# Using Common Ventilator Graphics to Provide Optimal Ventilation

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# Disclosure Information

- No disclosure information related to this topic

# Objectives

- Identify clinical problems associated with mechanical ventilation using a modern ventilator and their graphic package
- Discuss the adjustment of settings and use of graphics in correcting common clinical problems

# Topics

- Common graphics displays
- Pressure, flow and volume - time curves during VCV, PCV, PRVC, SIMV, PSV
- Pressure - volume curves
- Flow-volume loops
- Common clinical conditions
- Case study

# Common Graphics Displays

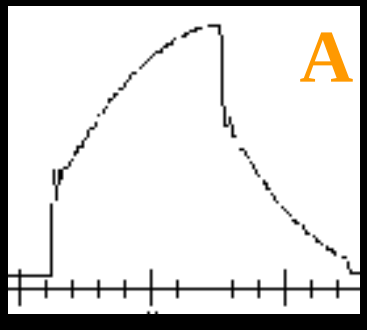
A. Pressure - Time curves

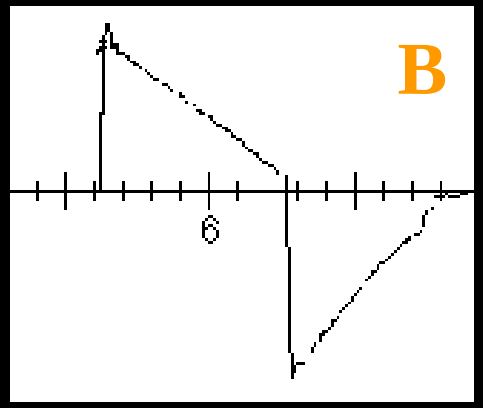
B. Flow - Time curves

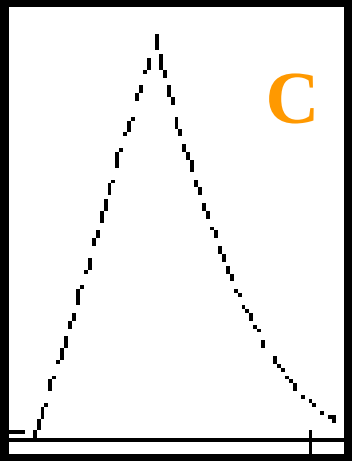
C. Volume - Time curves

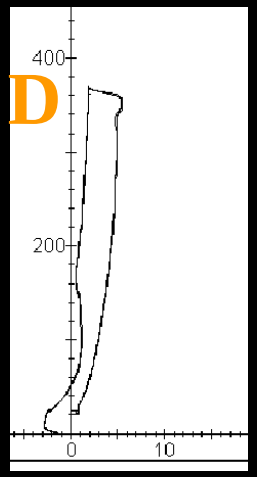
D. Pressure -Volume curves

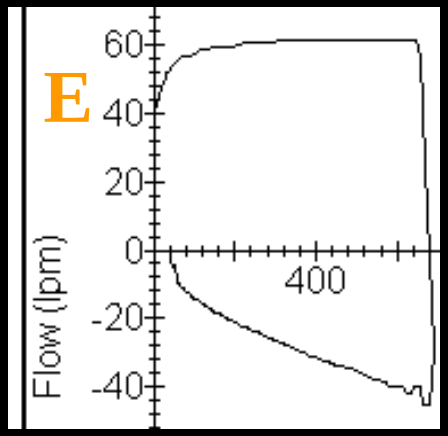
E. Flow - Volume curves



# Modes of Ventilation

- **Two parts**
  - **Pattern of the Breaths**
  - **Type of Breath Delivered**

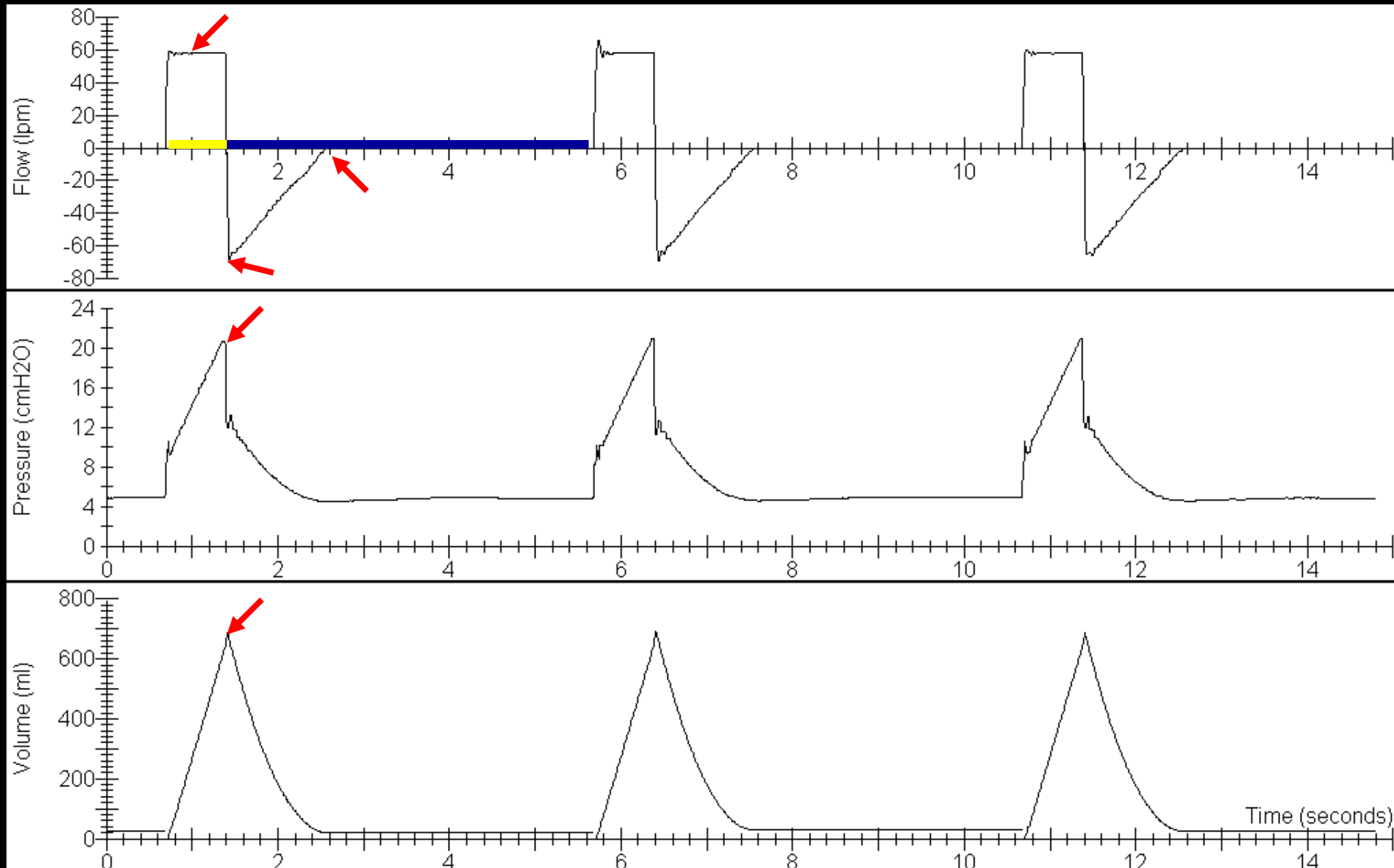
# Modes of Ventilation

- **Pattern of the Breaths**
  - **Assist/Control**
    - *Patient/time triggered into inspiration*
  - **SIMV**
    - *Patient/time triggered into inspiration*
  - **Spontaneous Breathing / CPAP**
    - *Patient triggered into inspiration*

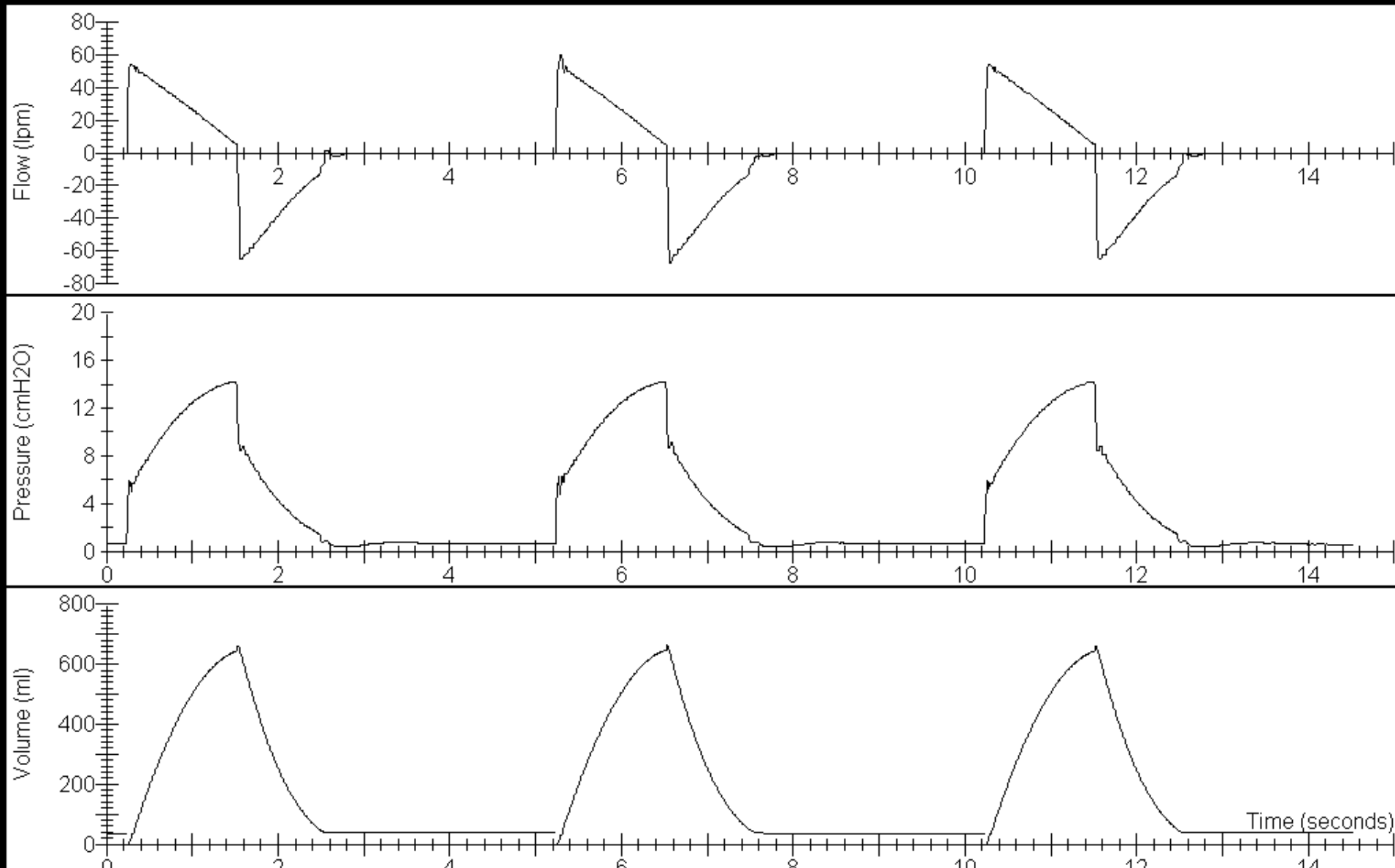
# Modes of Ventilation

- **Type of Breath Delivered**
  - **Volume Ventilation**
    - *Patient/ time triggered, flow/volume limited, Volume / time cycled*
  - **Pressure Control** Ventilation
    - *Patient/ time triggered, pressure limited, time cycled*
  - **Dual Control / Pressure Regulated Volume Control (PRVC)**
    - *Patient/ time triggered, pressure limited and volume targeted, time cycled*
  - **Spontaneous ventilation with Pressure Support**
    - *Patient triggered, pressure limited, flow cycled*

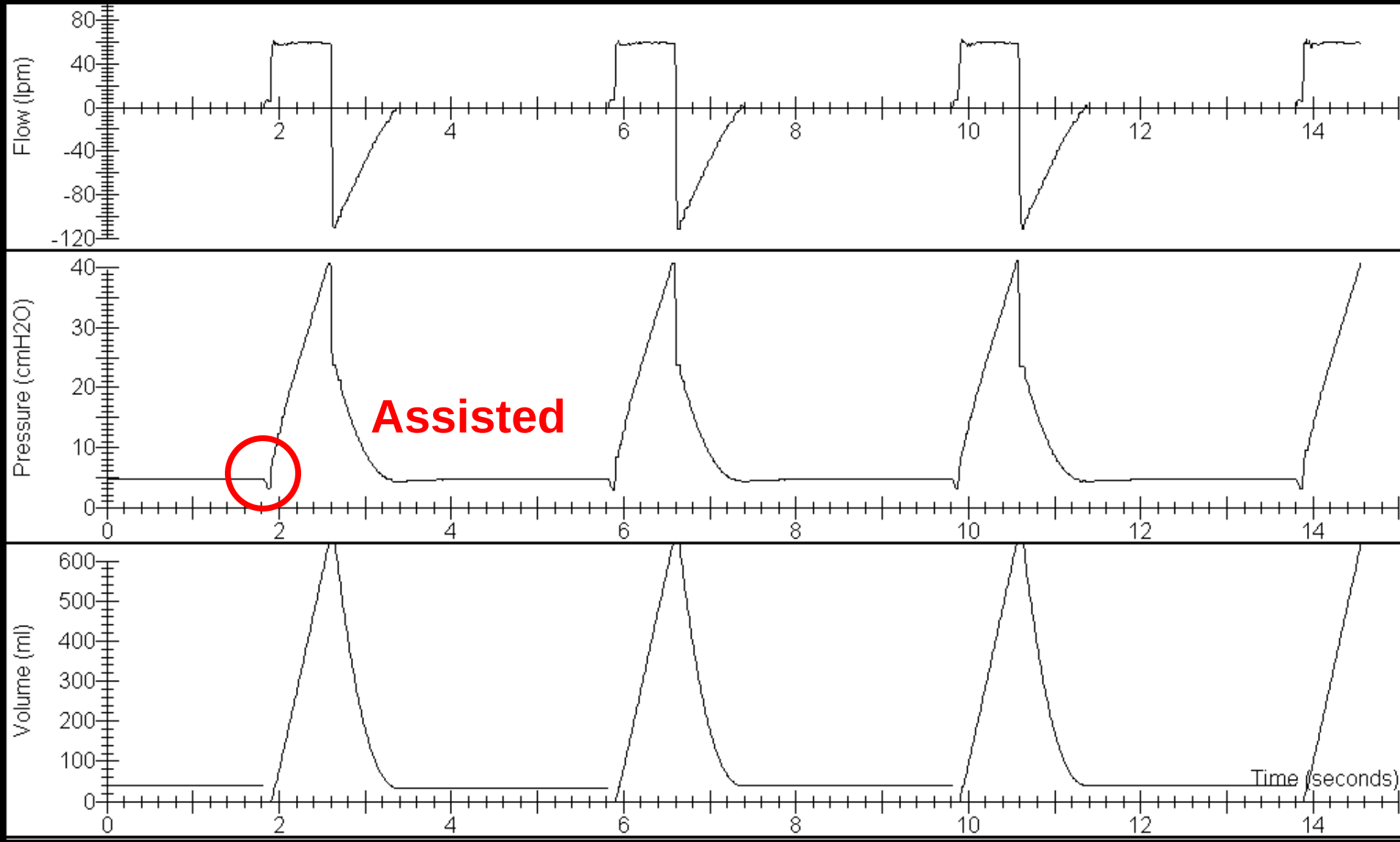
# Flow, Pressure, & Volume Time Curves during Volume Control Ventilation



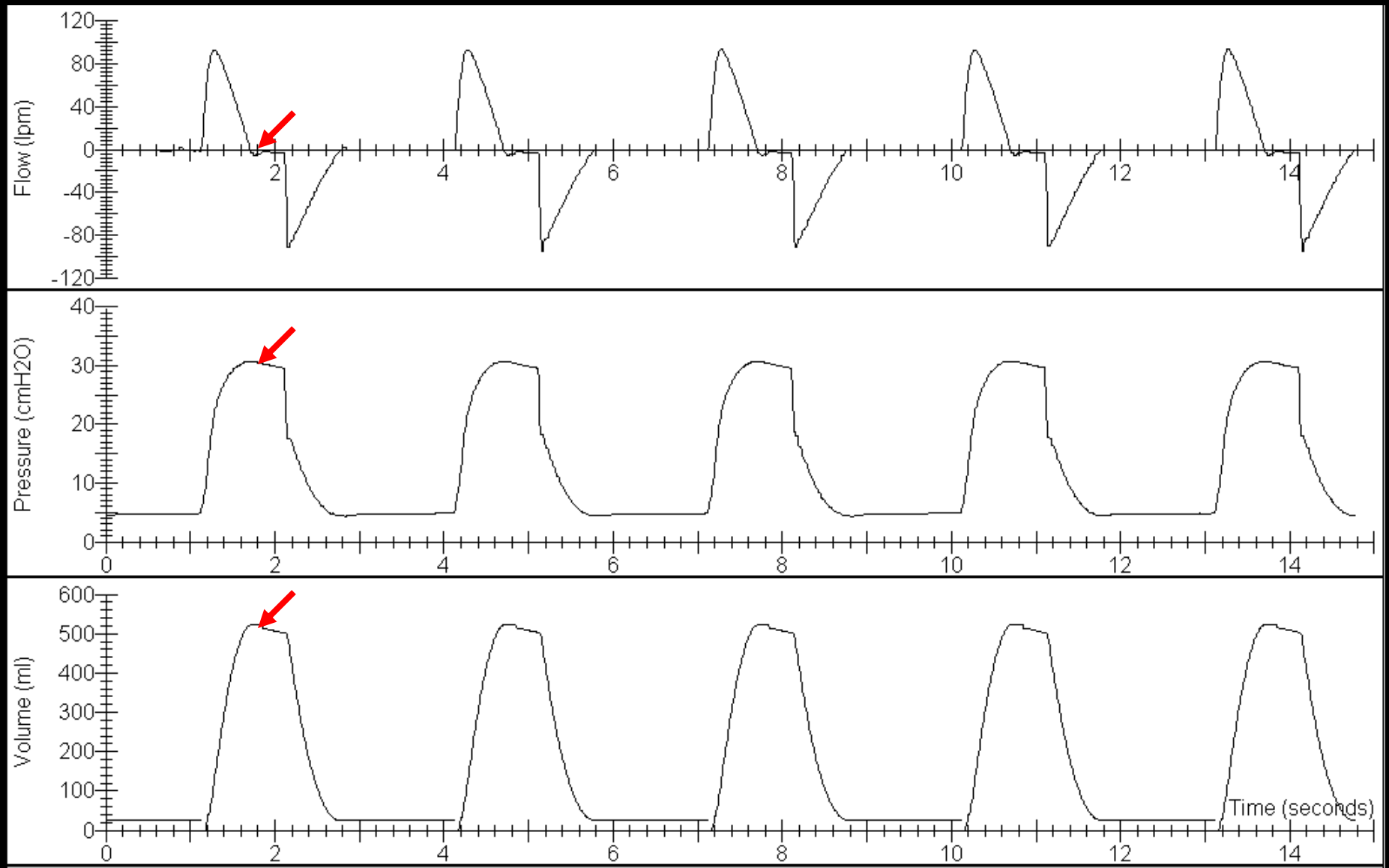
# Flow, Pressure, & Volume Time Curves during Volume Control Ventilation



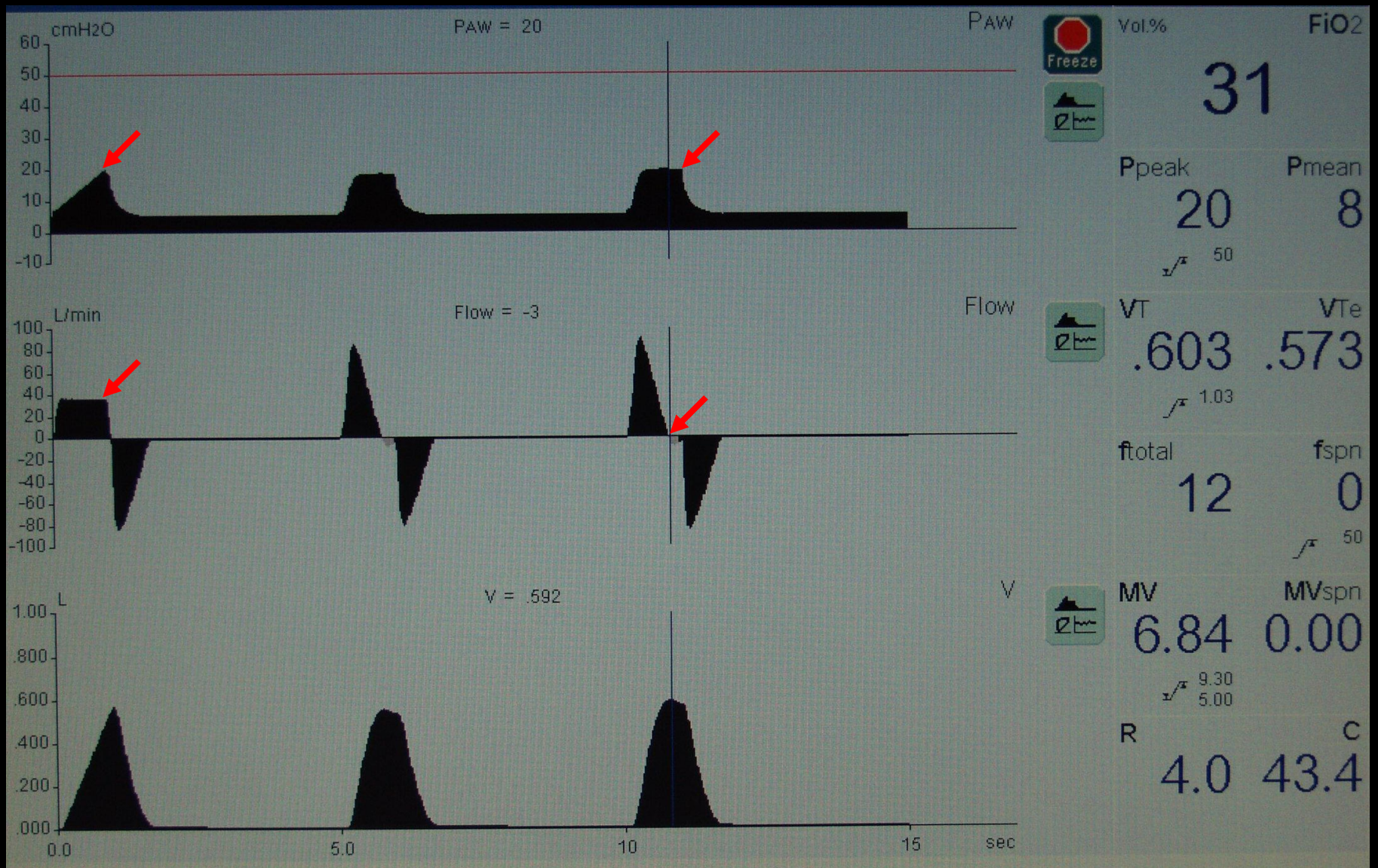
# Flow, Pressure, & Volume Time Curves during Volume Control Ventilation



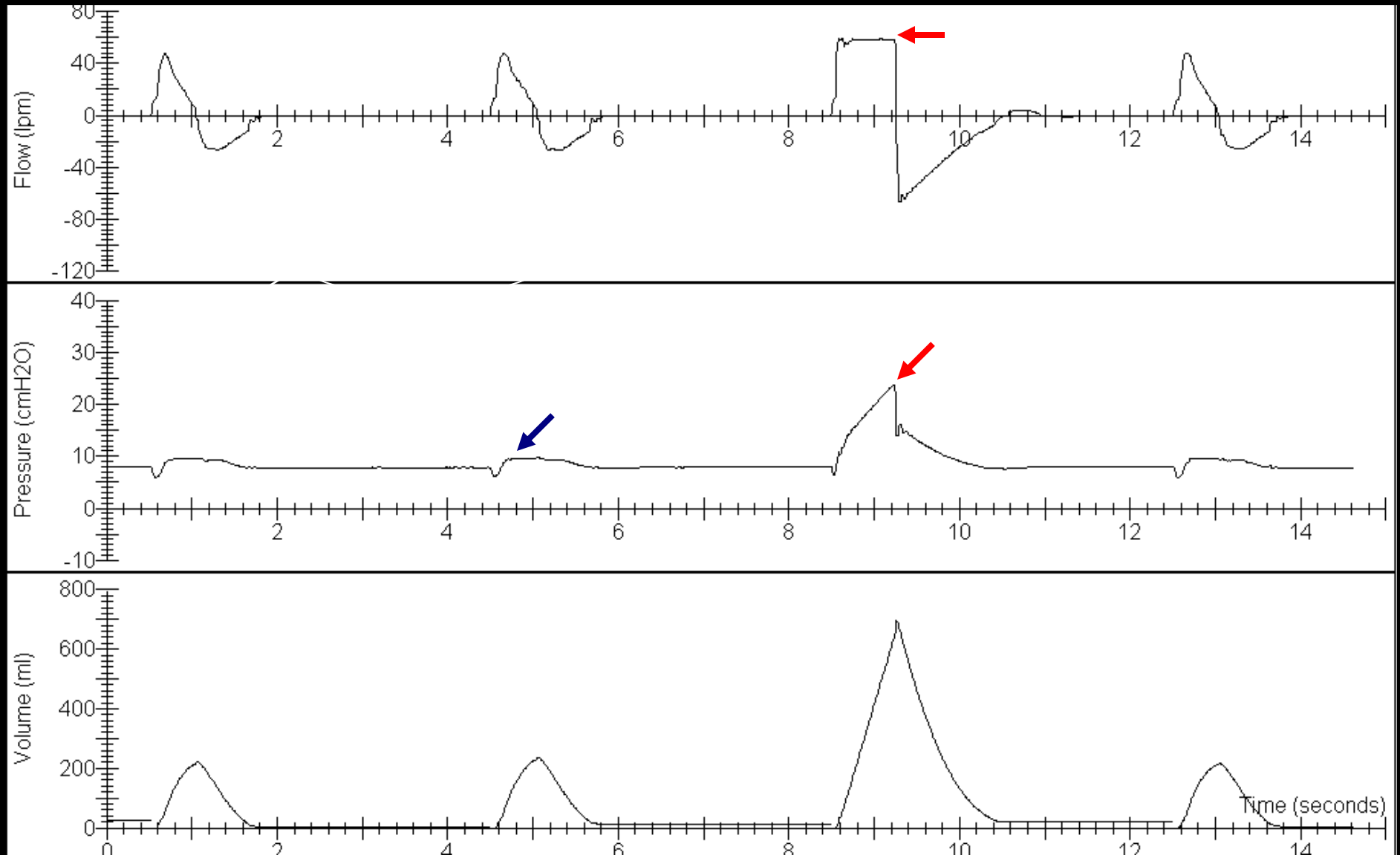
# Flow, Pressure, & Volume Time Curves during Pressure Control Ventilation



