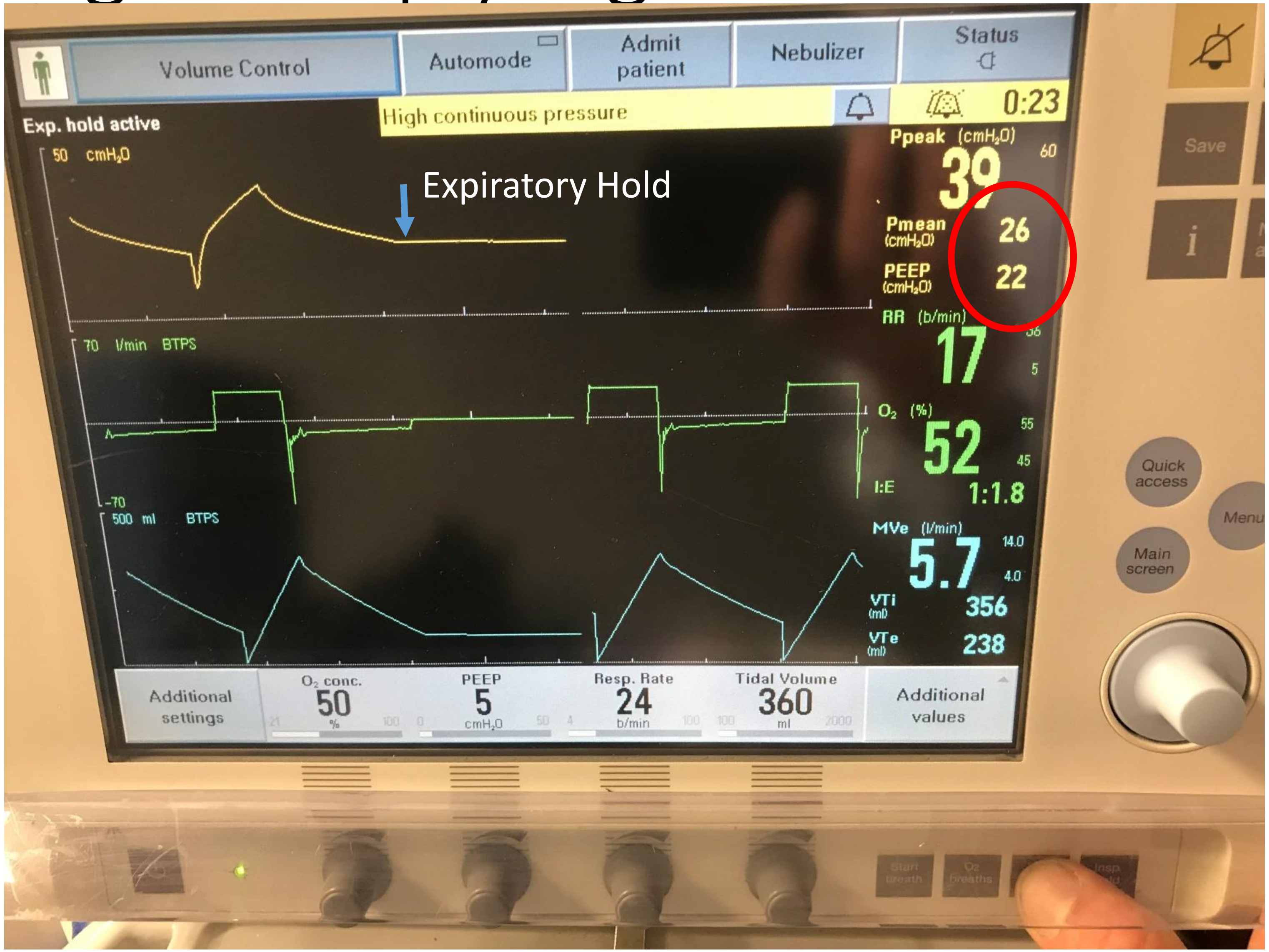


How do we know what is causing the high peak pressures?