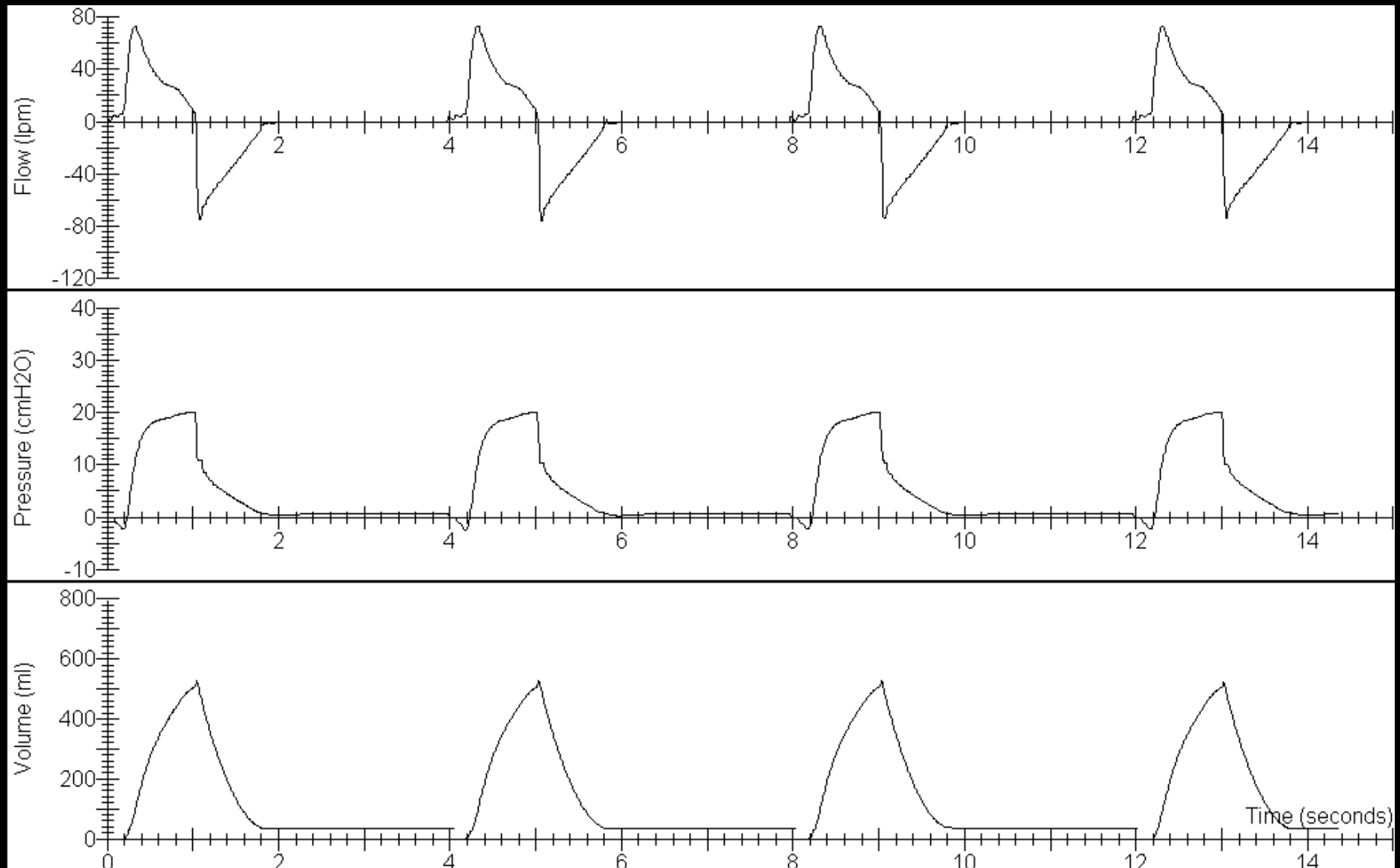
# Flow, Pressure, & Volume Time Curves during AutoFlow (PRVC)



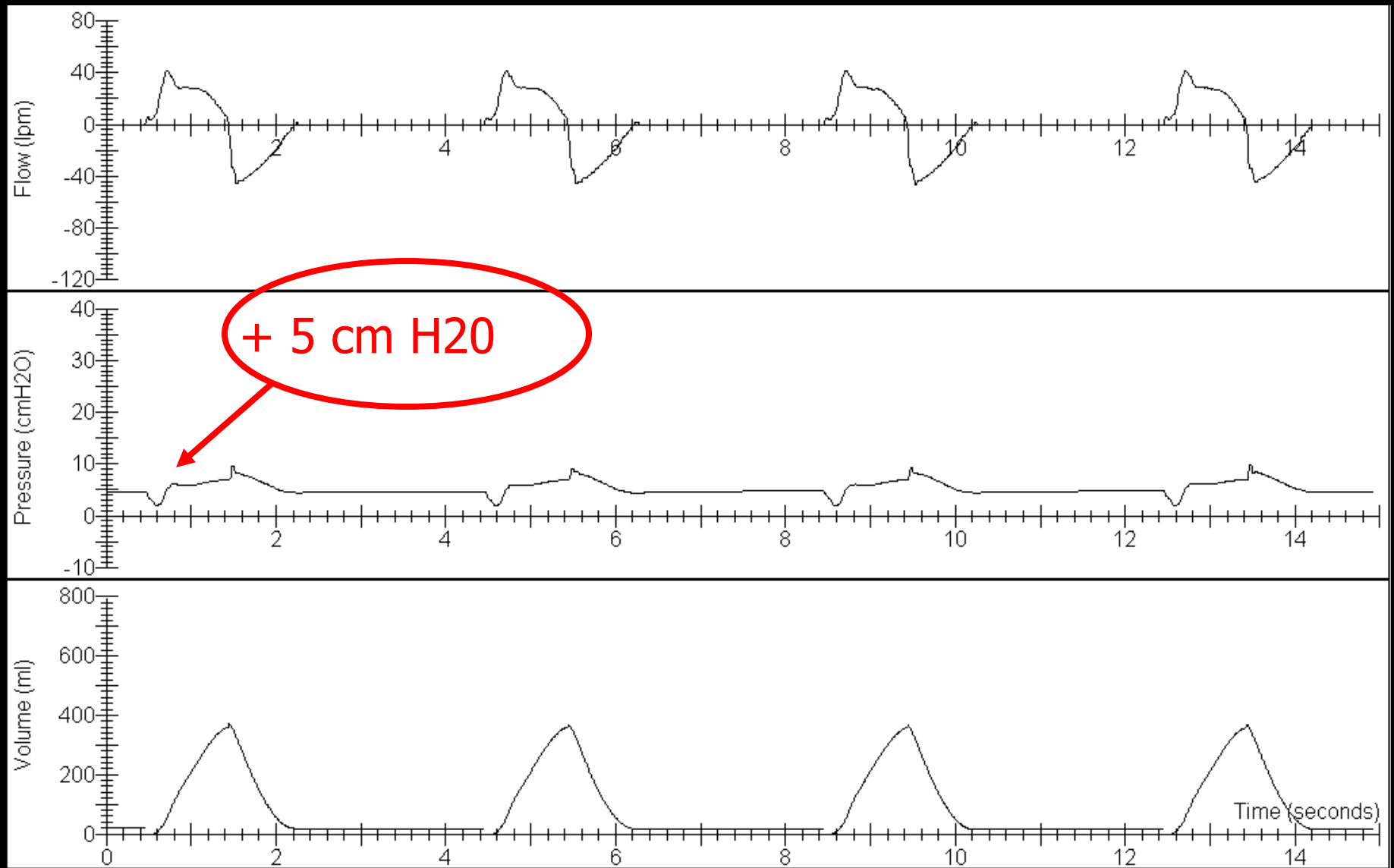
# Flow, Pressure, & Volume Time Curves during SIMV- volume with CPAP



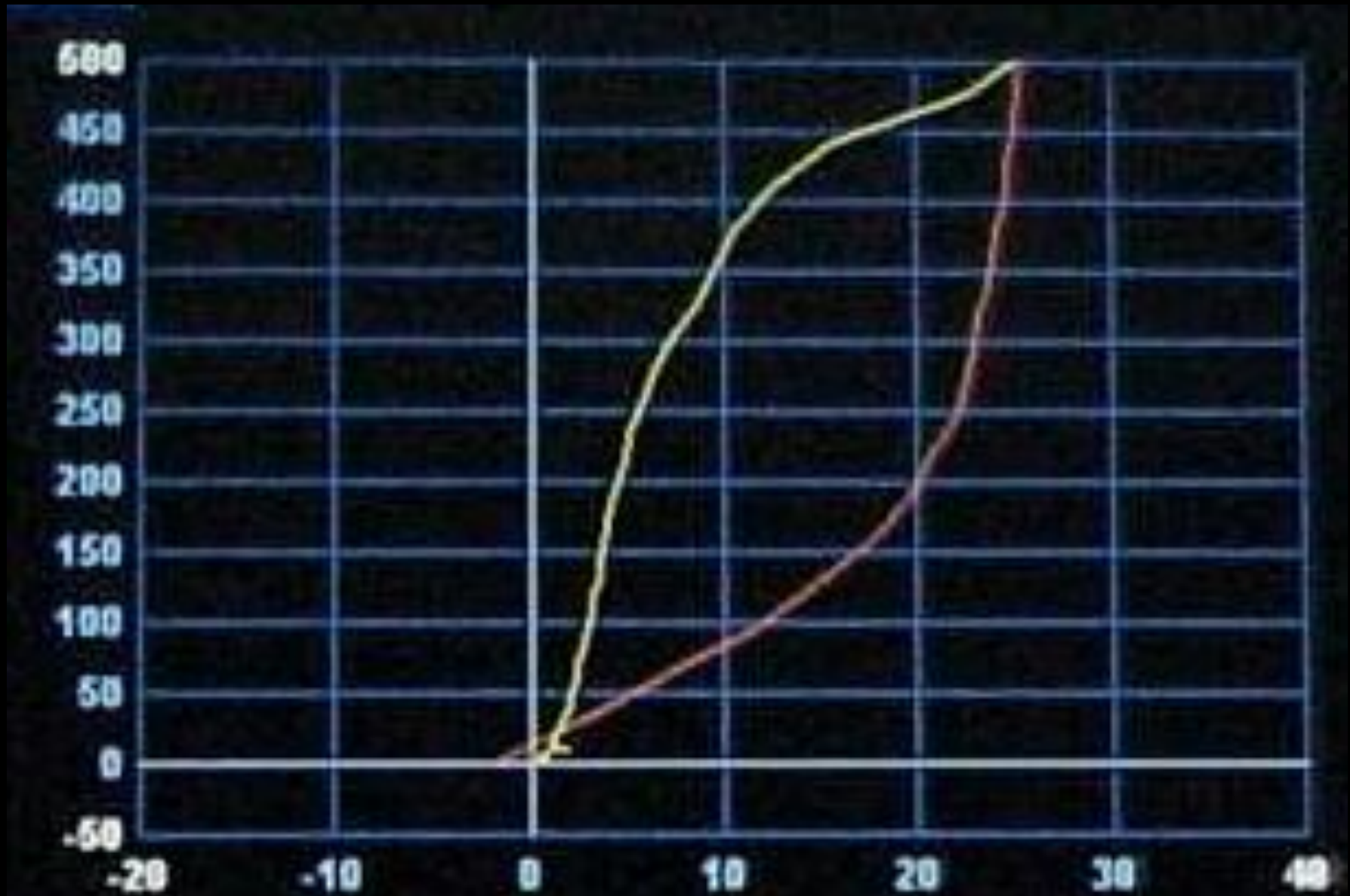
# Flow, Pressure, & Volume Time Curves during Spontaneous Breathing on PSV



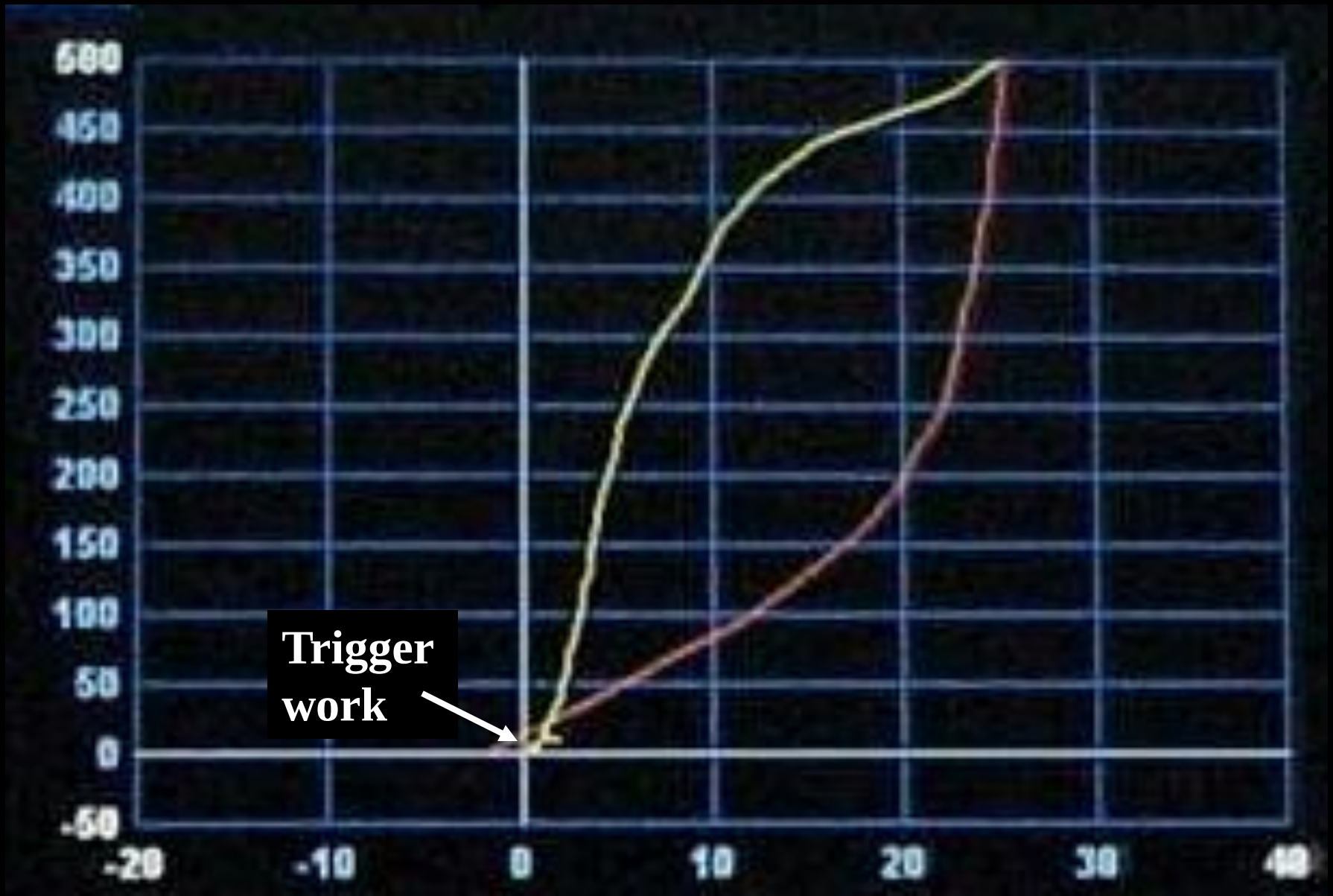
# Flow, Pressure, & Volume Time Curves during Spontaneous Breathing on CPAP



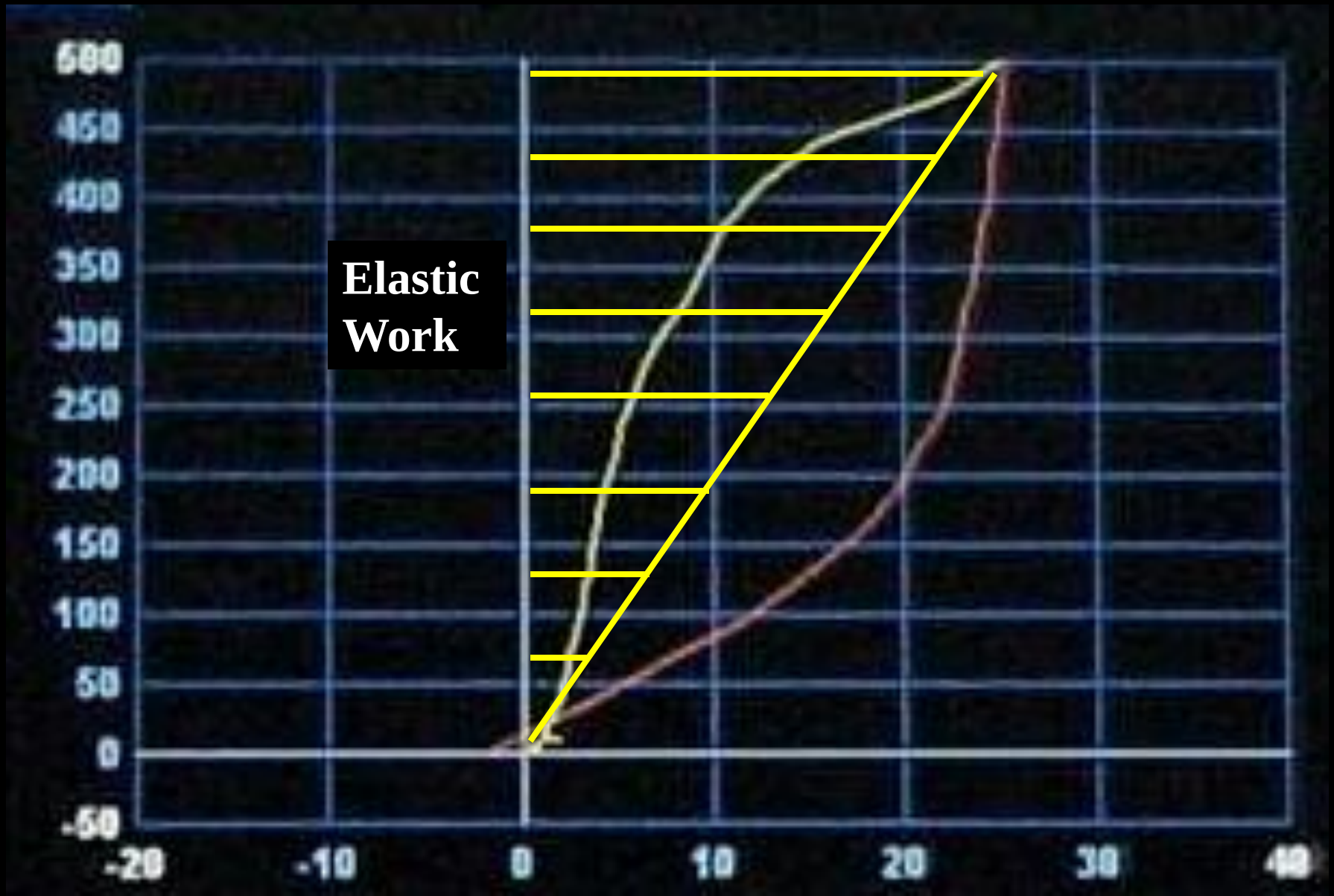
# Pressure-Volume Curve during Volume Control Ventilation



# Pressure-Volume Curve during Volume Control Ventilation



# Pressure-Volume Curve during Volume Control Ventilation

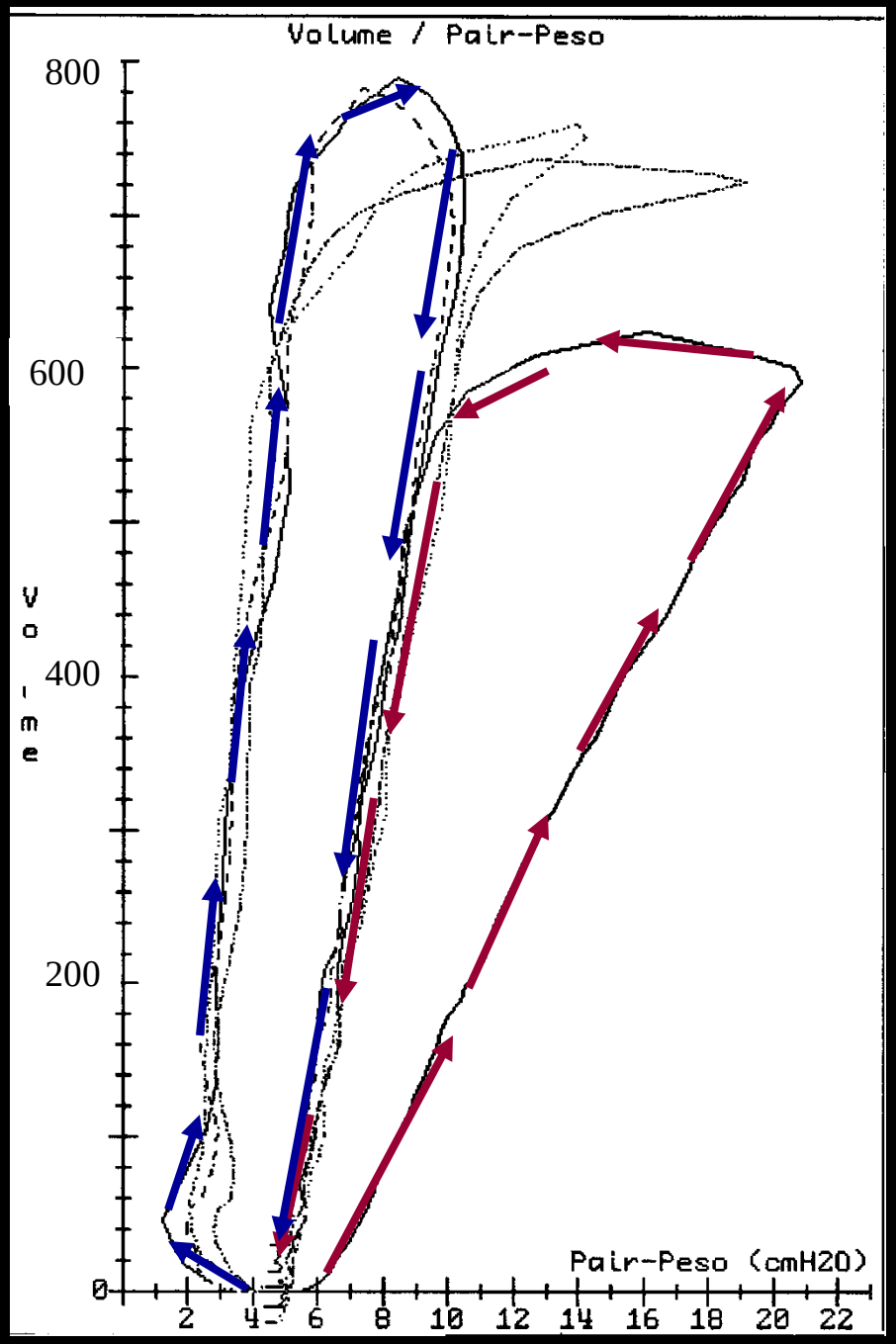


# Pressure-Volume Curve during Volume Control Ventilation

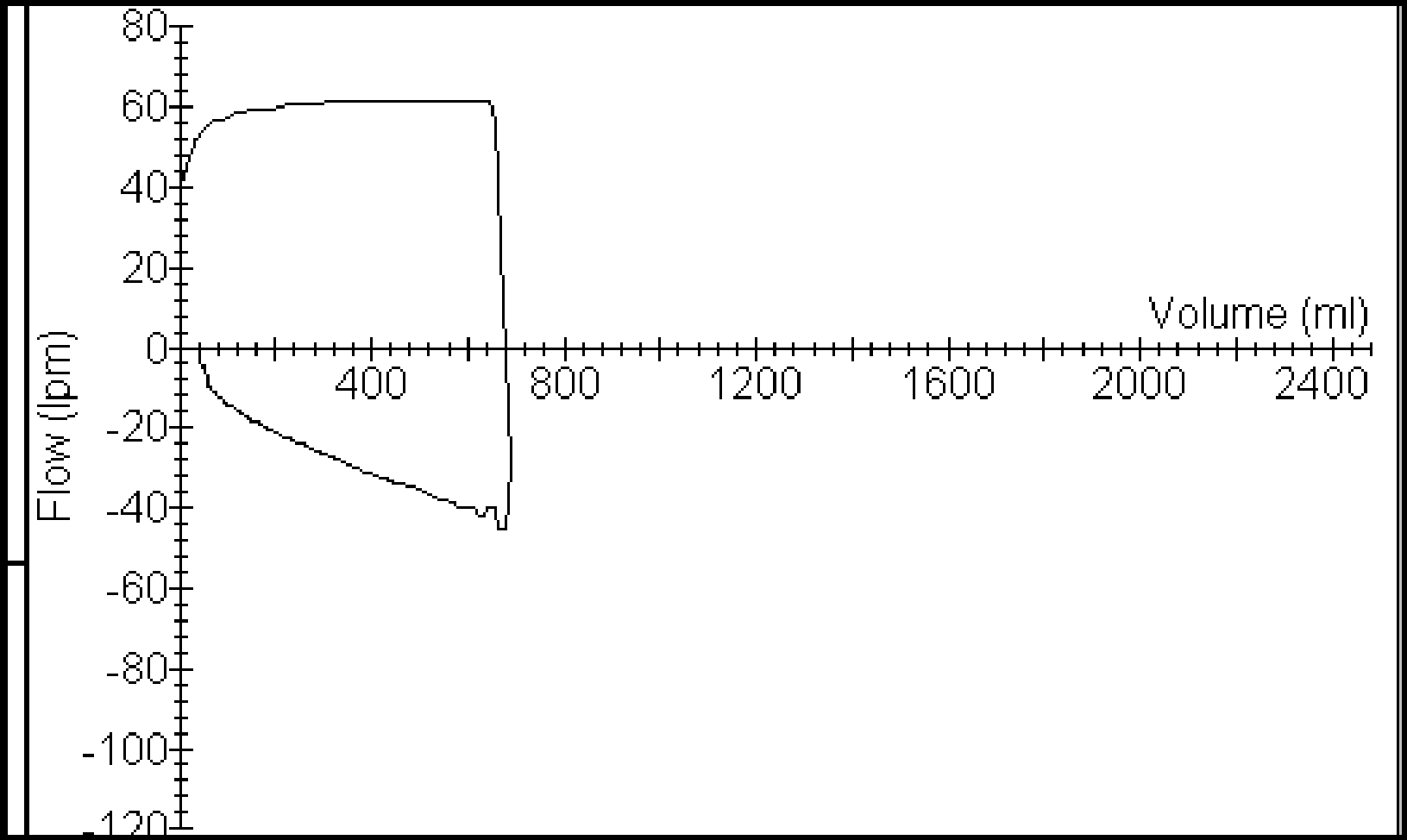
# Pressure-Volume Curve & Trigger Work

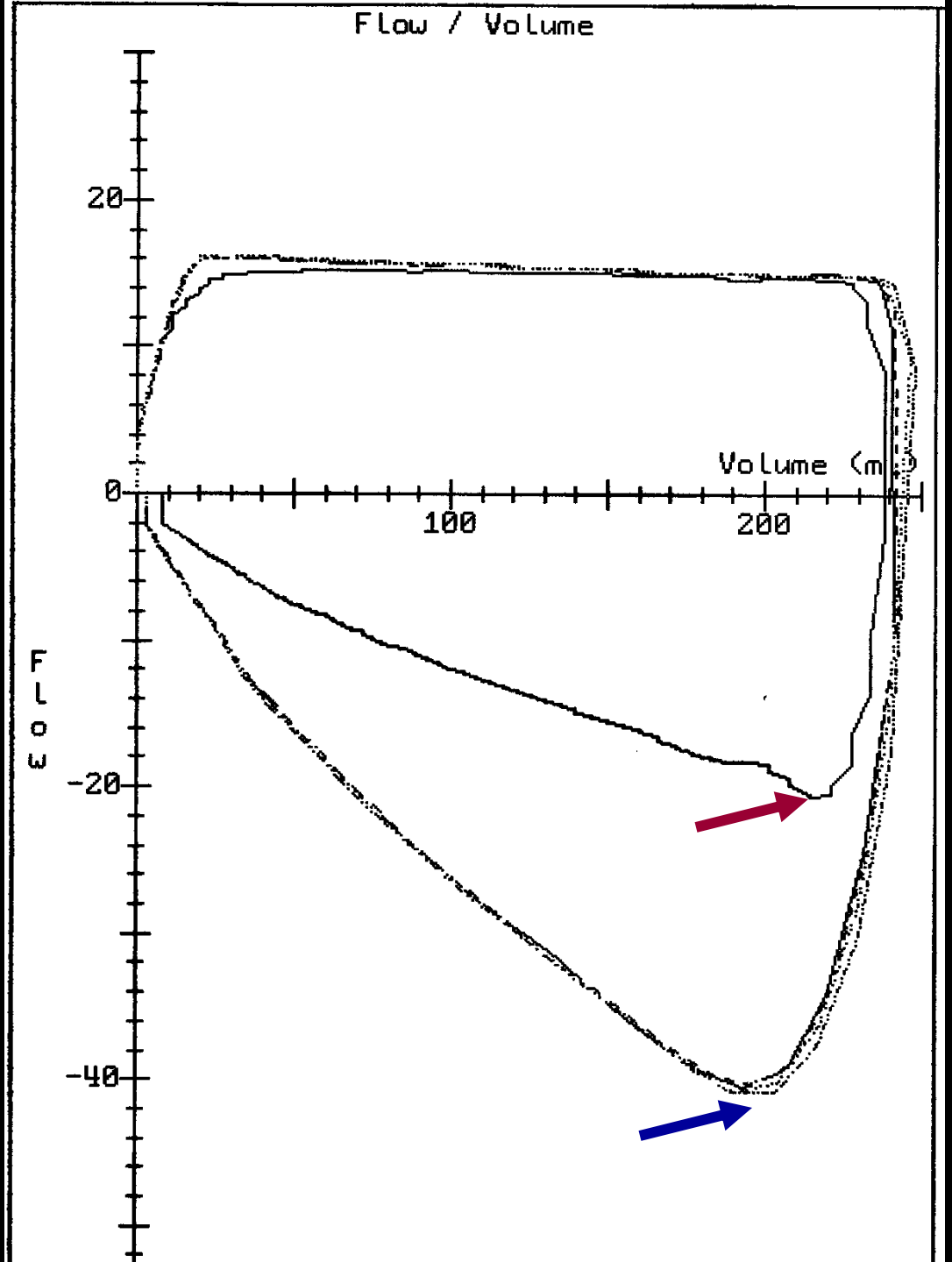

**Pressure Trigger**


**Flow Trigger**


Volume / Pair-Peso
800
600
400
200
0
Volumen
Pair-Peso (cmH2O)
2
4
6
8
10
12
14
16
18
20
22

# Flow-Volume Loop during Volume Control Ventilation

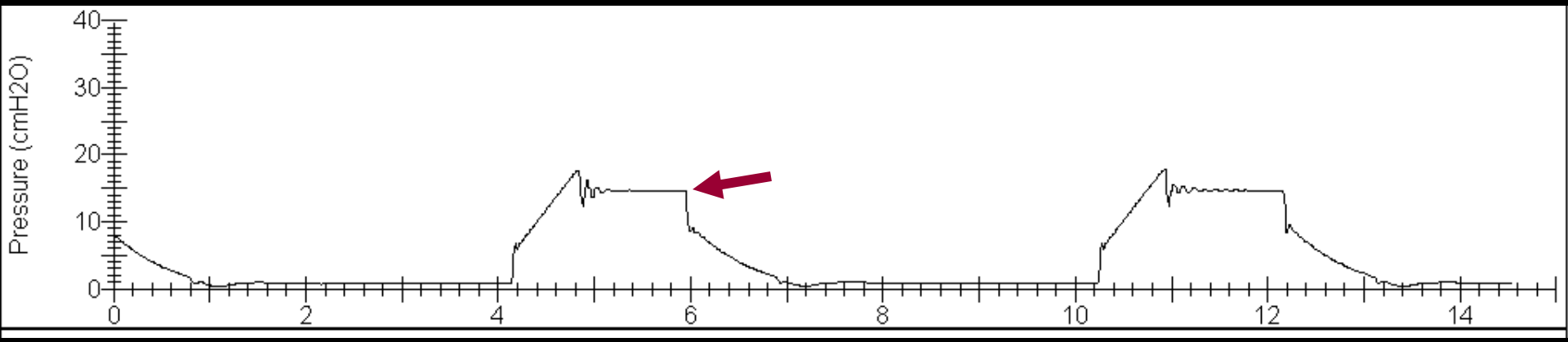


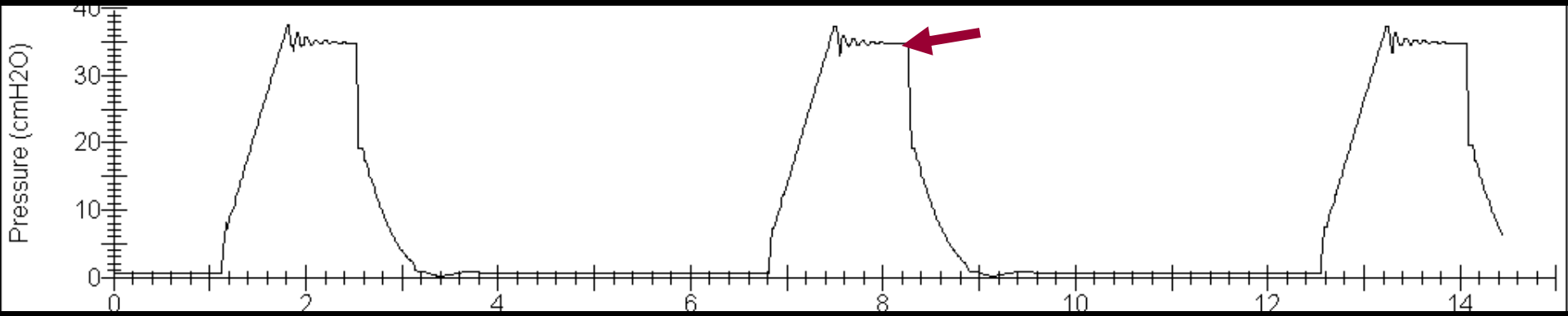

Flow / Volume
20
0
-20
-40
100
200
Volume (m
Flo

# Common Clinical Problems

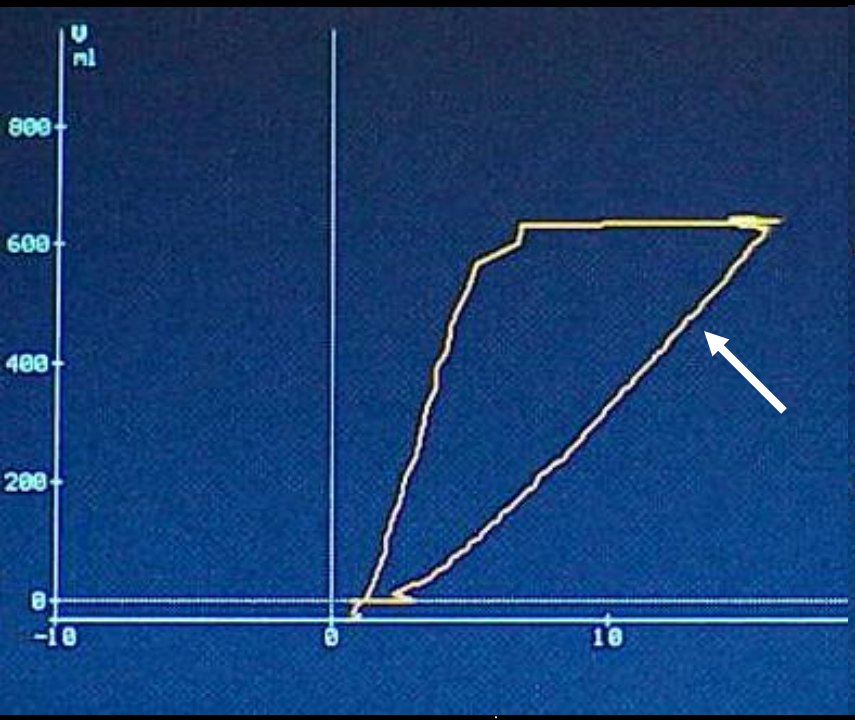
- Increased Impedance
  - ↓Compliance and ↑Resistance
- Over distension
- Inadequate inspiratory flows
- Air leak
- Auto PEEP and I:E Ratio
- Setting Rise Time or Pressure Ramp
- Setting Expiratory Trigger Sensitivity (ETS)

# Decreased Compliance during Volume Control Ventilation

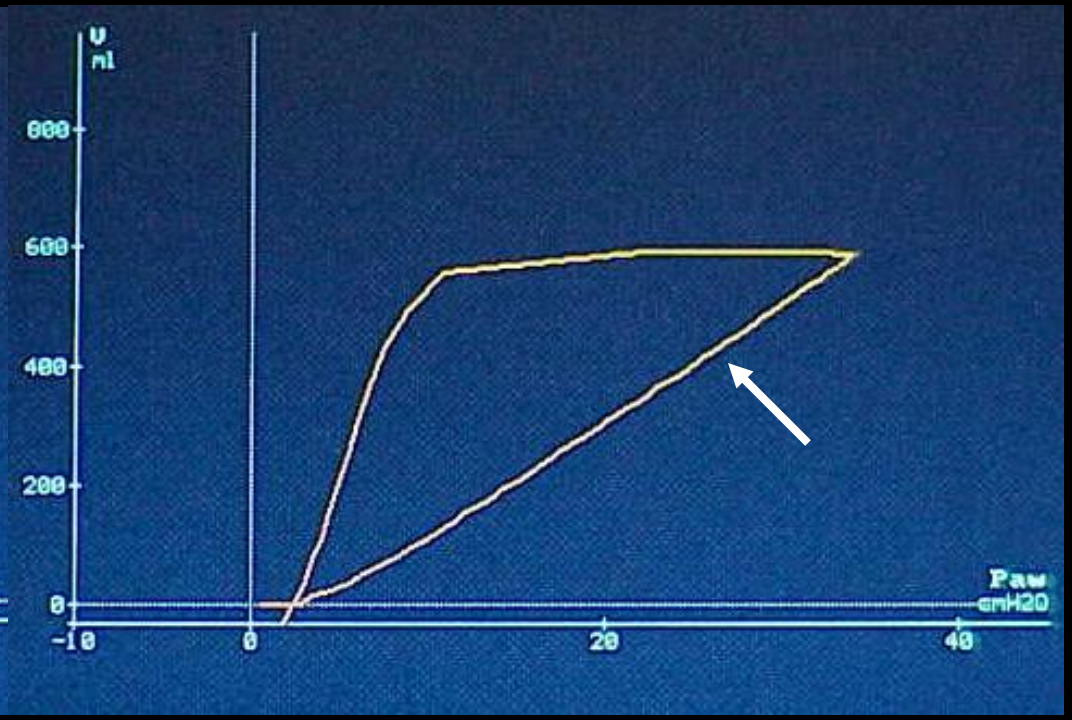


# Decreased Compliance during Volume Control Ventilation

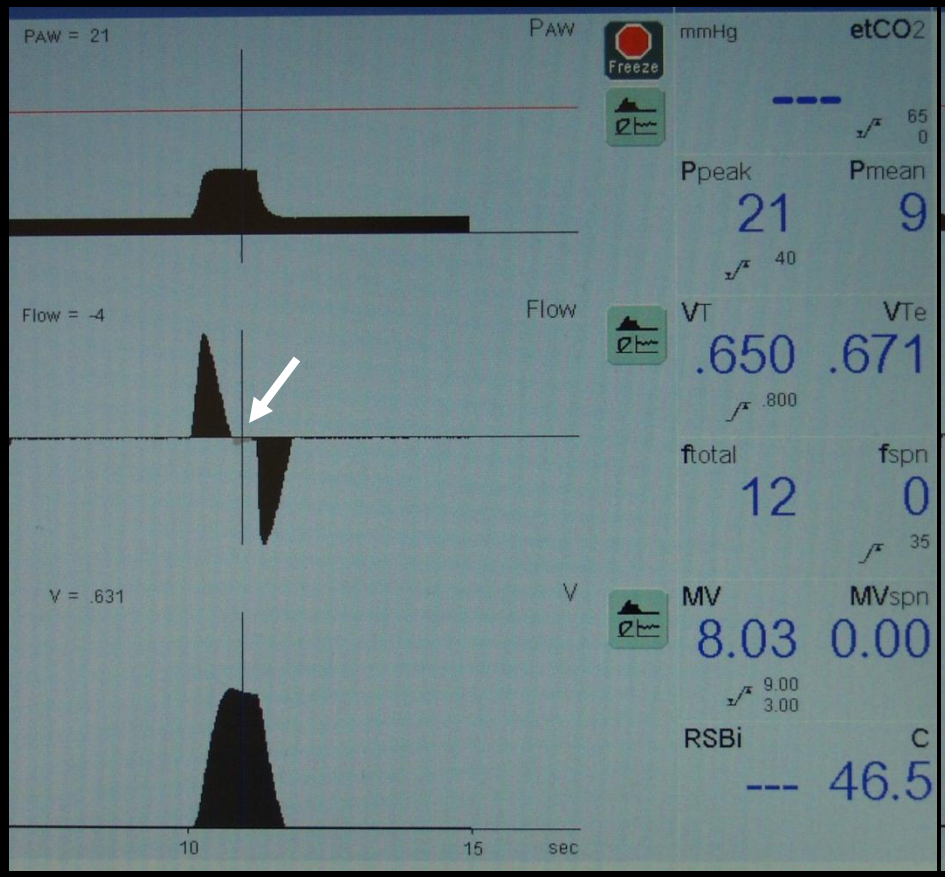


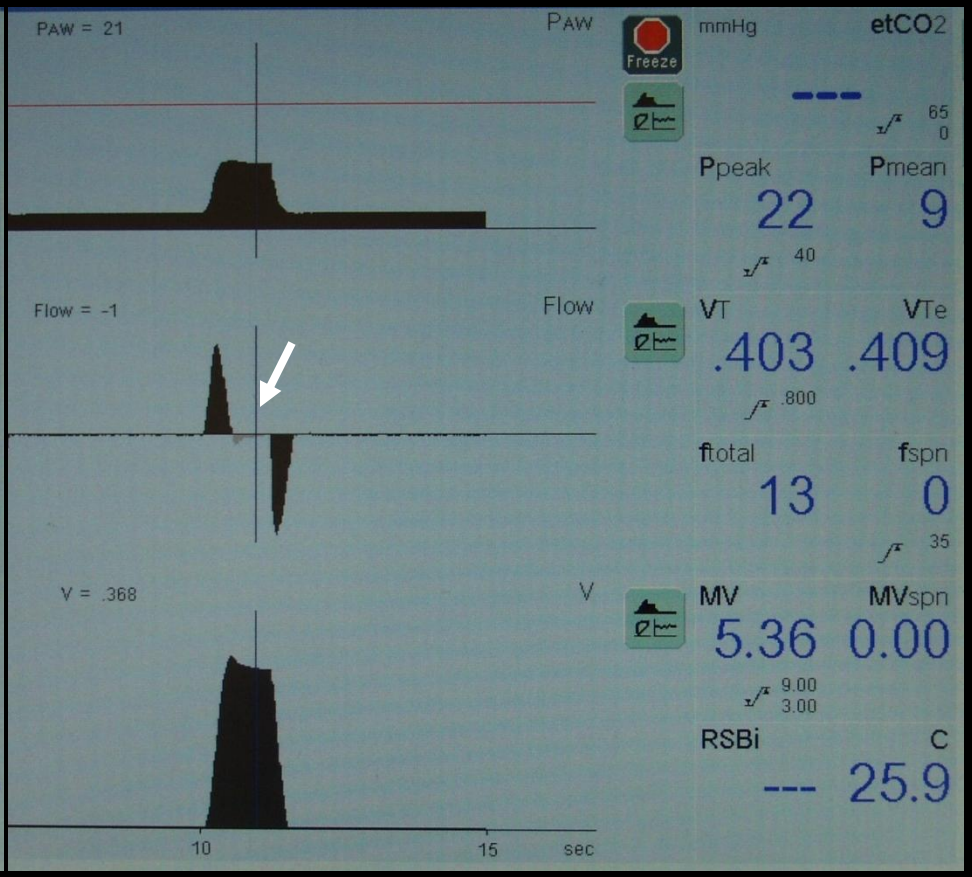

C=.05;R=5;




C=.02;R=5;

# Decreased Compliance during Pressure Control Ventilation



# Decreased Compliance during PRVC

# Increased Resistance during Volume Control Ventilation

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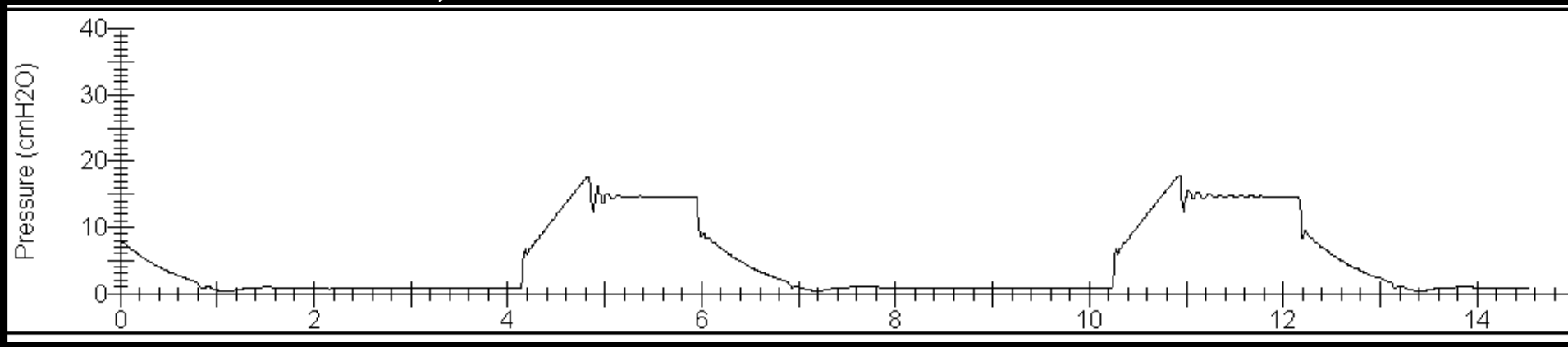
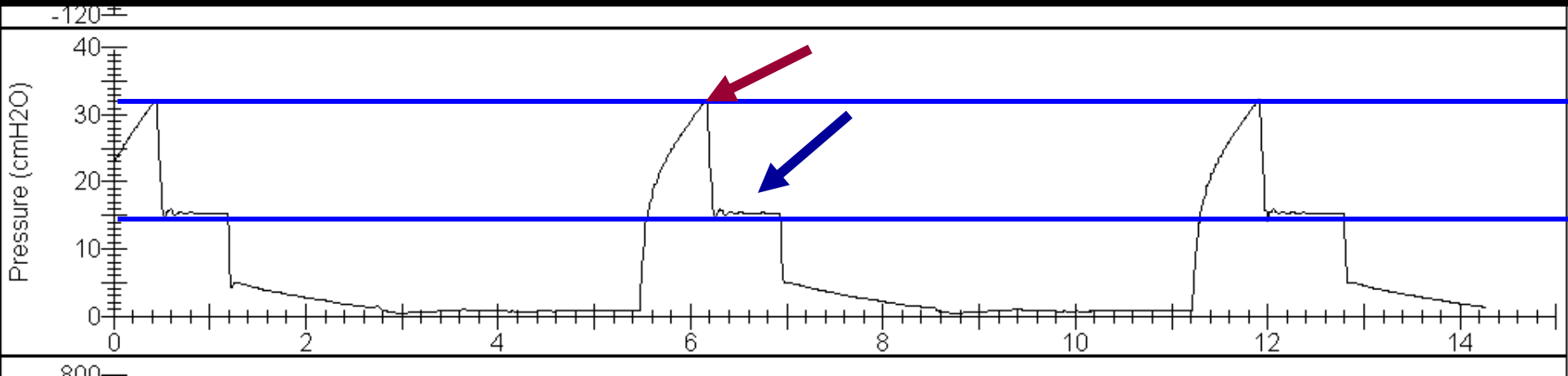
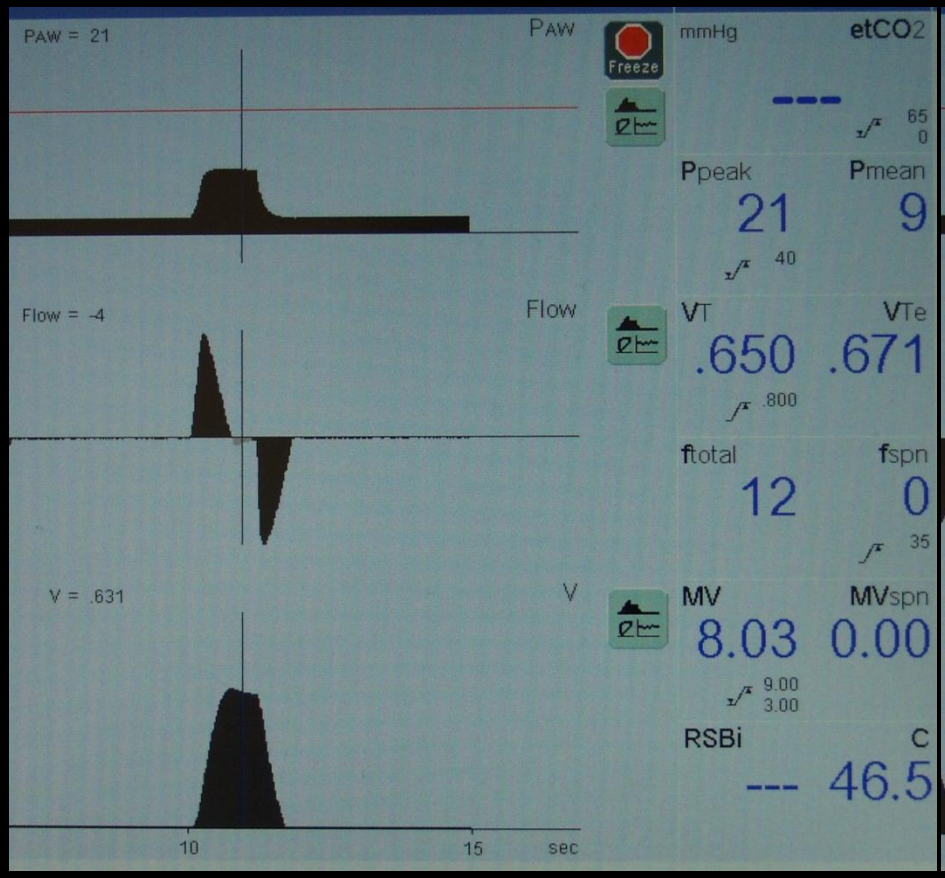