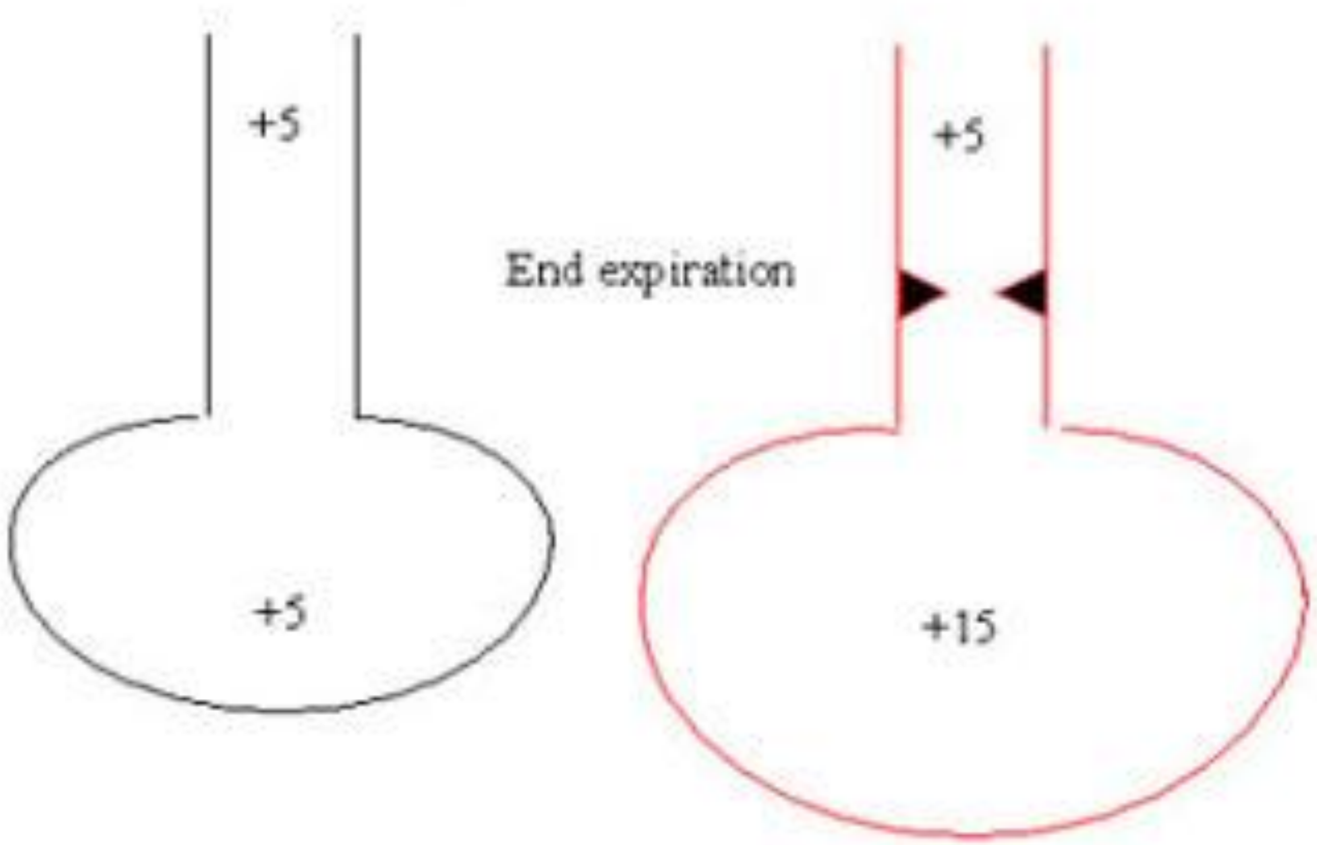
$$\mathbf{P_{vent} = P_{elastic} + P_{resistive}}$$

$$\mathbf{P_{vent\,=}\ (Elastance * Volume) + \cancel{(Resistance * Flow)}}$$

Is there air trapping or simply high resistance?



What is AutoPEEP?