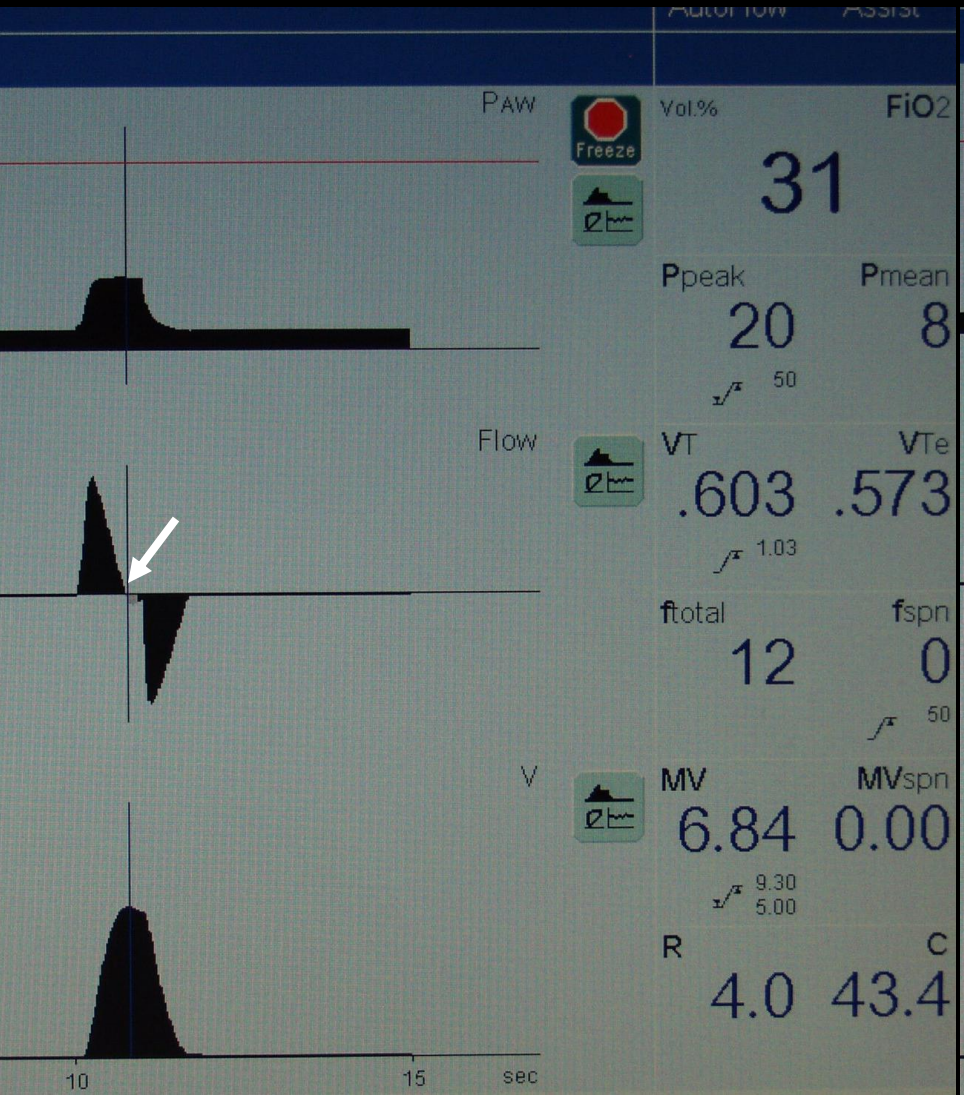

C=.05;R=20

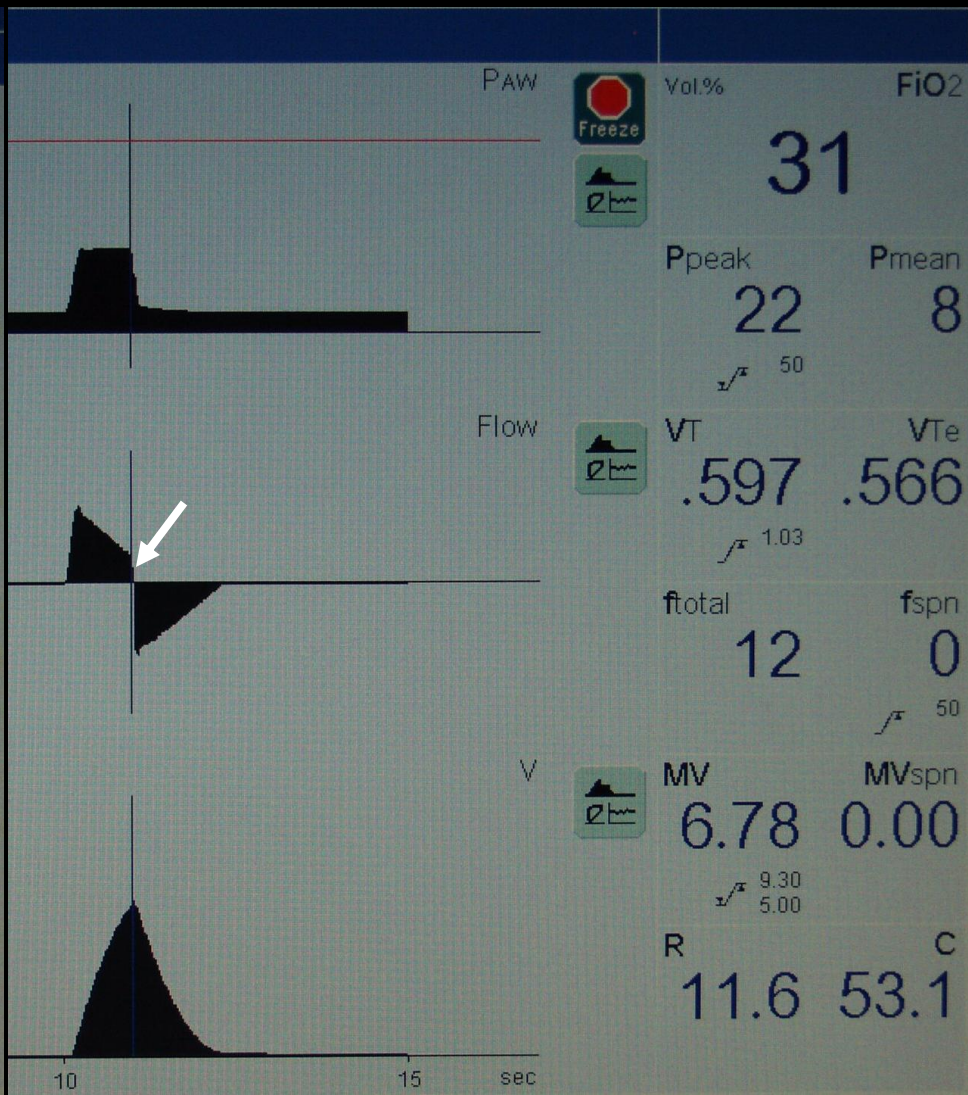


# Increased Resistance during Pressure Control Ventilation

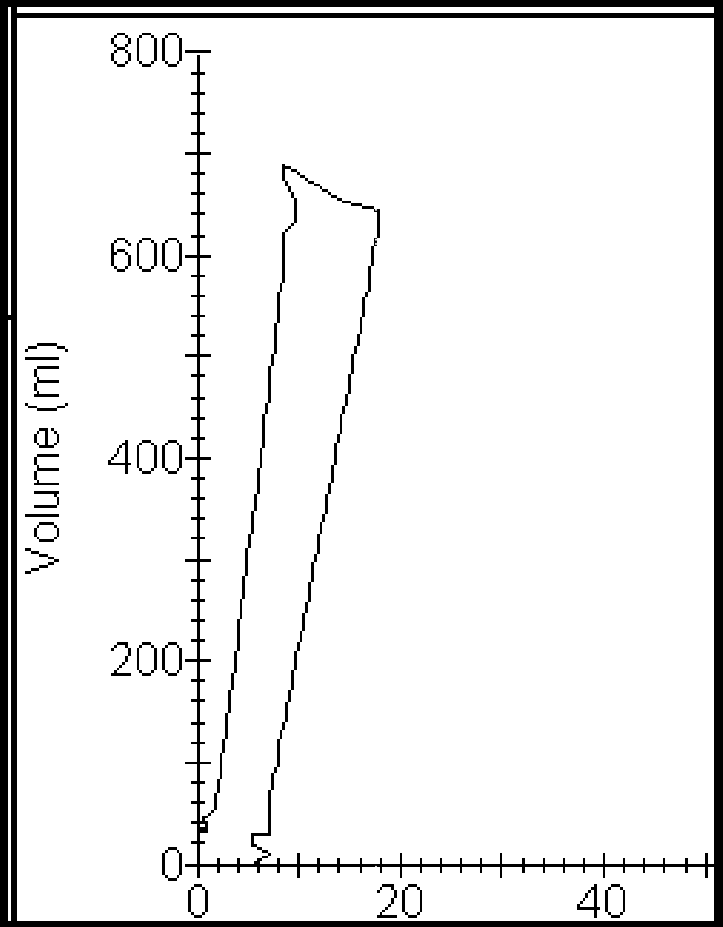



# Increased Resistance during PRVC

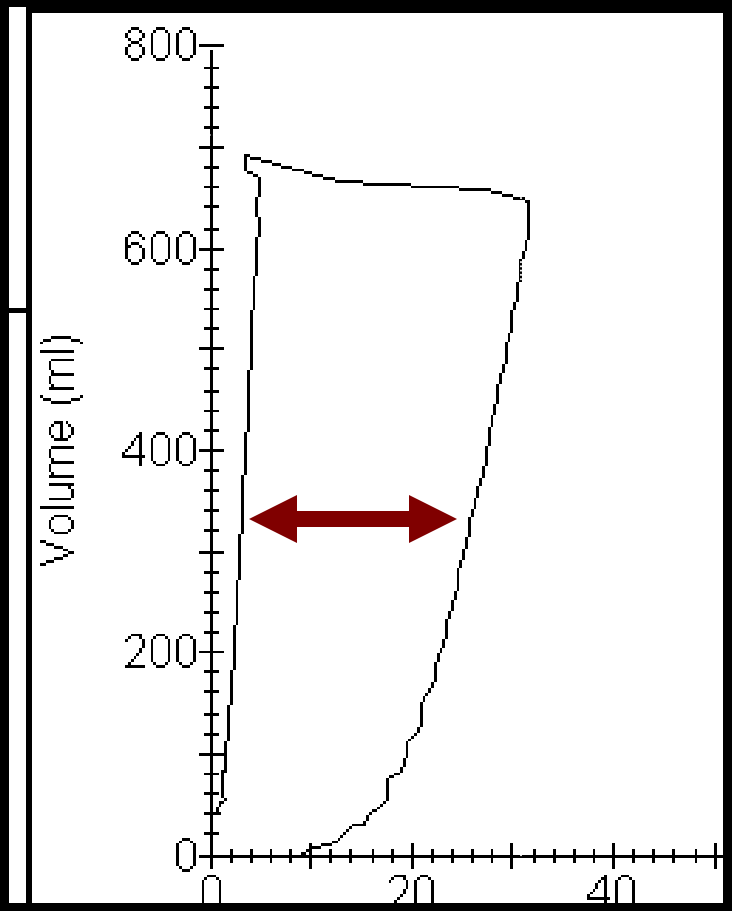


# Increased Resistance

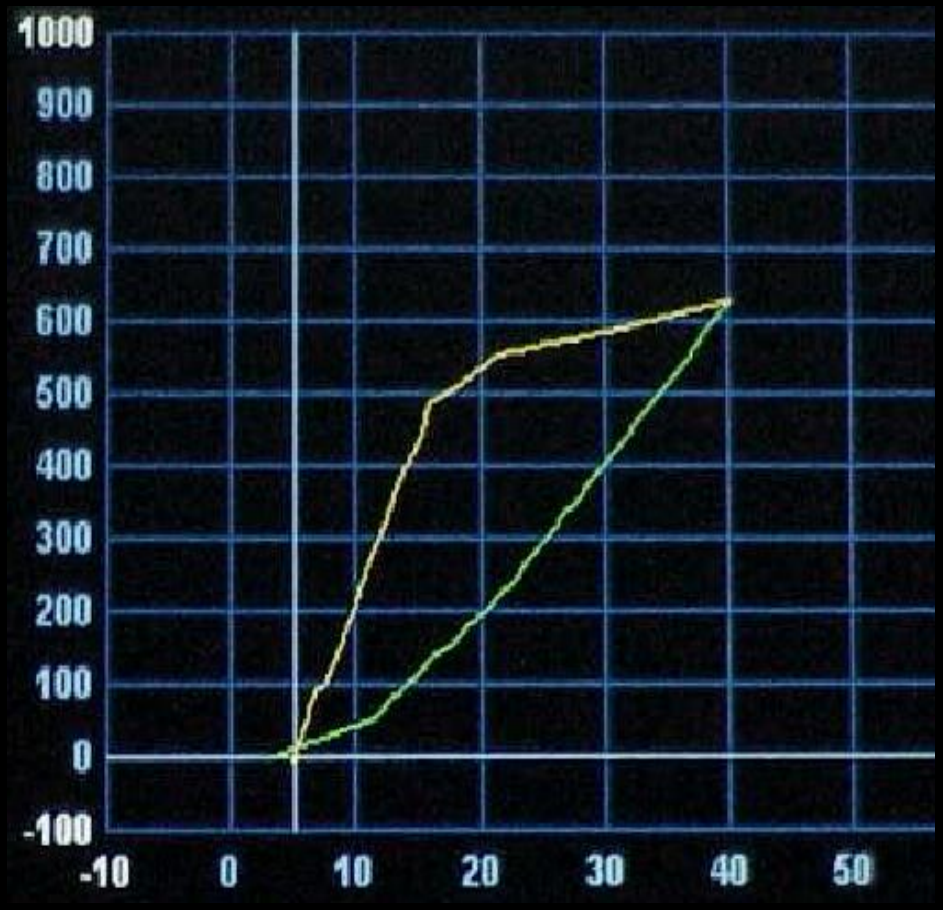


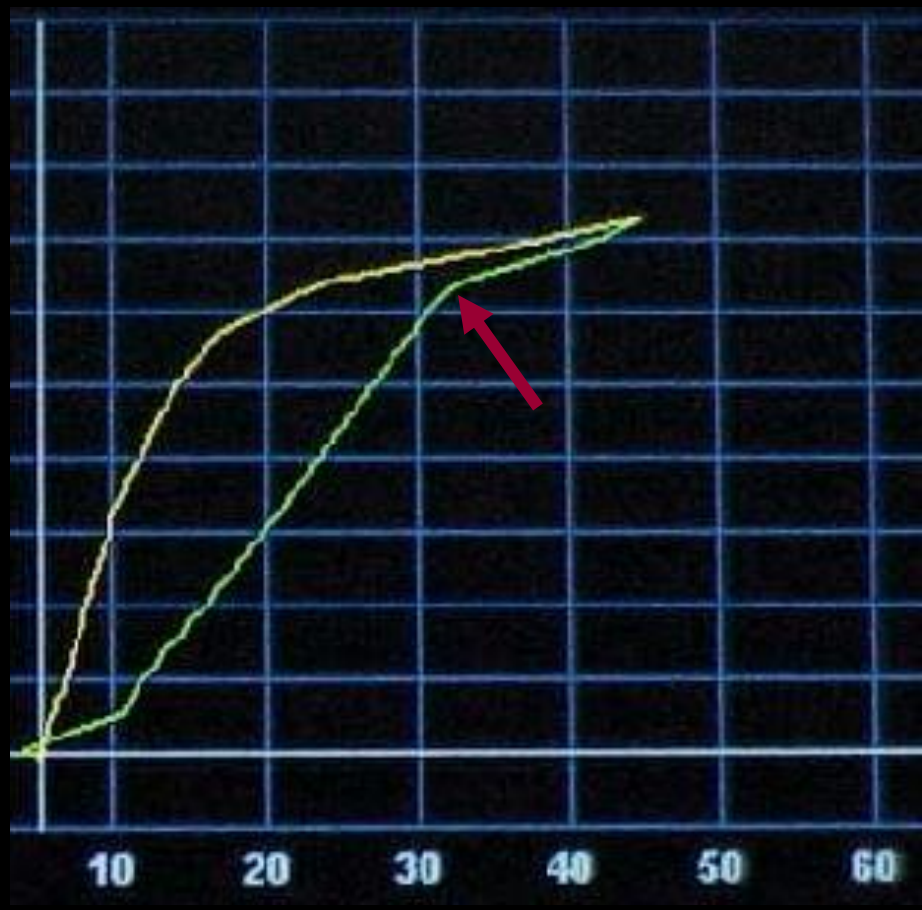

C=.05;R=5




C=.05;R=20

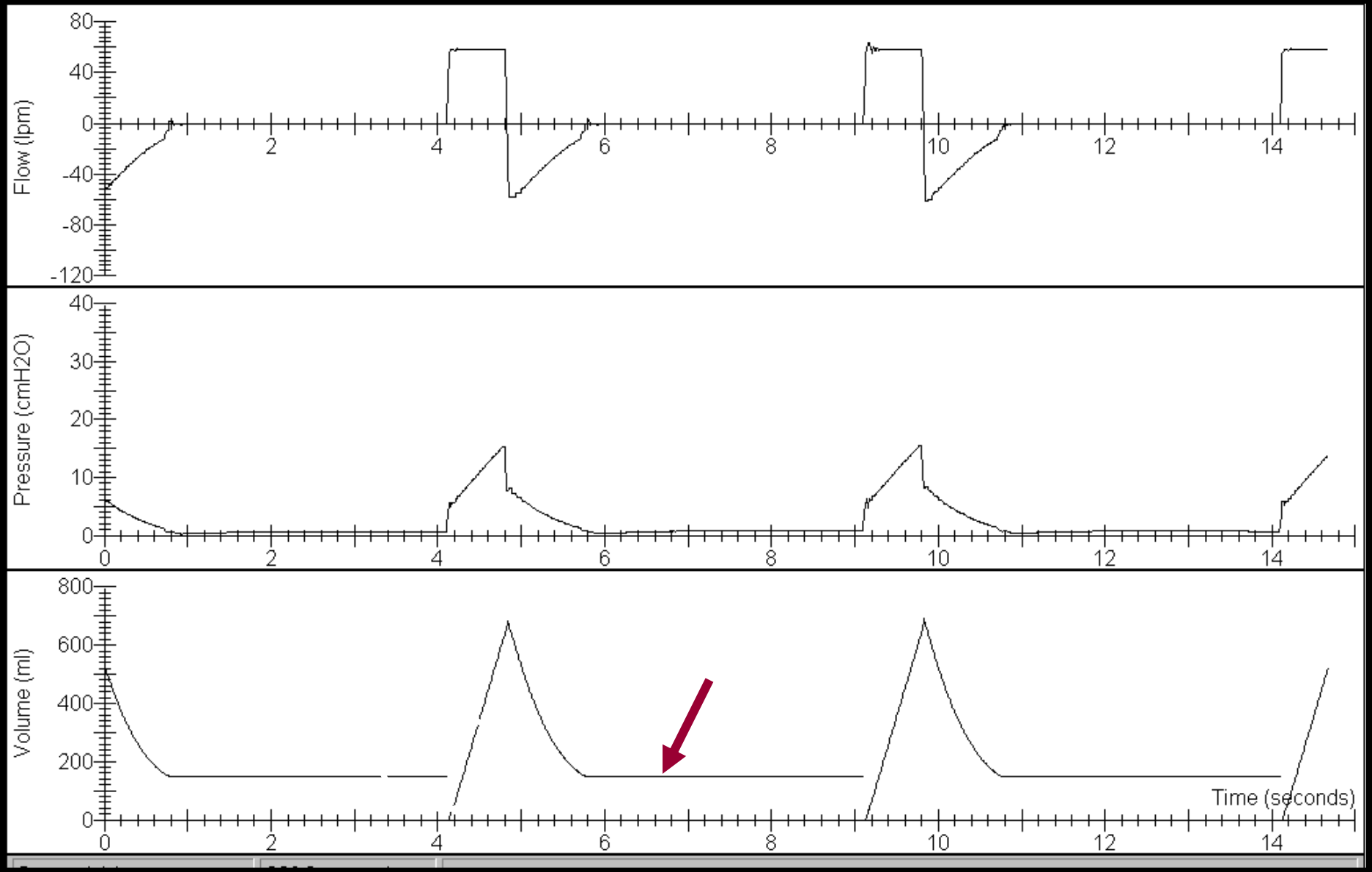
# Over Distention



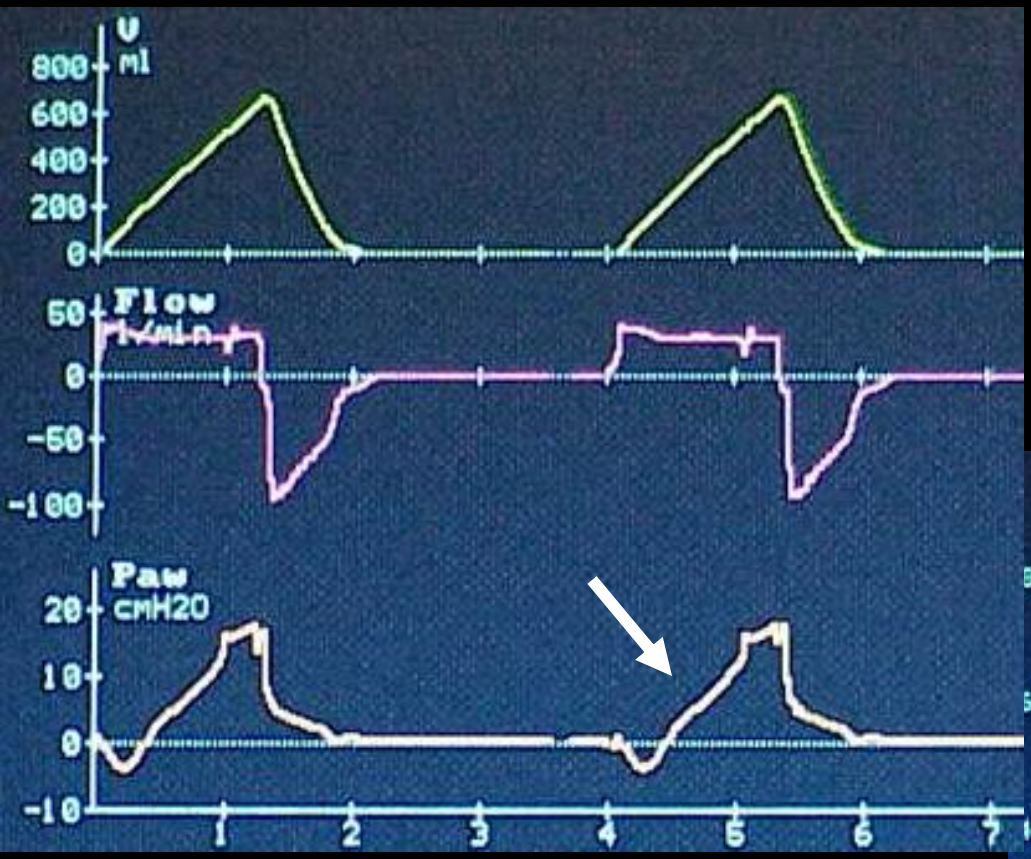



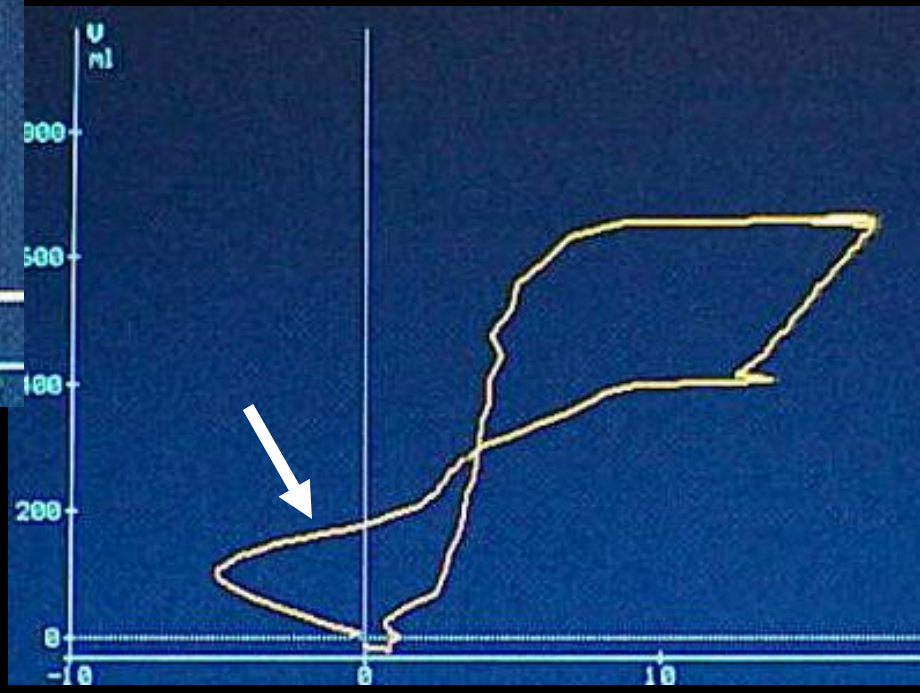

No patient effort

# Air Leak

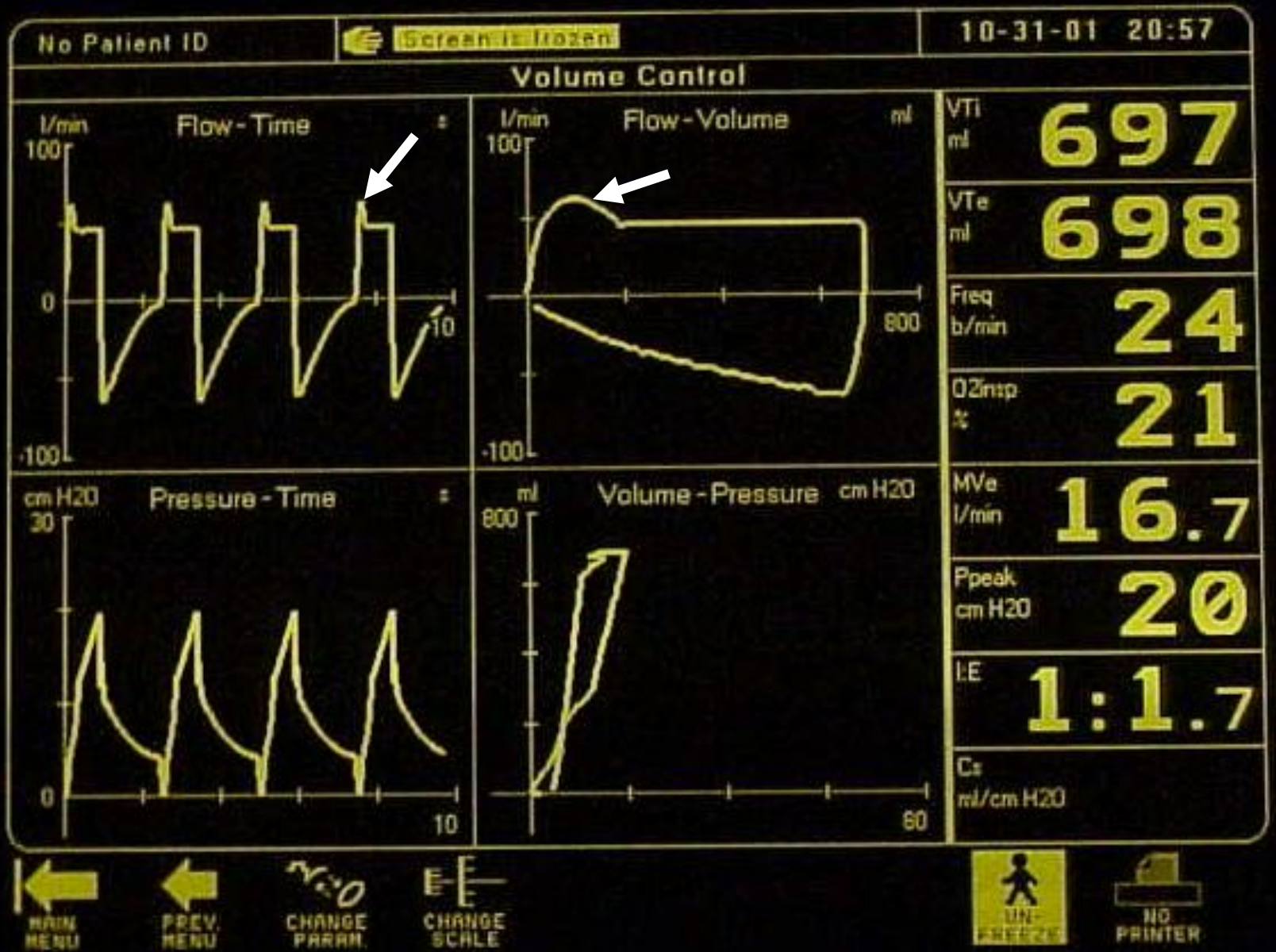

Flow (lpm)
80
40
0
-40
-80
-120
2
4
6
8
10
12
14
Pressure (cmH2O)
40
30
20
10
0
0
2
4
6
8
10
12
14
Volume (ml)
800
600
400
200
0
0
2
4
6
8
10
12
14
Time (seconds)

# Inadequate Inspiratory Flow

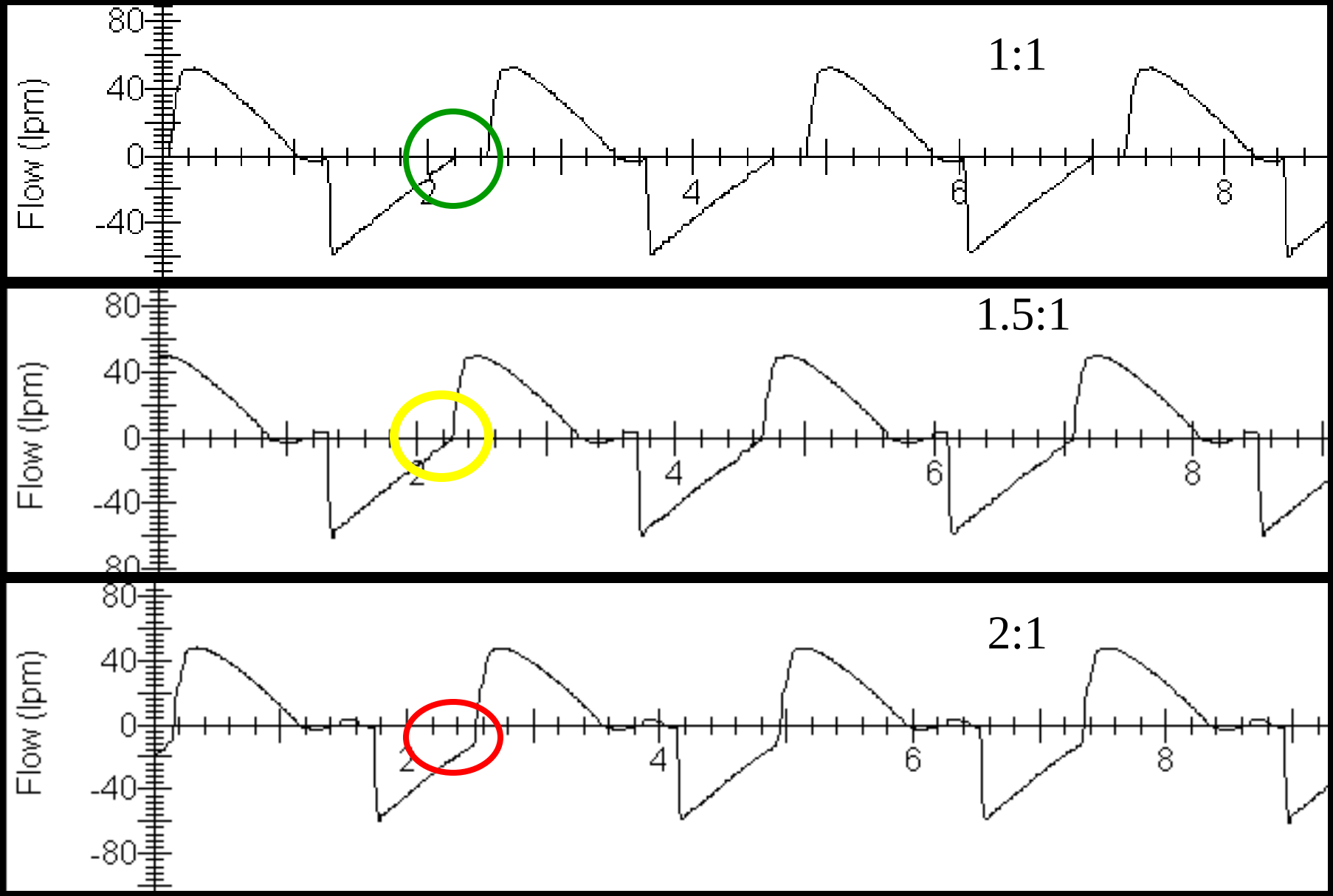


# Inadequate Inspiratory Flow



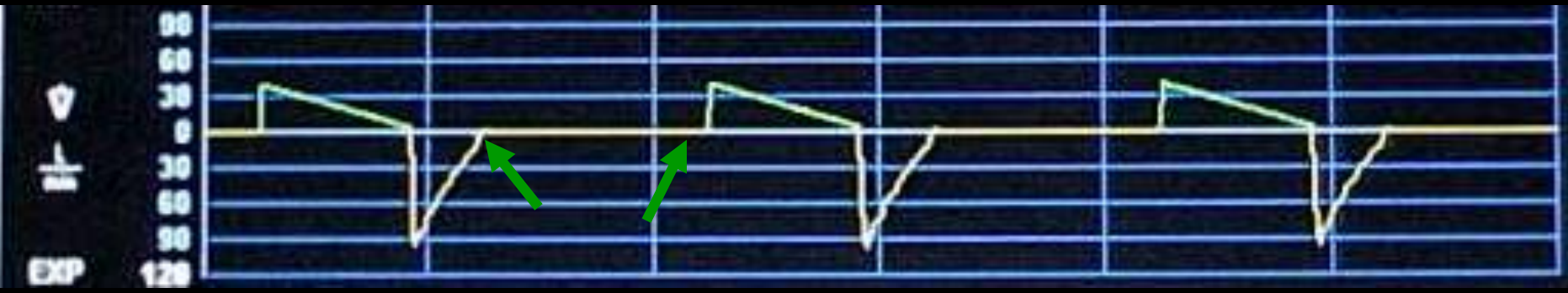
# Auto PEEP



# Auto PEEP

## Set rate -15

1:2

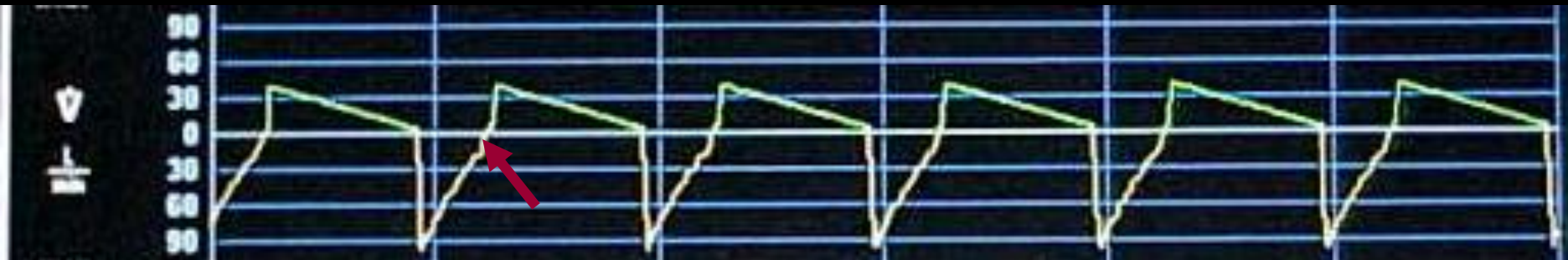



## Total rate -22

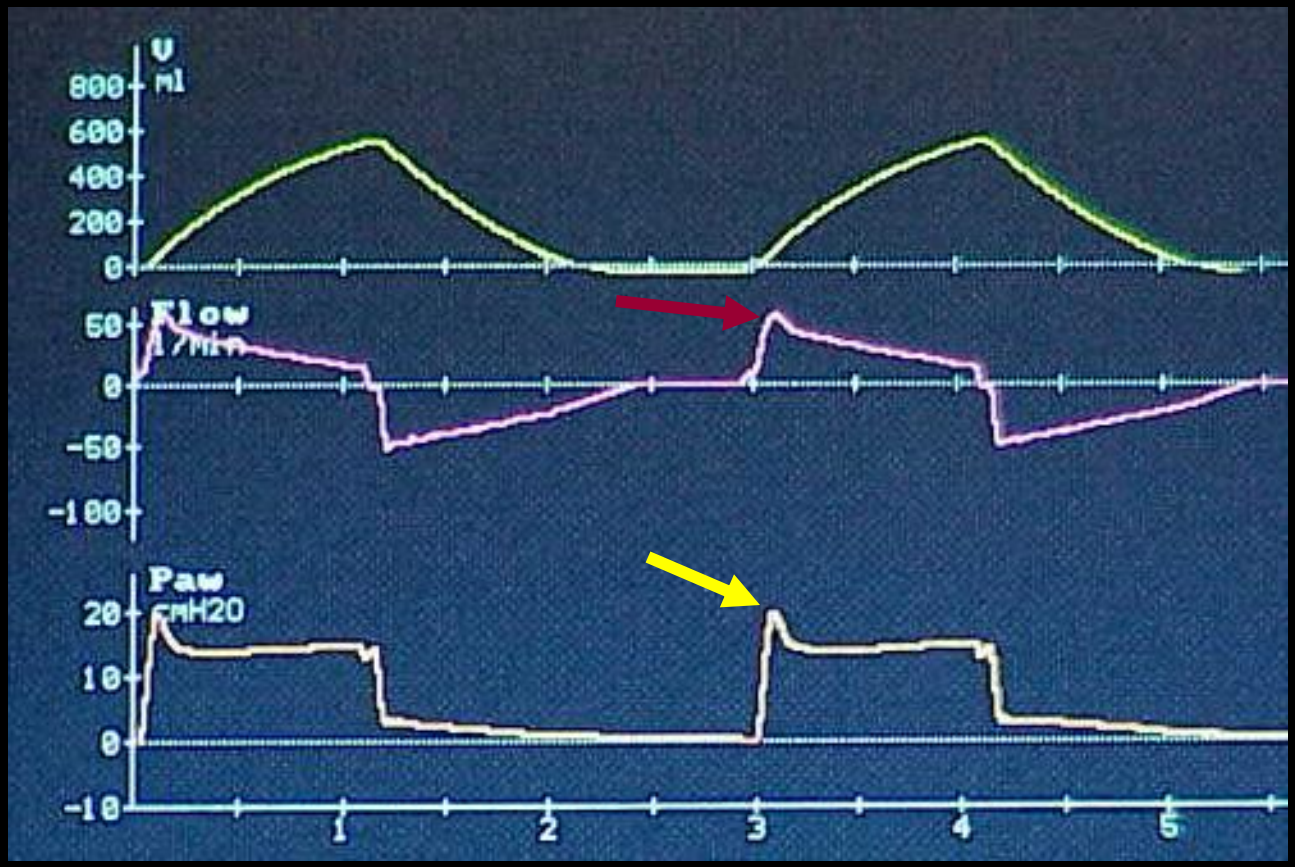
1:1


## Total rate -30

2:1

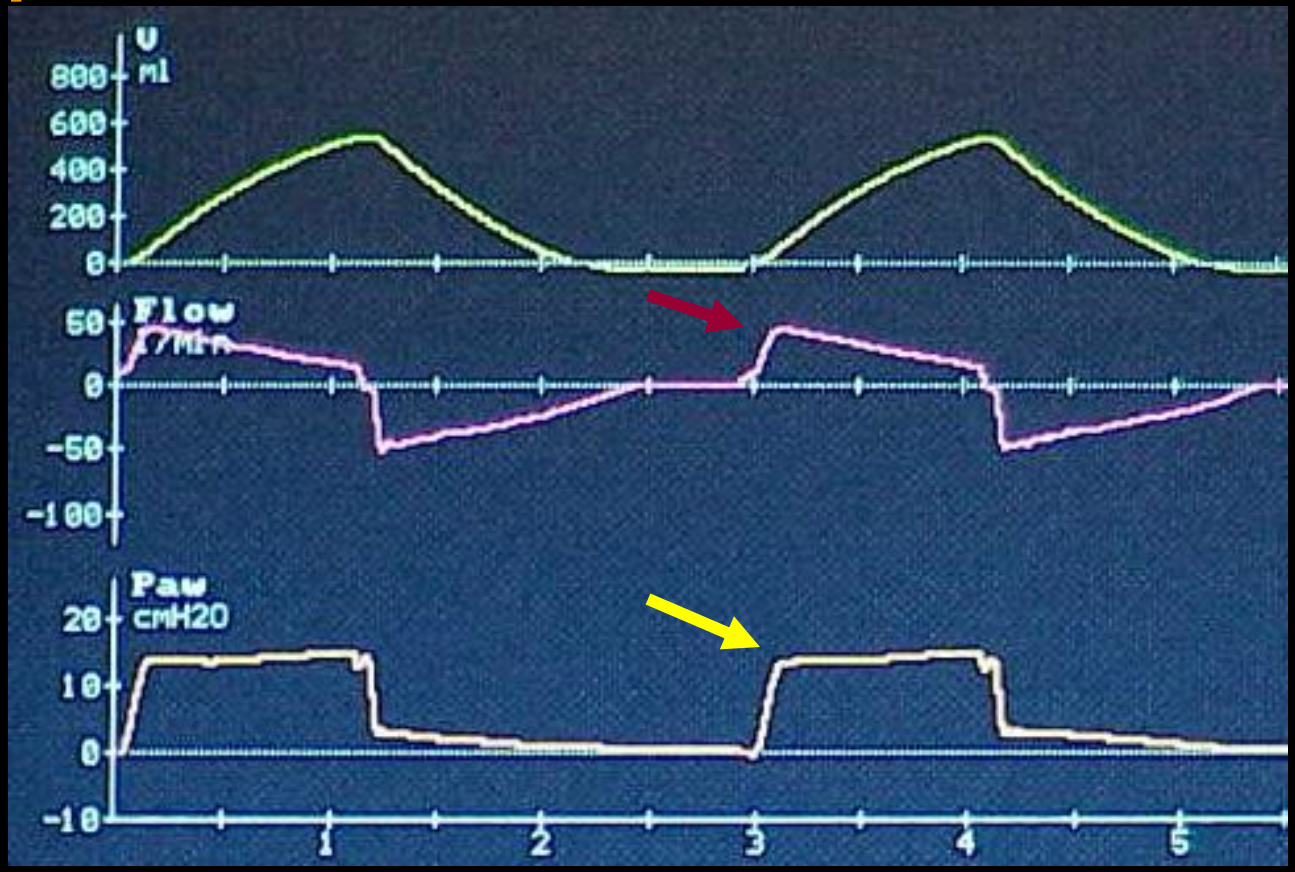


# Setting Rise Time or Pressure Ramp



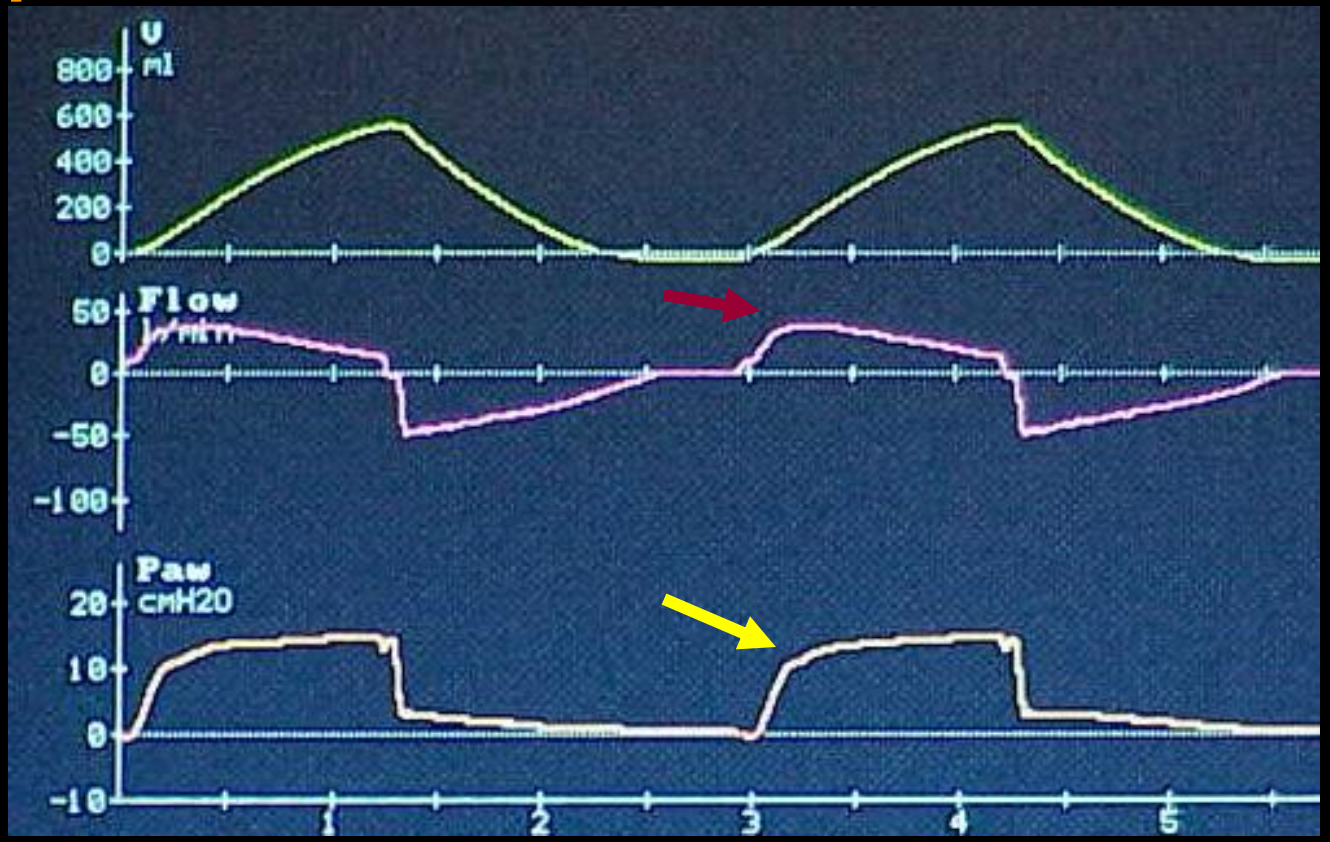

- PS- 15; Pramp – 20 ms; Resistance- 20
- RR- 20; Exhaled VT- 591 mL

# Setting Rise Time or Pressure Ramp



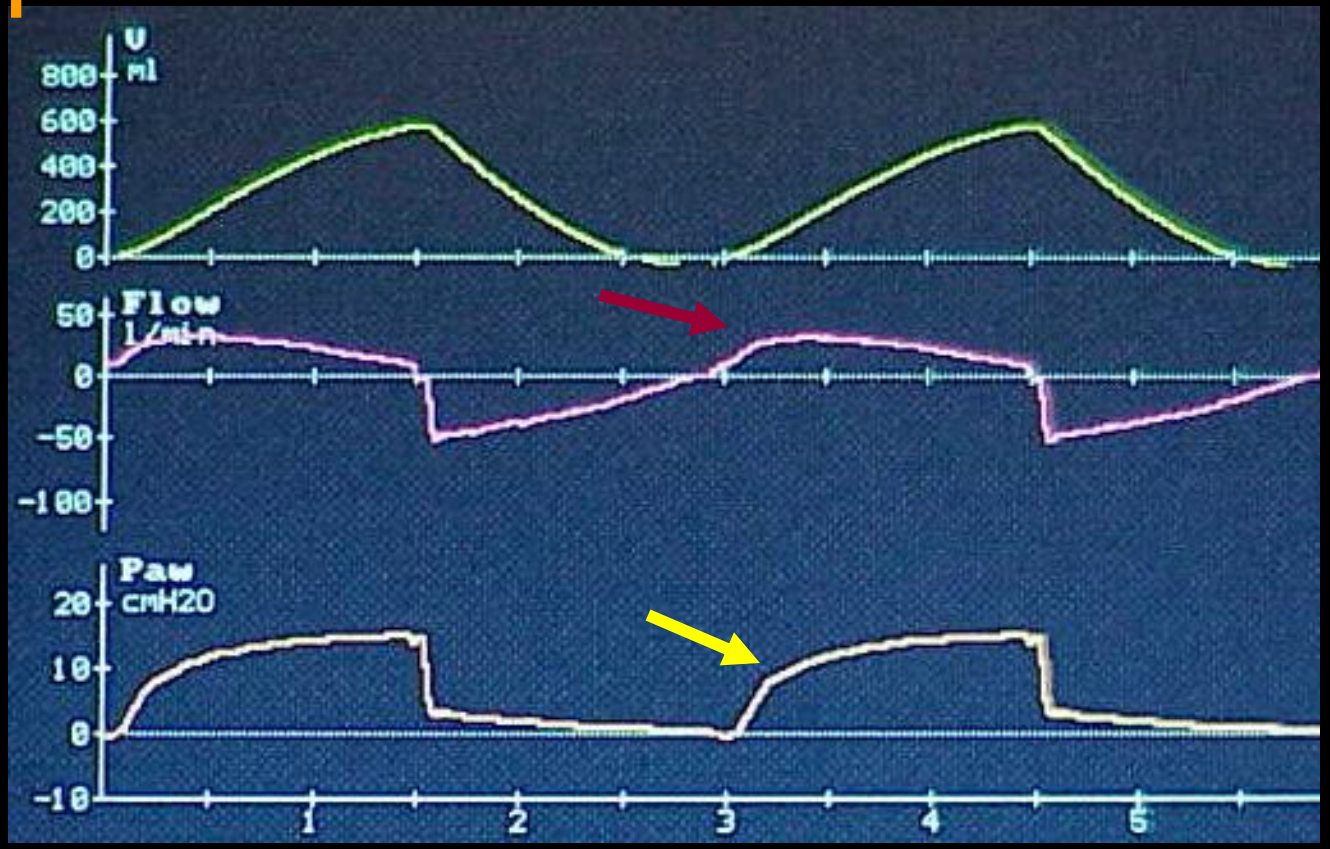

- PS- 15; Pramp – 50 ms; Resistance- 20
- RR- 20; Exhaled VT- 580 mL

# Setting Rise Time or Pressure Ramp



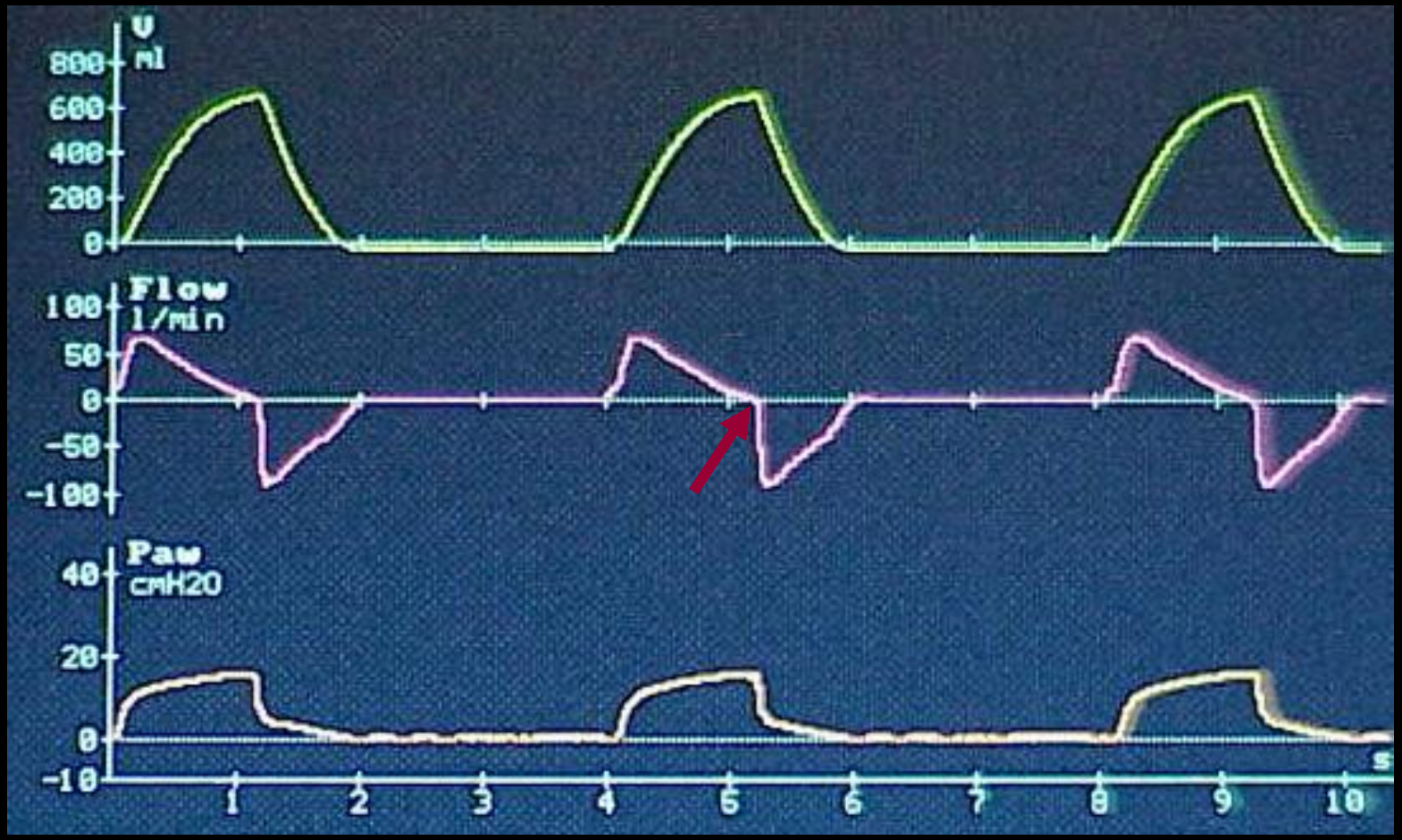

- PS- 15; Pramp – 100 ms; resistance- 20
- RR- 20; Exhaled VT- 597 mL

# Setting Rise Time or Pressure Ramp



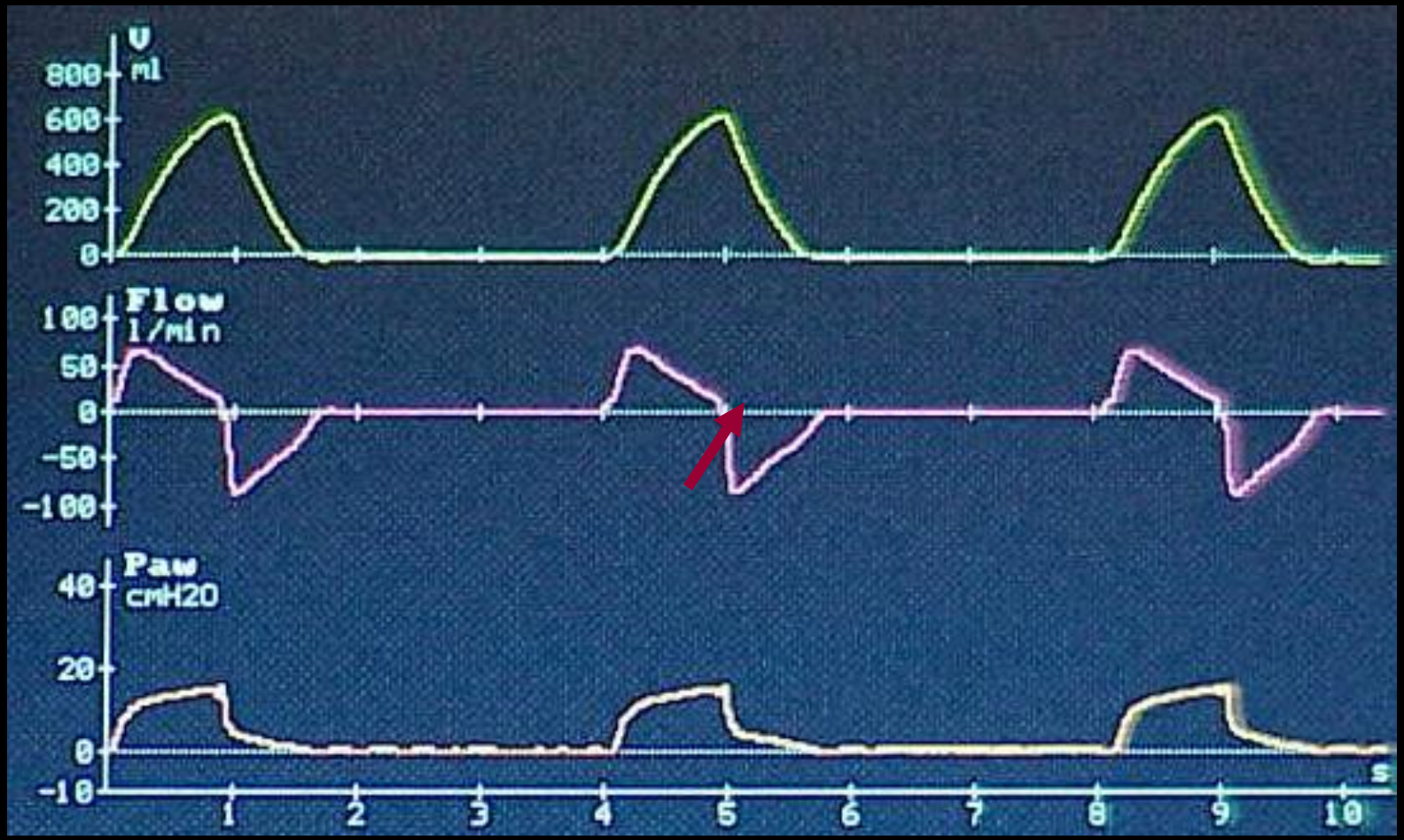

- PS- 15; Pramp – 200 ms; Resistance- 20