For more on Auto-PEEP…

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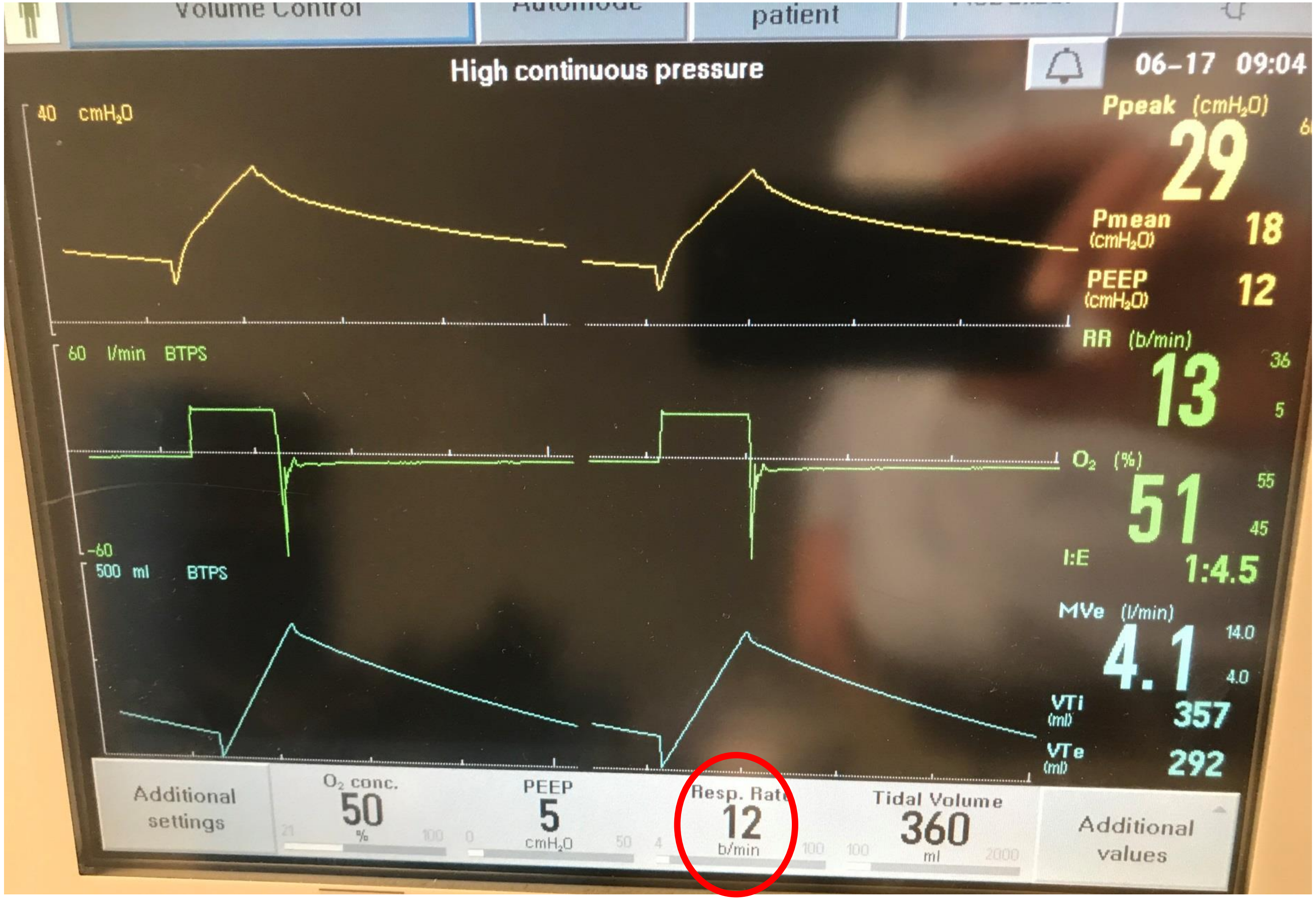
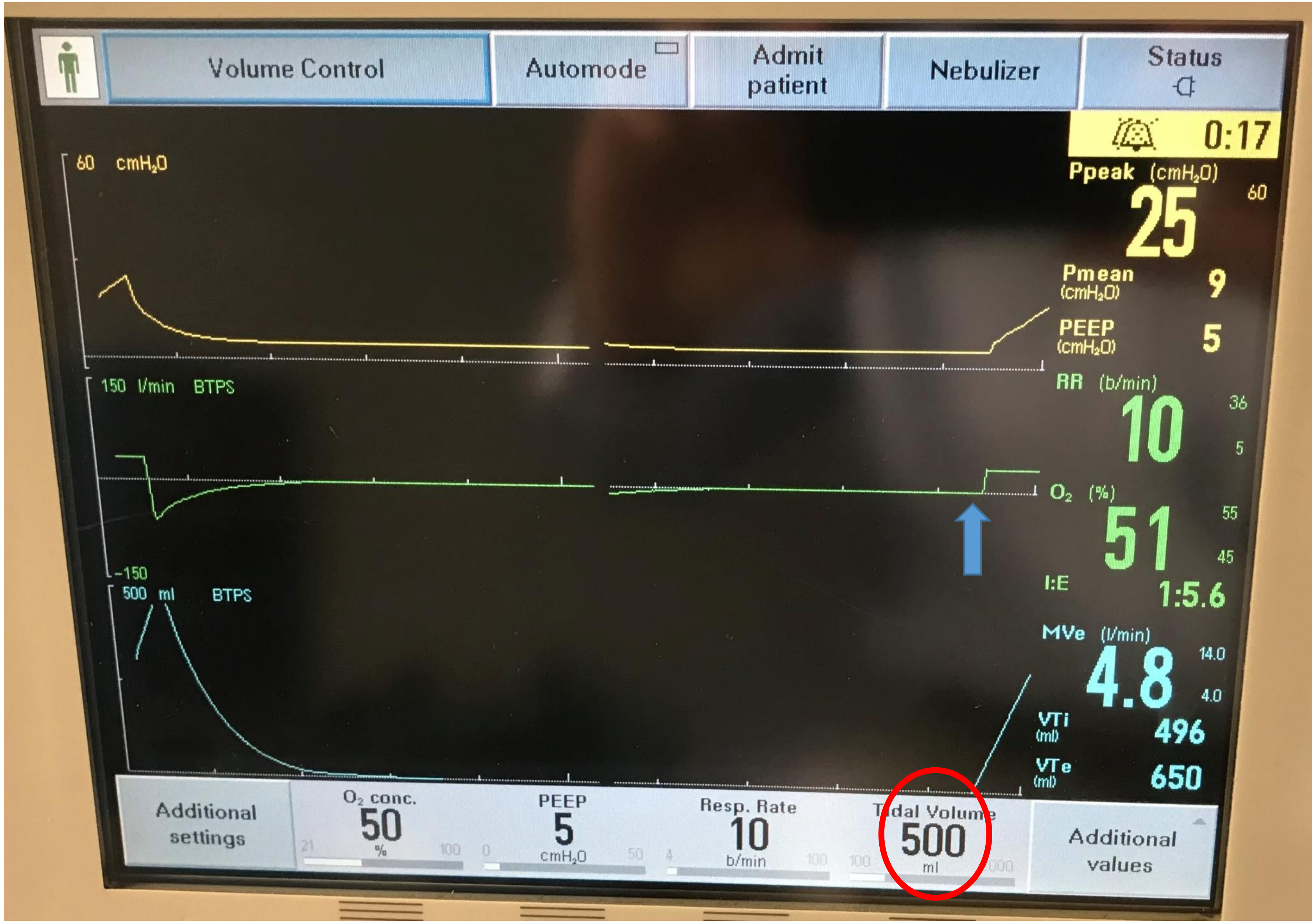
Best of ATS Video Lecture Series Video