- RR- 20; Exhaled VT- 625 mL

# Setting Expiratory Trigger Sensitivity



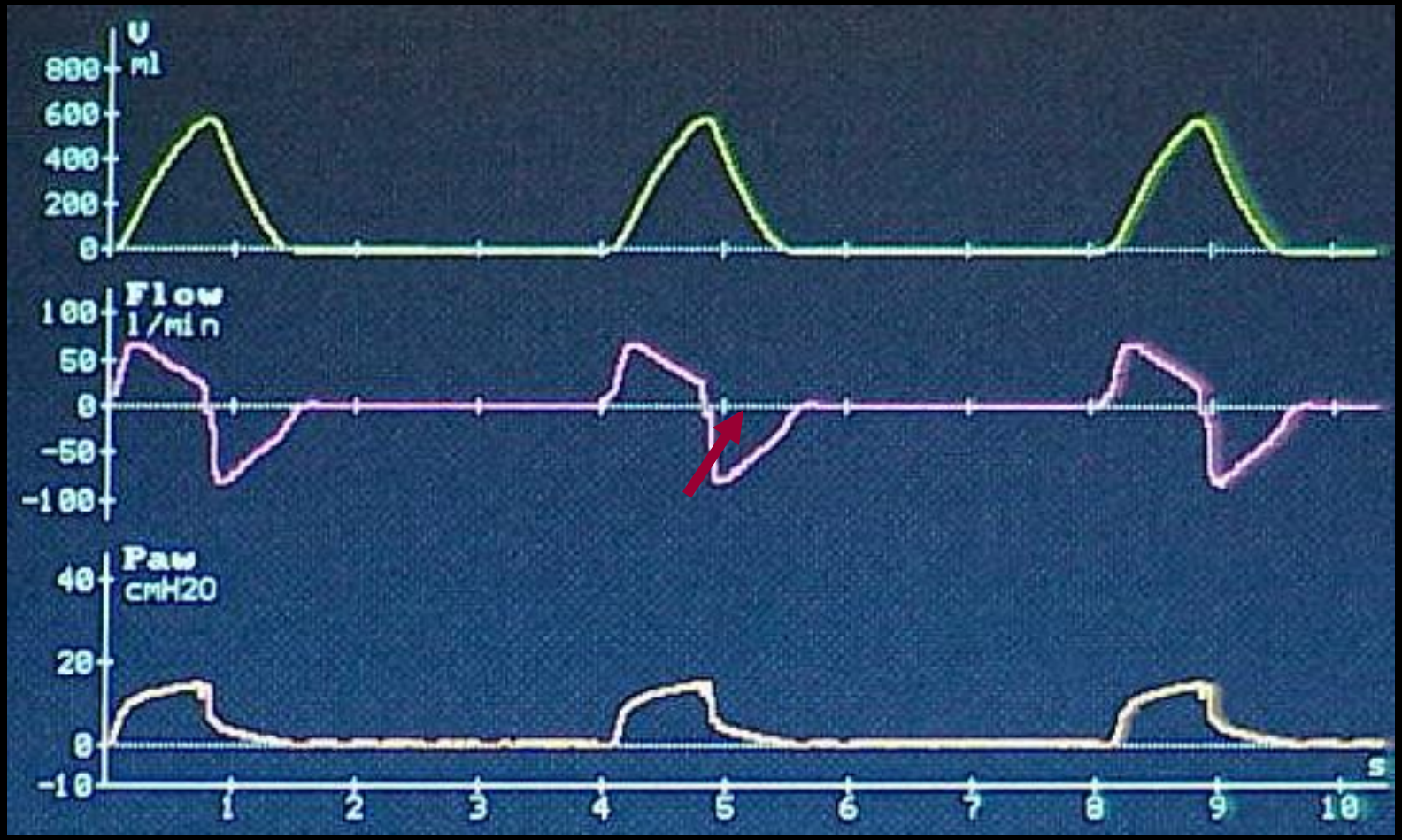

- PS- 15; Pramp – 50 ms; **ETS- 10%**
- RR- 20; Exhaled VT- 700 mL

# Setting Expiratory Trigger Sensitivity



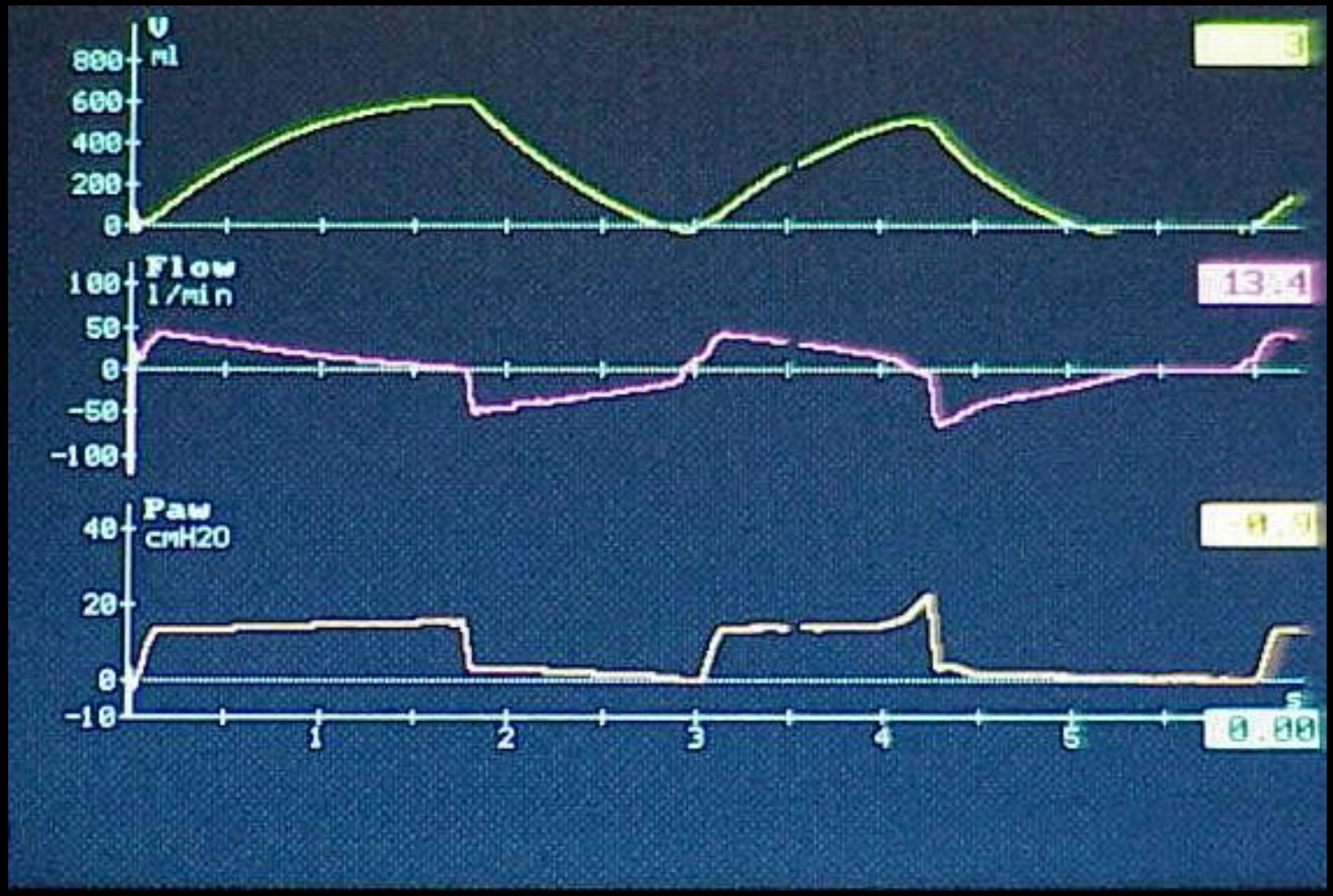

- PS- 15; Pramp – 50 ms; **ETS- 25%**
- RR- 20; Exhaled VT- 654 mL

# Setting Expiratory Trigger Sensitivity

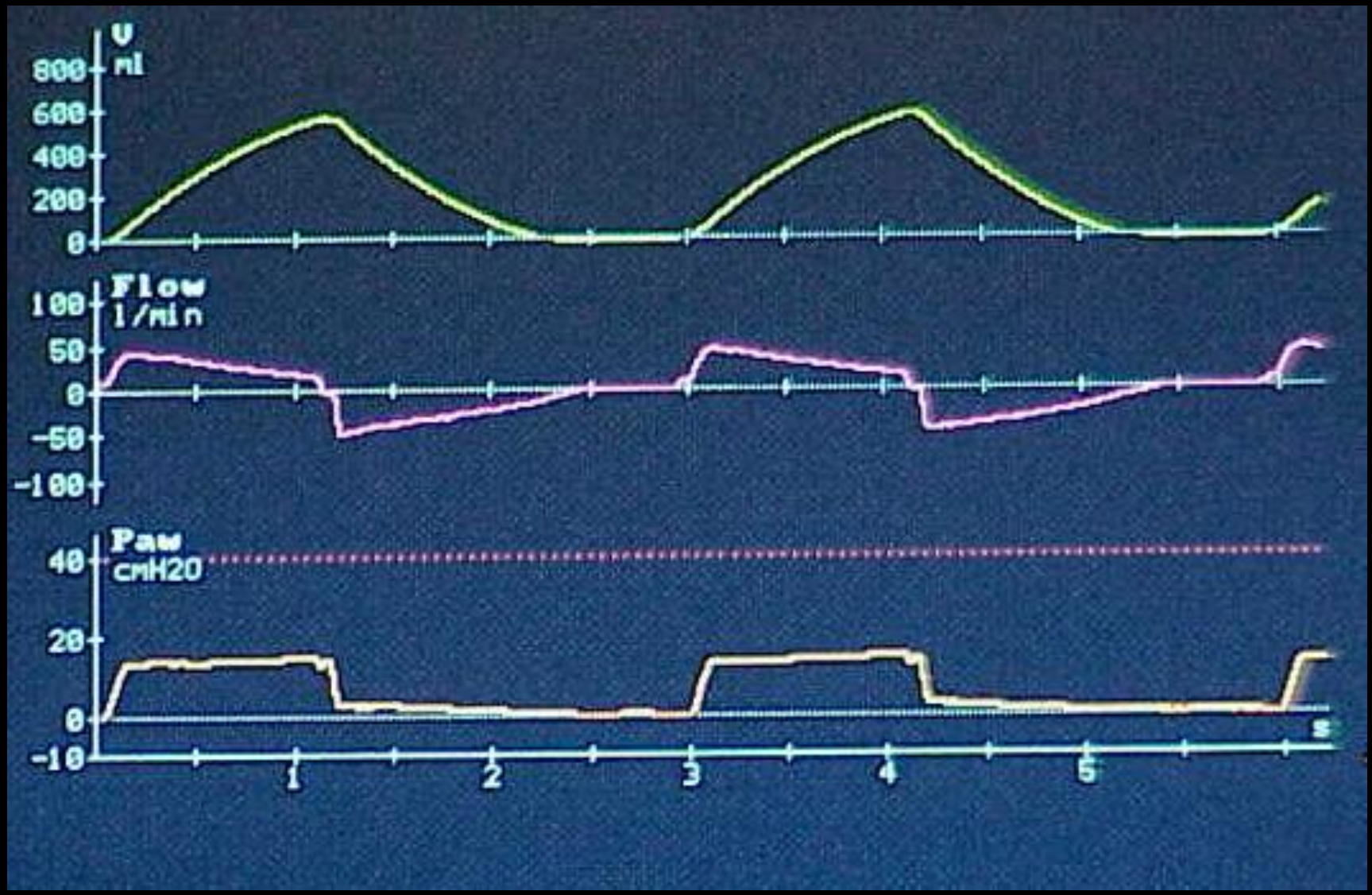



- PS- 15; Pramp – 50 ms; **ETS- 40%**
- RR- 20; Exhaled VT- 604 mL

# Avoid a Low ETS when Airway Resistance is High!




- PS- 15; Pramp – 50 ms; ETS- 10%




# Increase ETS – 40%

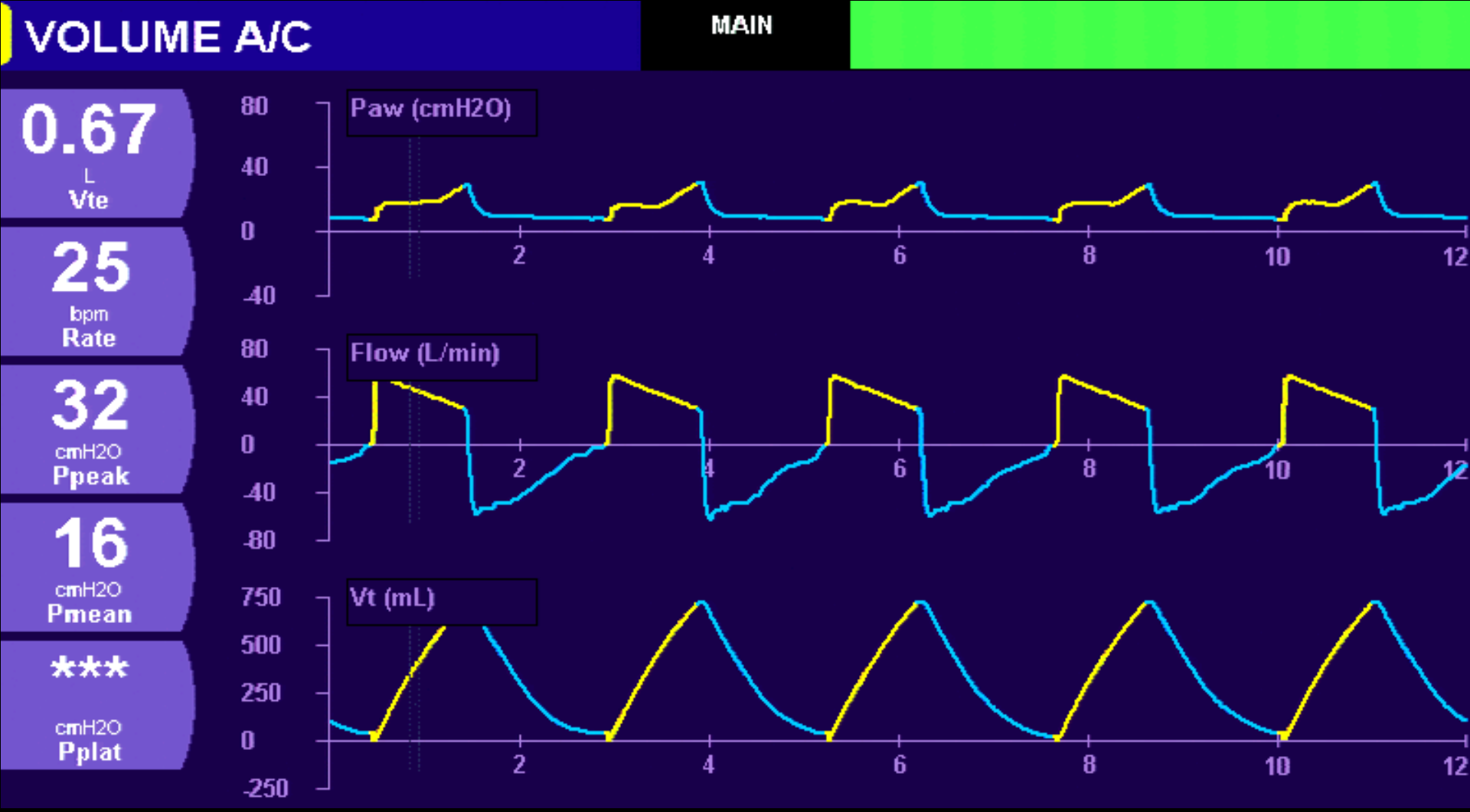
# Case: 38 Year Old Trauma Patient

- A male weighing – 90 Kg (IBW)
- Obtunded, labored breathing
- NRB @ 15 L/min $O_2$, $SpO_2$- 85%
- Intubated and placed on an Avea
- Initial ventilator settings are
  - Tidal volume – 720 mL
  - Rate- 12
  - PEEP- 10
  - $FIO_2$- 1.0
  - I-Time- 1.0 /  Decelerating flow- 60 L/min

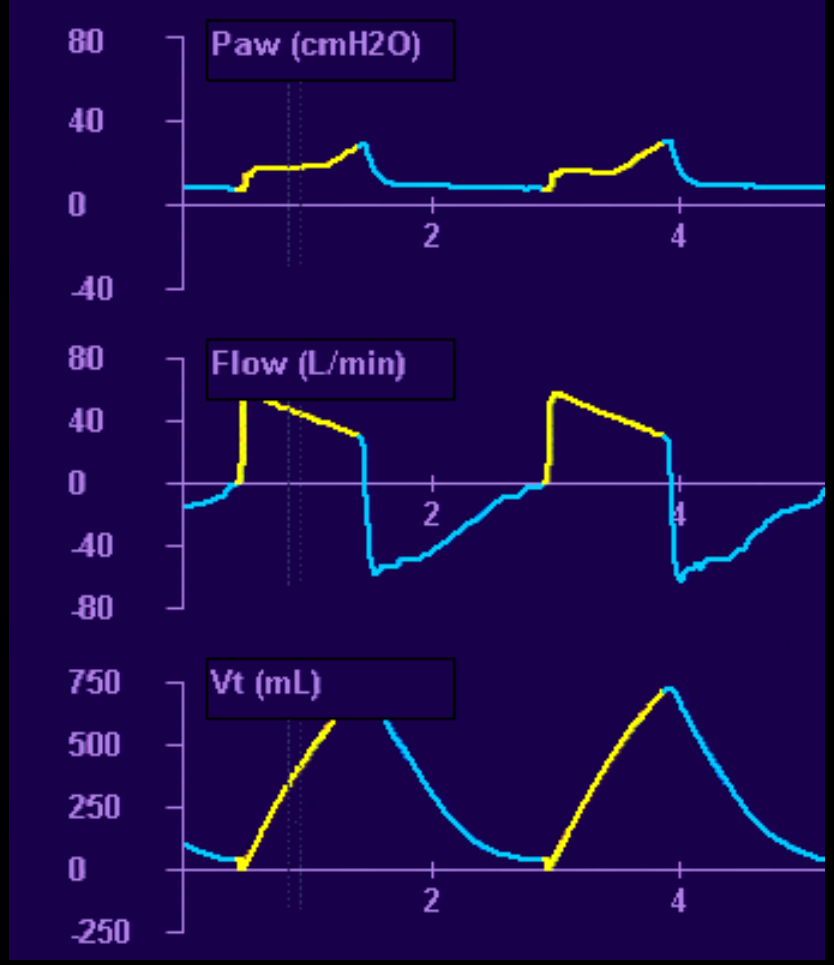

VOLUME A/C
MAIN
0.67
L
Vte
25
bpm
Rate
32
cmH2O
Ppeak
16
cmH2O
Pmean
***
cmH2O
Pplat
Paw (cmH2O)
80
40
0
-40
2
4
6
8
10
12
Flow (L/min)
80
40
0
-40
-80
Vt (mL)
750
500
250
0
-250
12
bpm
Rate
0.72
L
Volume
60
L/min
Peak Flow
0.00
sec
Insp Pause
10
cmH2O
PEEP
2.0
L/min
Flow Trig
100
%
FiO2
alc Ve
L
8.64
0.96sec
4.04sec
1:4.2

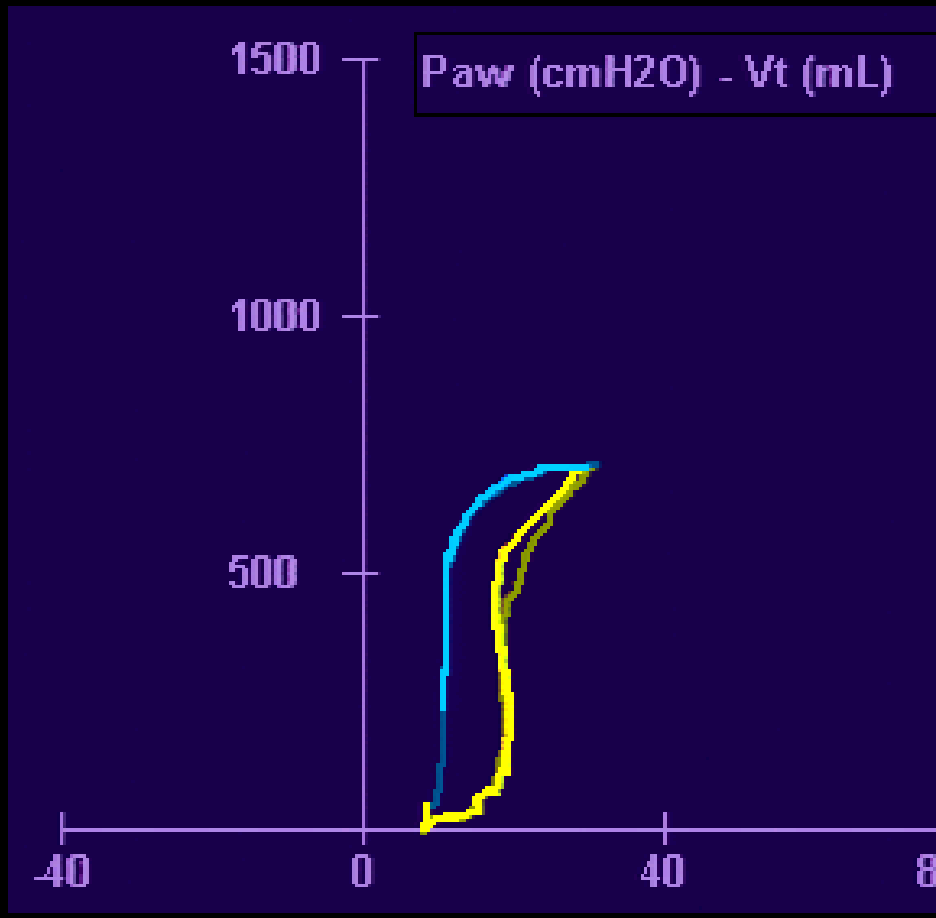

VOLUME A/C
MAIN
0.68
L
Vte
24
bpm
Rate
32
cmH2O
Ppeak
16
cmH2O
Pmean
30
cmH2O
Pplat
Paw (cmH2O)
80
40
0
-40
2
4
6
8
10
12
Flow (L/min)
80
40
0
-40
-80
Vt (mL)
750
500
250
0
-250
12
bpm
Rate
0.72
L
Volume
60
L/min
Peak Flow
0.00
sec
Insp Pause
10
cmH2O
PEEP
2.0
L/min
Flow Trig
100
%
FiO2
alc Ve
L
8.64
0.96sec
4.04sec
1:4.2


VOLUME A/C
LOOPS
0.67
L
Vte
25
bpm
Rate
1:1.5
I:E
32
cmH2O
Ppeak
9
cmH2O
PEEP
Vt (mL) - Flow (L/min)
80
40
0
-40
-80
500
1000
1500
Paw (cmH2O) - Vt (mL)
1500
1000
500
-40
0
40
12
bpm
Rate
0.72
L
Volume
60
L/min
Peak Flow
0.00
sec
Insp Pause
10
cmH2O
PEEP
2.0
L/min
Flow Trig
90
%
FiO2
Calc Ve
L
8.64
0.96sec
4.04sec
1:4.2