How might we correct AutoPEEP?



Uh Oh… what’s wrong now!


Volume Control
Automode
Admit patient
Nebulizer
Status
0:17
60 cmH2O
Ppeak (cmH2O)
25
60
Pmean (cmH2O)
9
PEEP (cmH2O)
5
150 l/min BTPS
RR (b/min)
10
36
5
O2 (%)
51
55
45
-150
500 ml BTPS
I:E
1:5.6
MVe (l/min)
4.8
14.0
4.0
VTi (ml)
496
VTe (ml)
650
Additional settings
O2 conc.
50
%
21
100
PEEP
5
cmH2O
0
50
Resp. Rate
10
b/min
4
100
Tidal Volume
500
ml
100
Additional values

LARGE GROUP

Key Points

- Remember the equation of motion
- Tidal volume and PEEP affect the plateau pressure
- PEEP and FIO2 affect PaO2
- Rate and tidal volume affect PCO2
- Maximize expiratory time to prevent dynamic hyperinflation.
- Look at the waveforms
- Don’t be afraid of the vent. It won’t bite you (despite what they say).

We wish you the best in your fellowship

- Rendell Ashton, MD
- Neal Chaisson, MD
- Susie Vehar, MD
- Sam Wiles, MD
- Steve Fox, MD
- Aman Thind, MD
- Ahmed Gohar, MD
- Lillie Morgan, MD
- Sherie Gause, MD
- Jorge Morales, MD