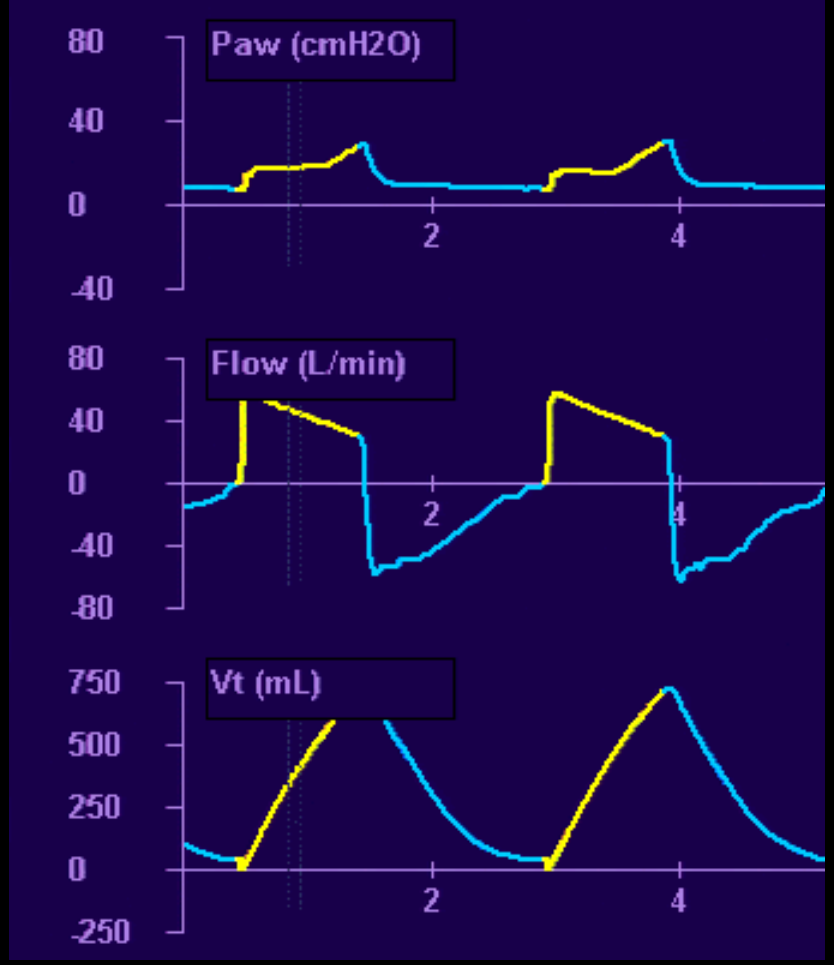


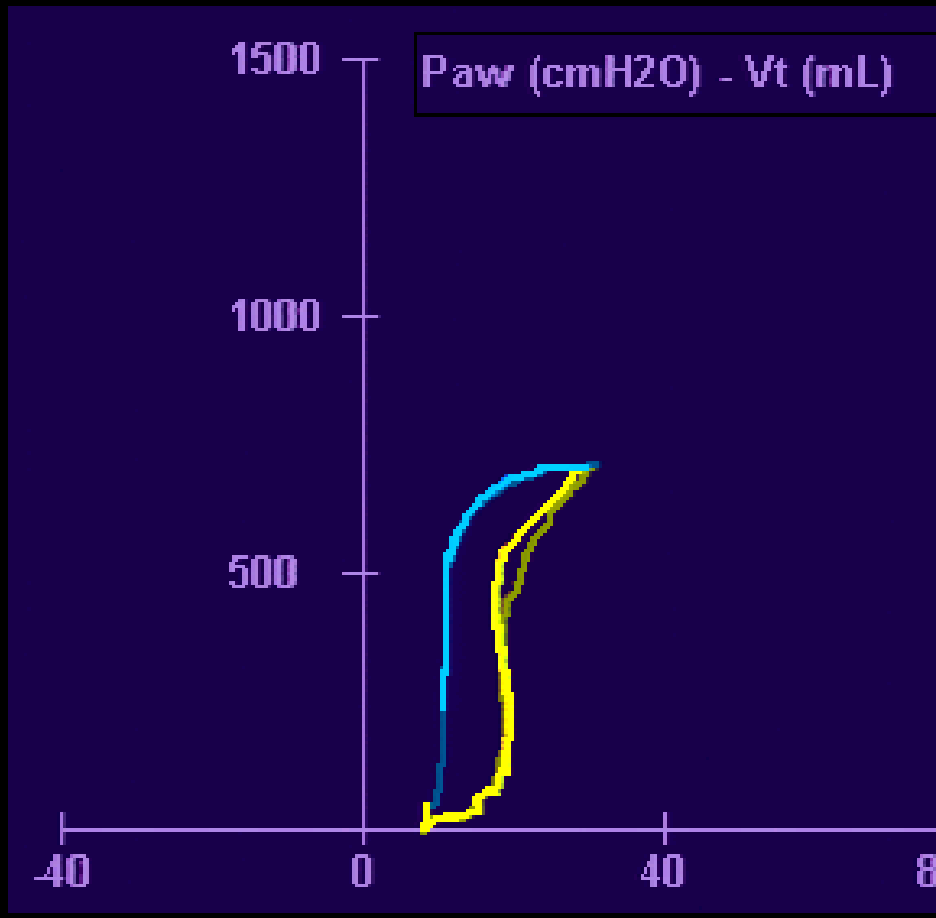

1. Which one of the following changes would you recommend?



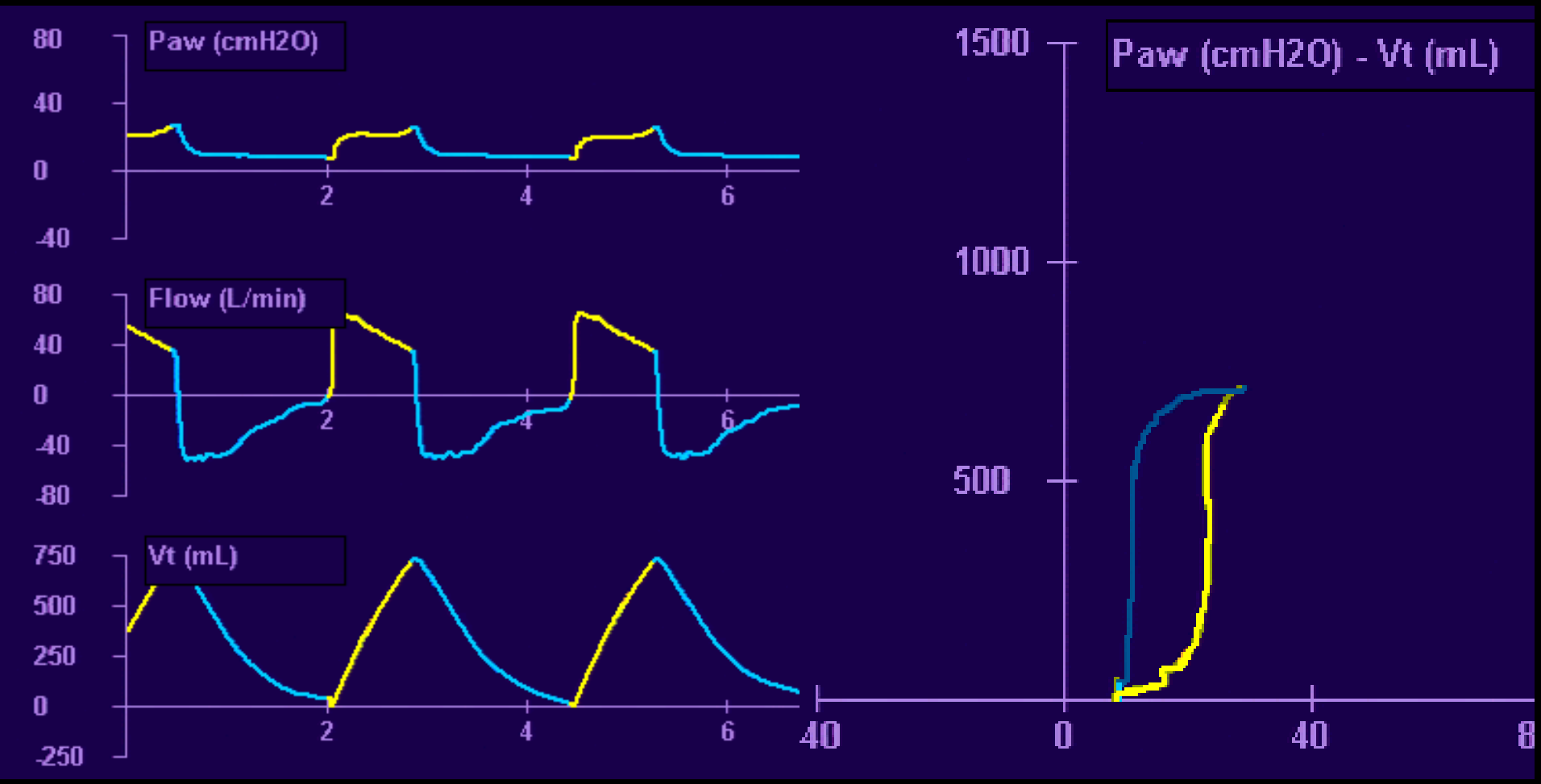

A. Increase Flow
B. Increase Rate
C. Decrease Tidal Volume
D. Decrease PEEP



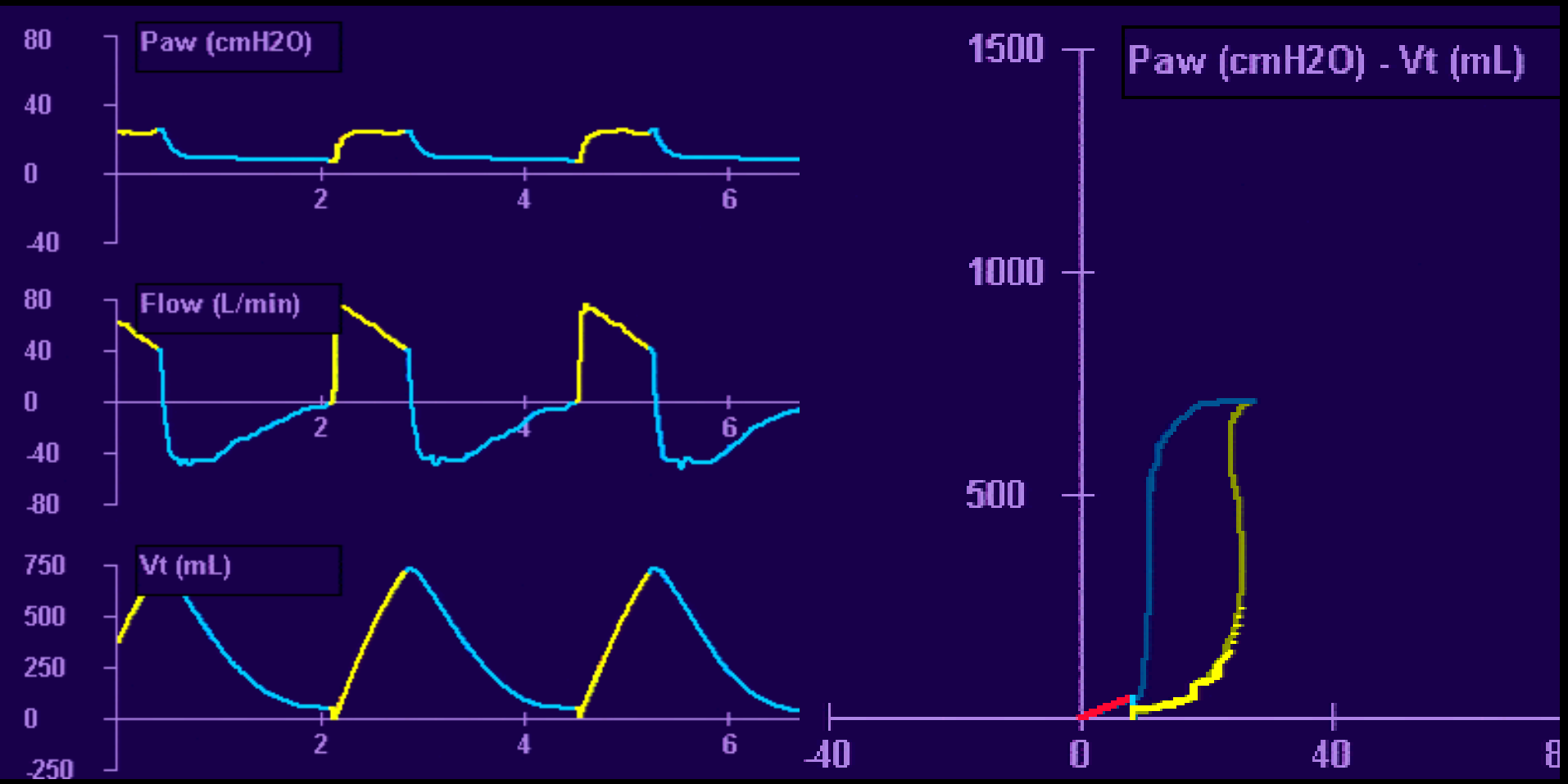




A. Increase Flow
B. Increase Rate
C. Decrease Tidal Volume
D. Decrease PEEP

# Increase Peak Flow 70 L/min



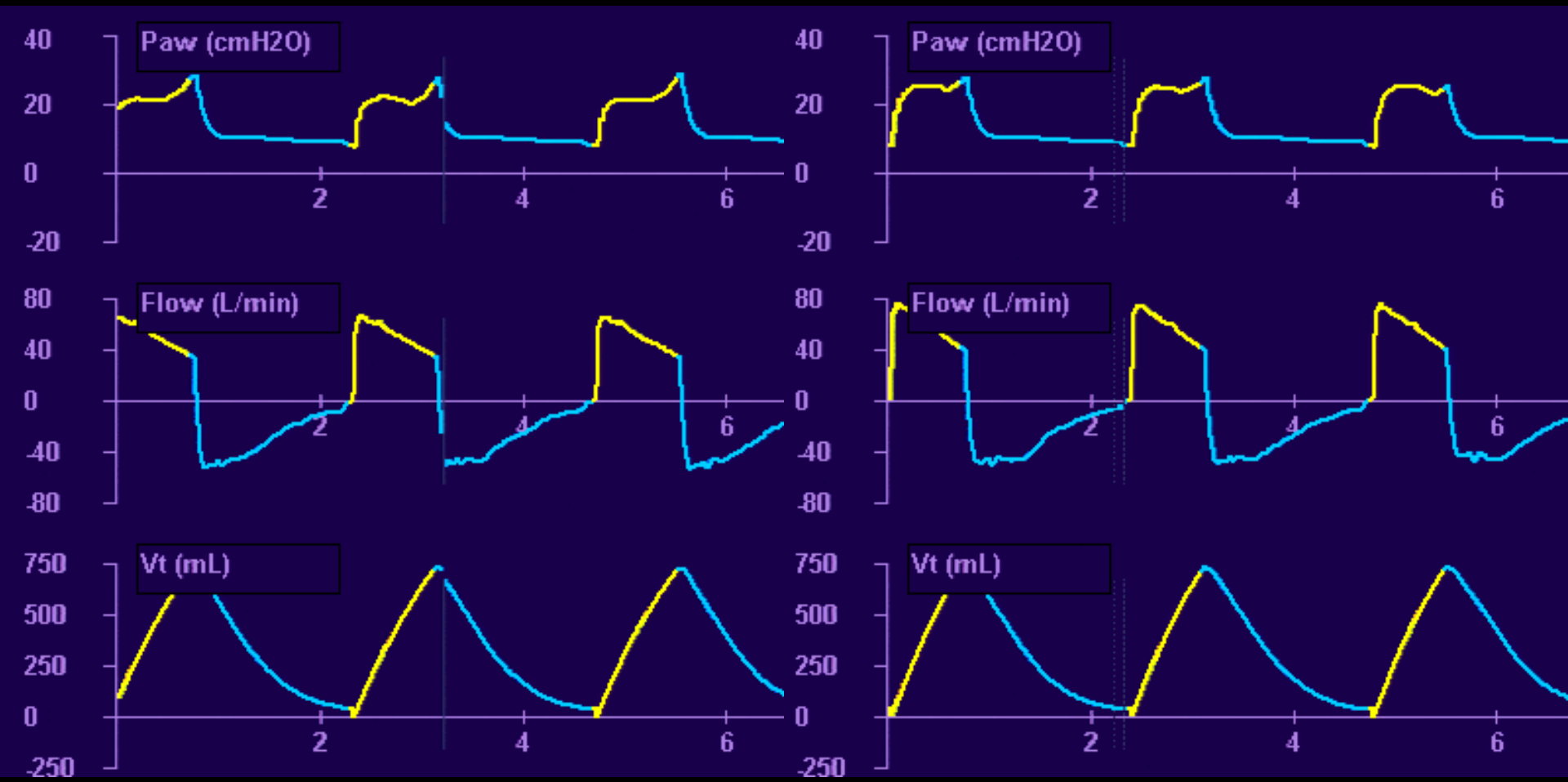
# Increase Peak Flow 80 L/min



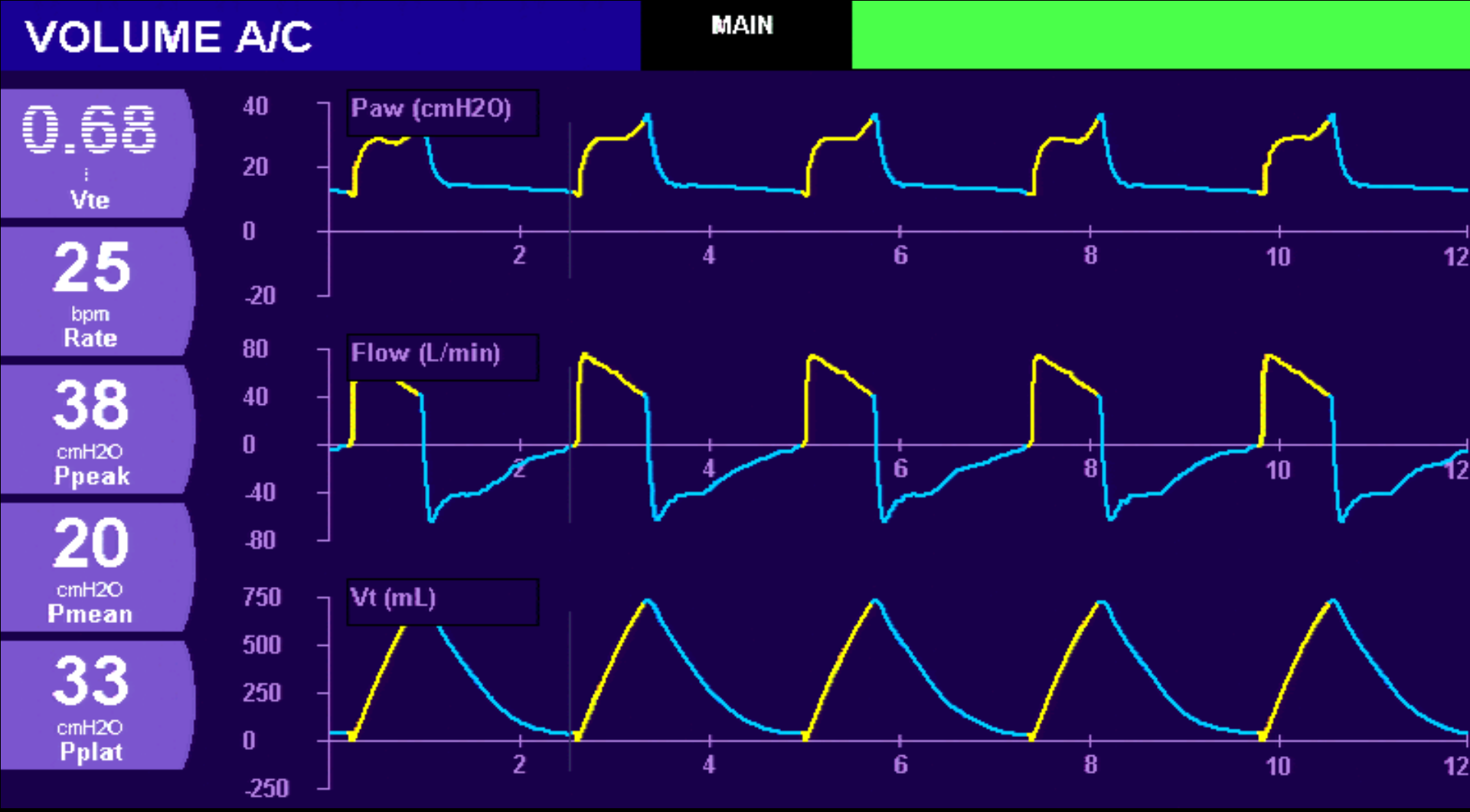
# Adjusting the Graphic Scales

70 L/min

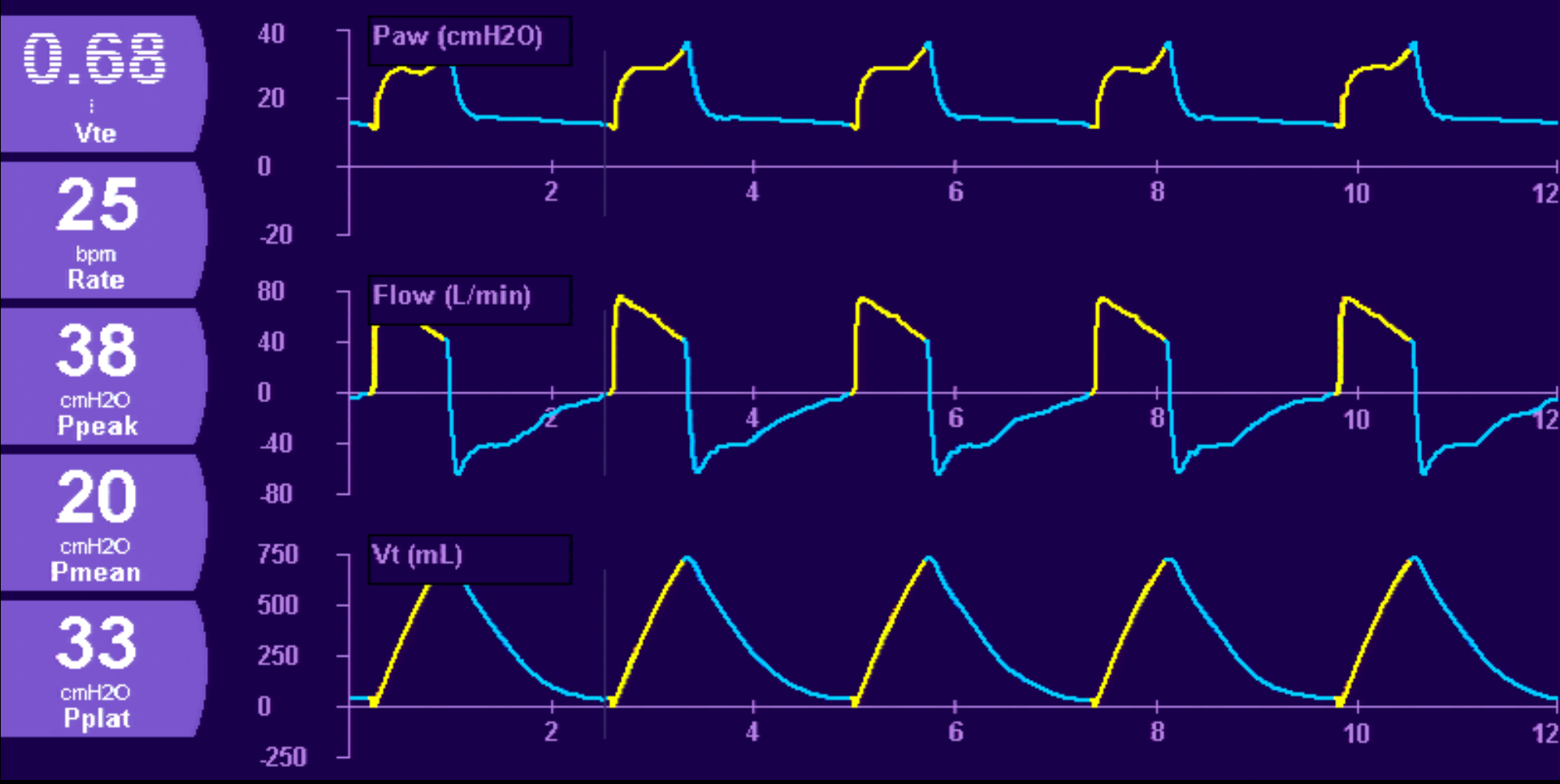
80 L/min



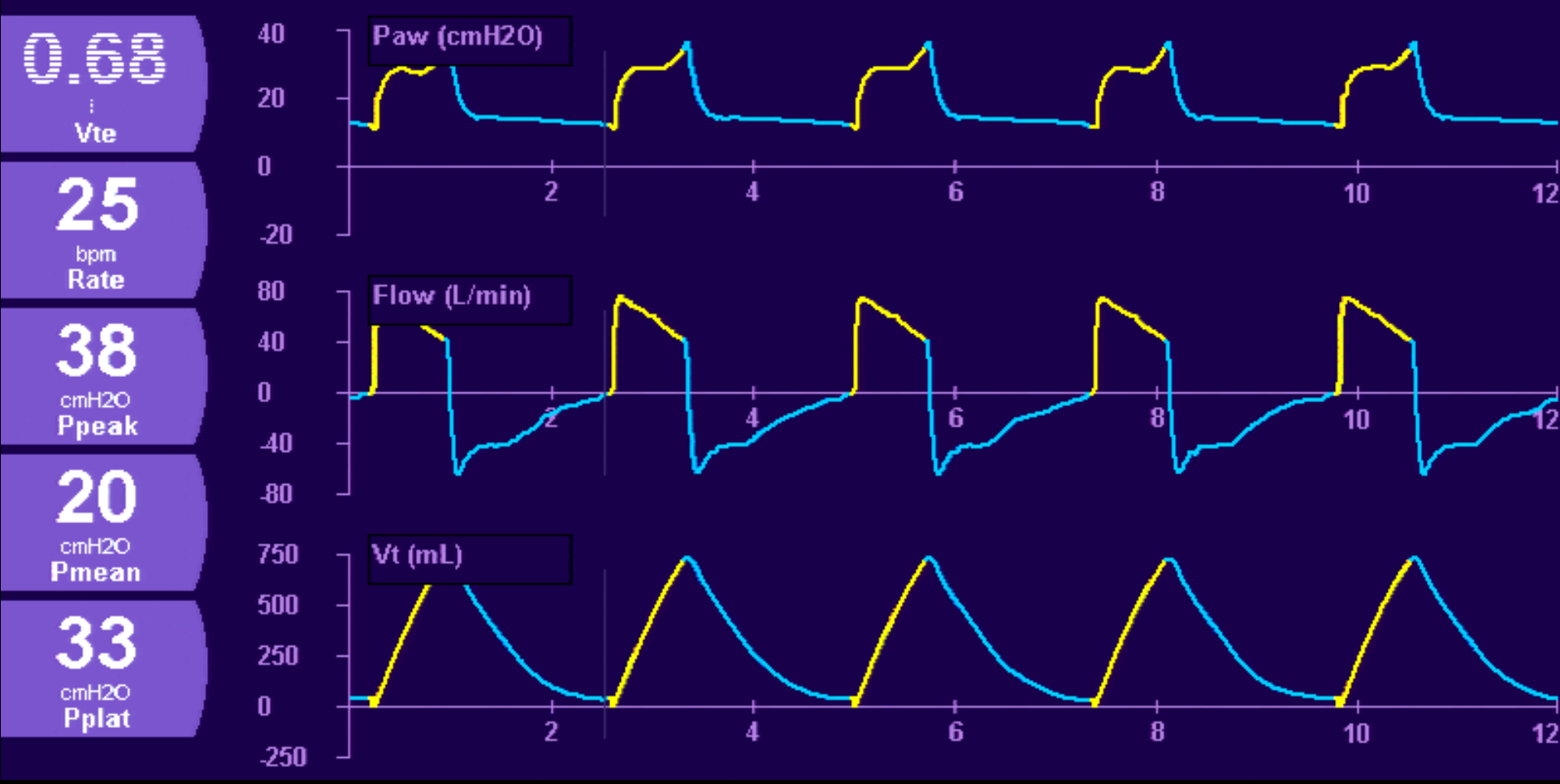
# $SpO_2$- 92%, FIO2-.80, PEEP- 10 to 14




2. Which one of the following changes would you recommend?




A. Decrease Flow
B. Decrease Rate
C. Decrease Tidal Volume
D. Decrease PEEP




A. Decrease Flow

B. Decrease Rate

C. Decrease Tidal Volume

D. Decrease PEEP

# Decreased Tidal Volume

# Decreased Flow – Increase I-Time

# Turn on V-sync

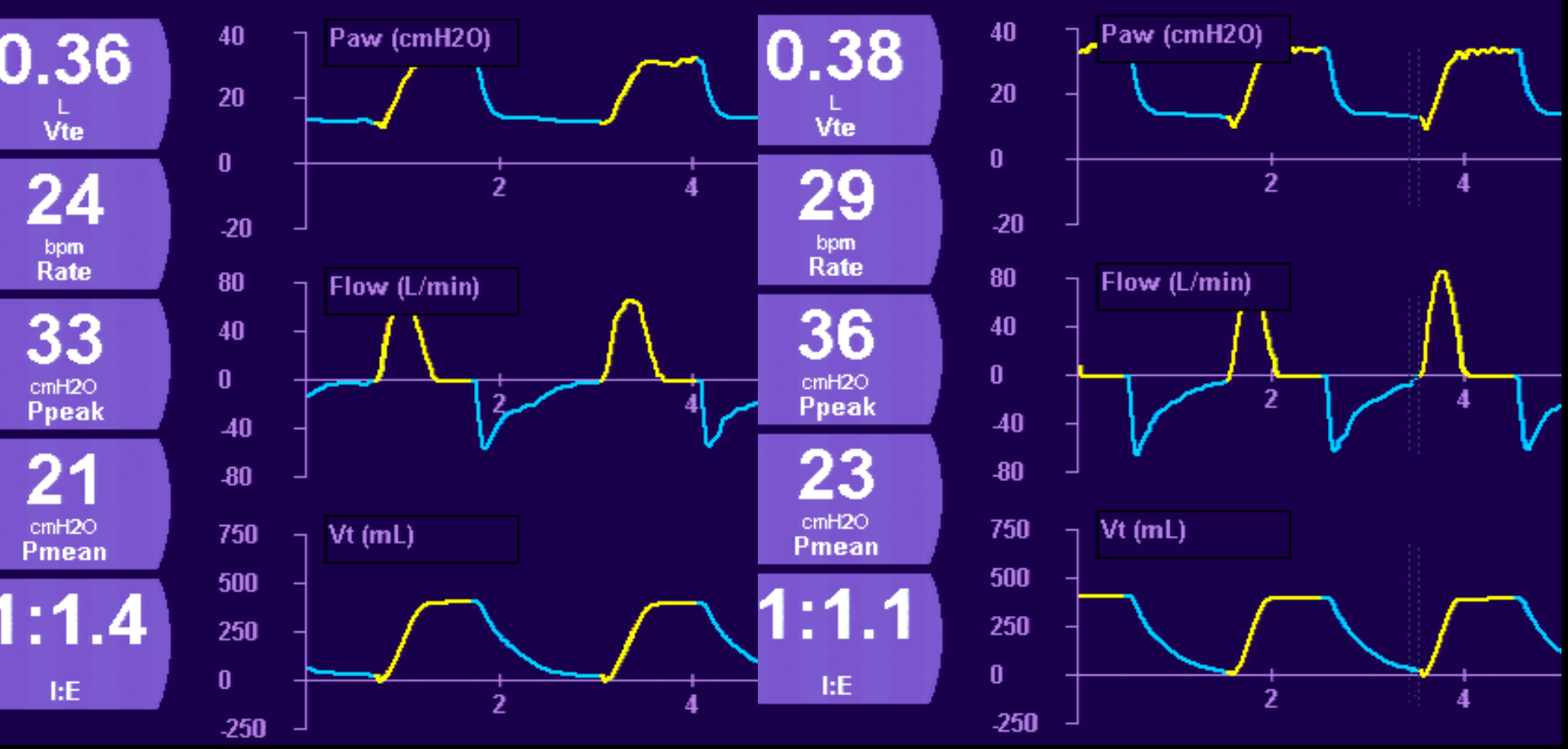

VOLUME A/C
Vsync
MAIN
0.50
L
Vte
25
bpm
Rate
27
cmH2O
Ppeak
17
cmH2O
Pmean
25
cmH2O
Pplat
Paw (cmH2O)
40
20
0
-20
2
4
6
8
10
12
Flow (L/min)
80
40
0
-40
-80
Vt (mL)
750
500
250
0
-250
12
bpm
Rate
~0.54
L
Volume
60
L/min
Peak Flow
0.00
sec
Insp Pause
14
cmH2O
PEEP
2.0
L/min
Flow Trig
80
%
FiO2
Calc Ve
L
6.48
0.72sec
4.28sec
1:5.9

# Increase I-Time

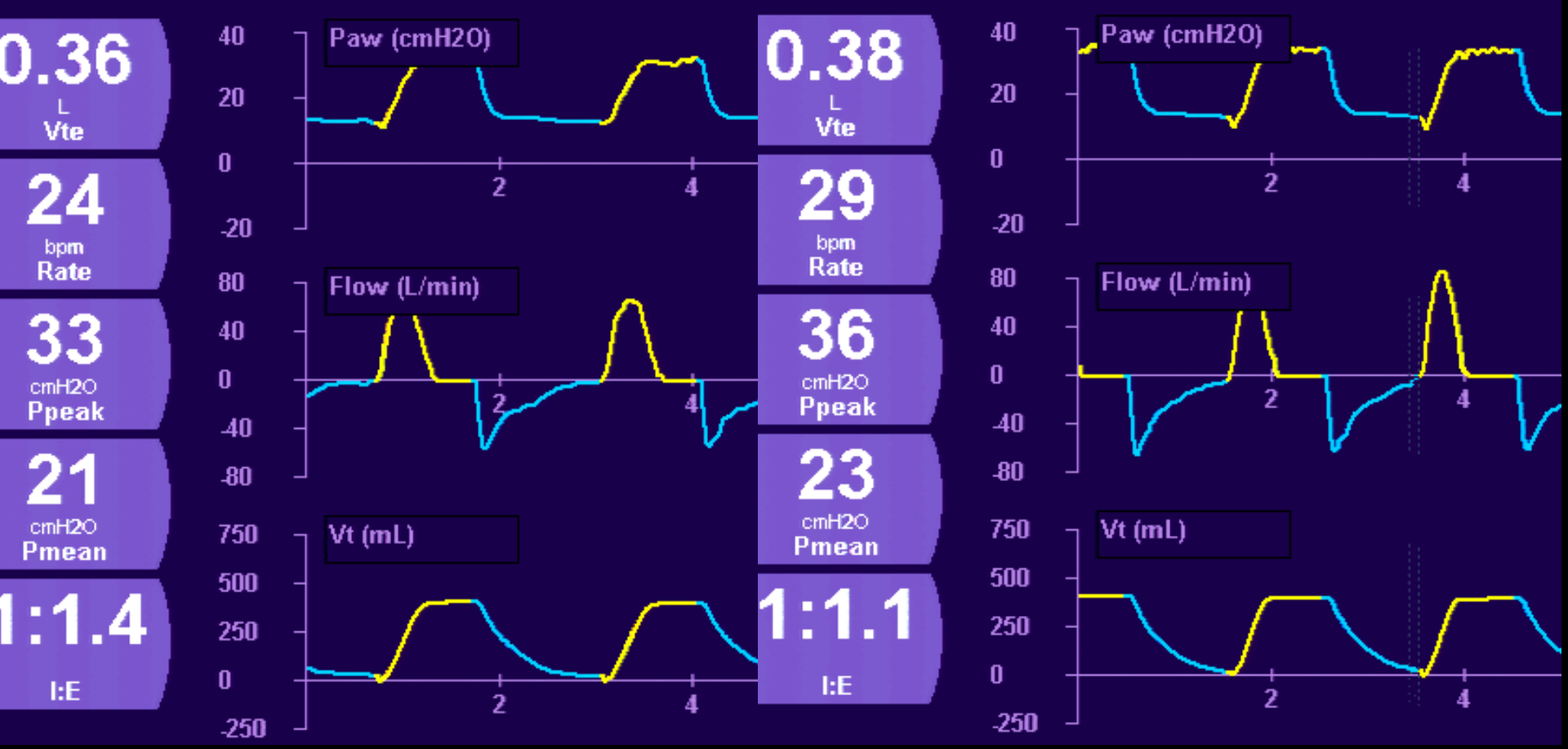
# Decreased Tidal Volume


VOLUME A/C
Vsync
MAIN
0.38
L
Vte
29
bpm
Rate
36
cmH2O
Ppeak
23
cmH2O
Pmean
1:1.1
I:E
Paw (cmH2O)
40
20
0
-20
Flow (L/min)
80
40
0
-40
-80
Vt (mL)
750
500
250
0
-250
2
4
6
8
10
12
12
bpm
Rate
0.40
L
Volume
32
L/min
Peak Flow
0.00
sec
Insp Pause
14
cmH2O
PEEP
2.0
L/min
Flow Trig
70
%
FiO2
Calc Ve
L
4.80
1.00sec
4.00sec
1:4.0


3. Which one of the following best explains these changes?




A. Decrease in Airway Resistance
B. Decrease in Compliance
C. Increase in Airway Resistance
D. Increase in Compliance

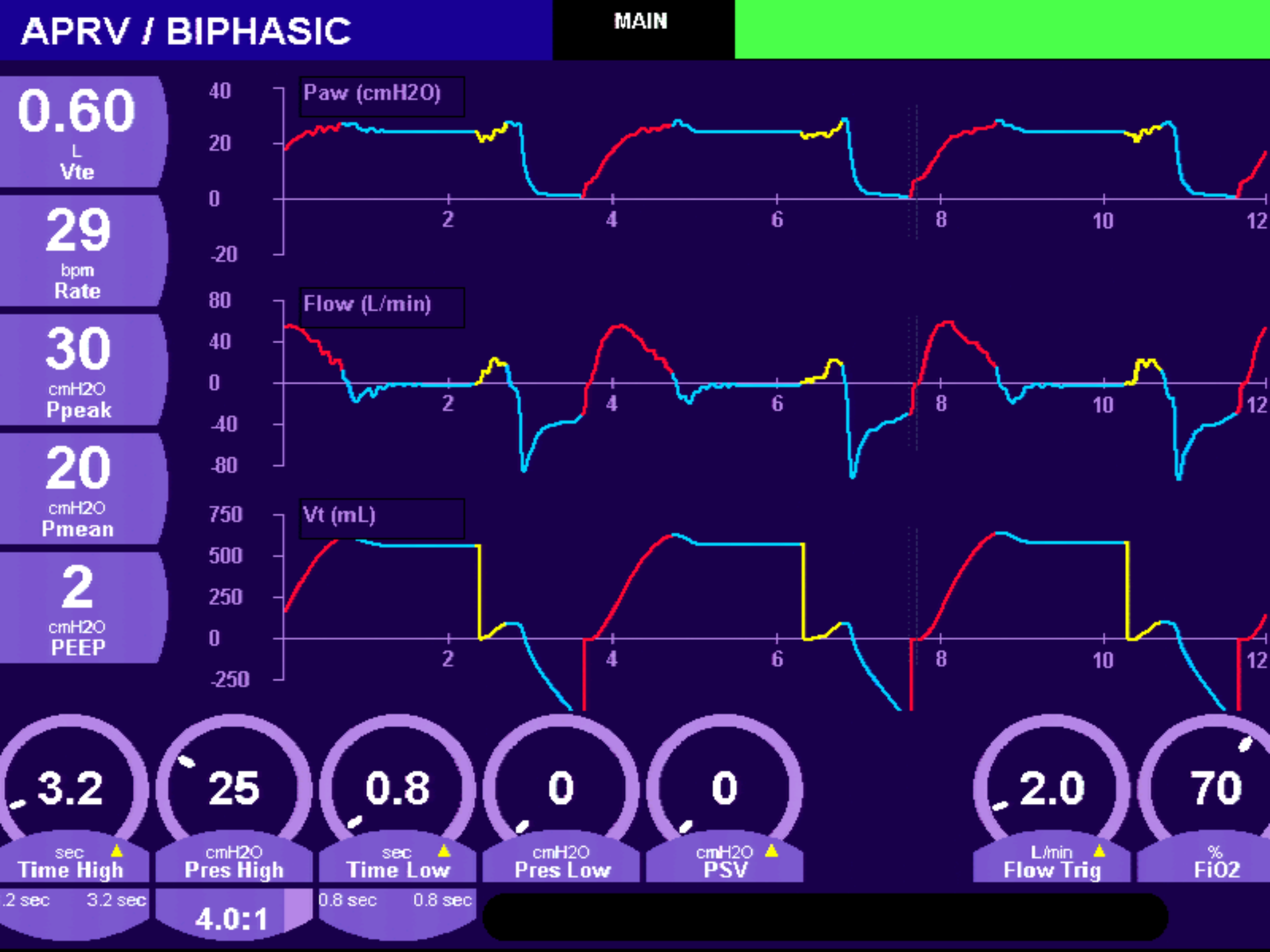


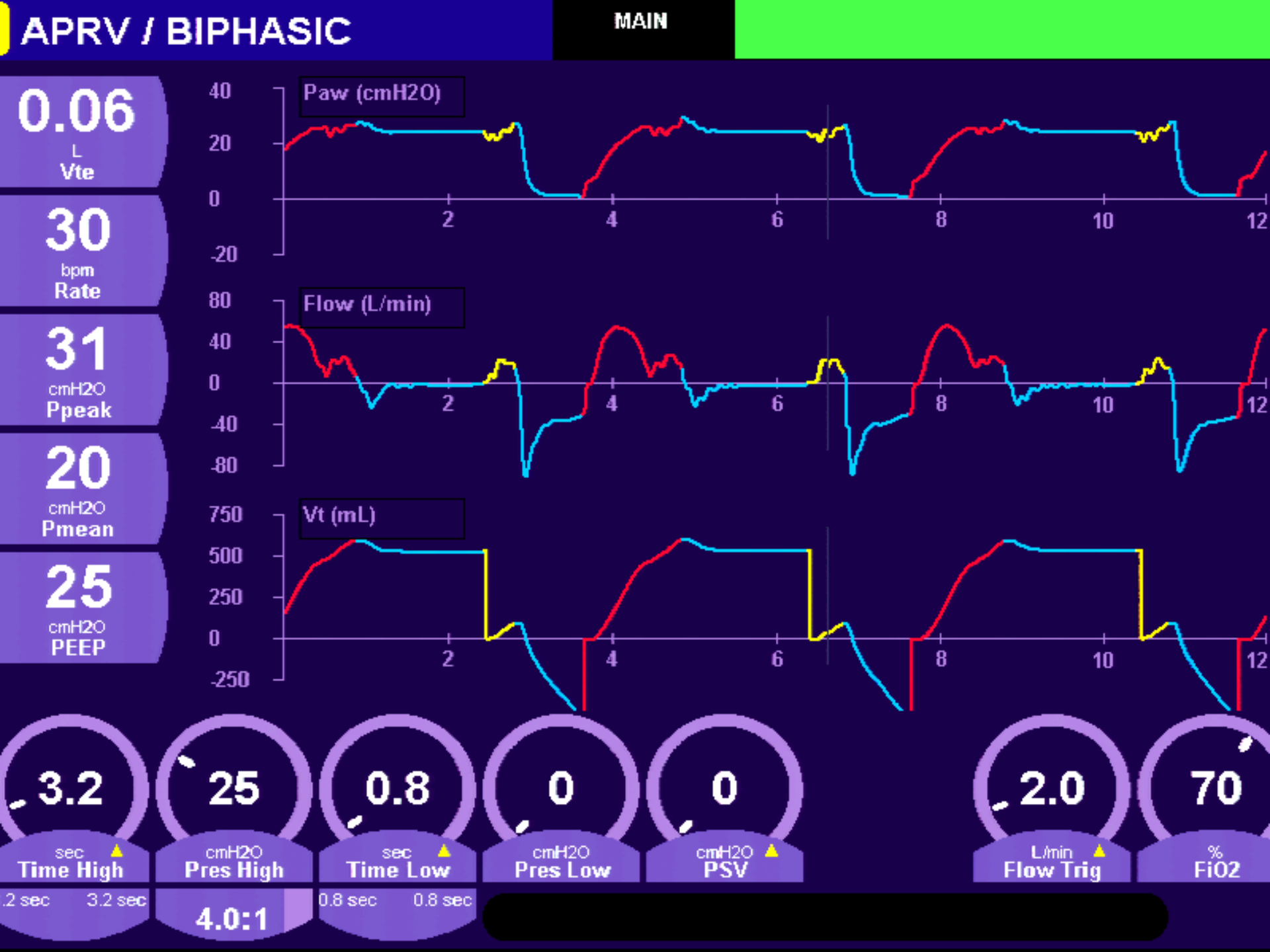

A. Decrease in Airway Resistance

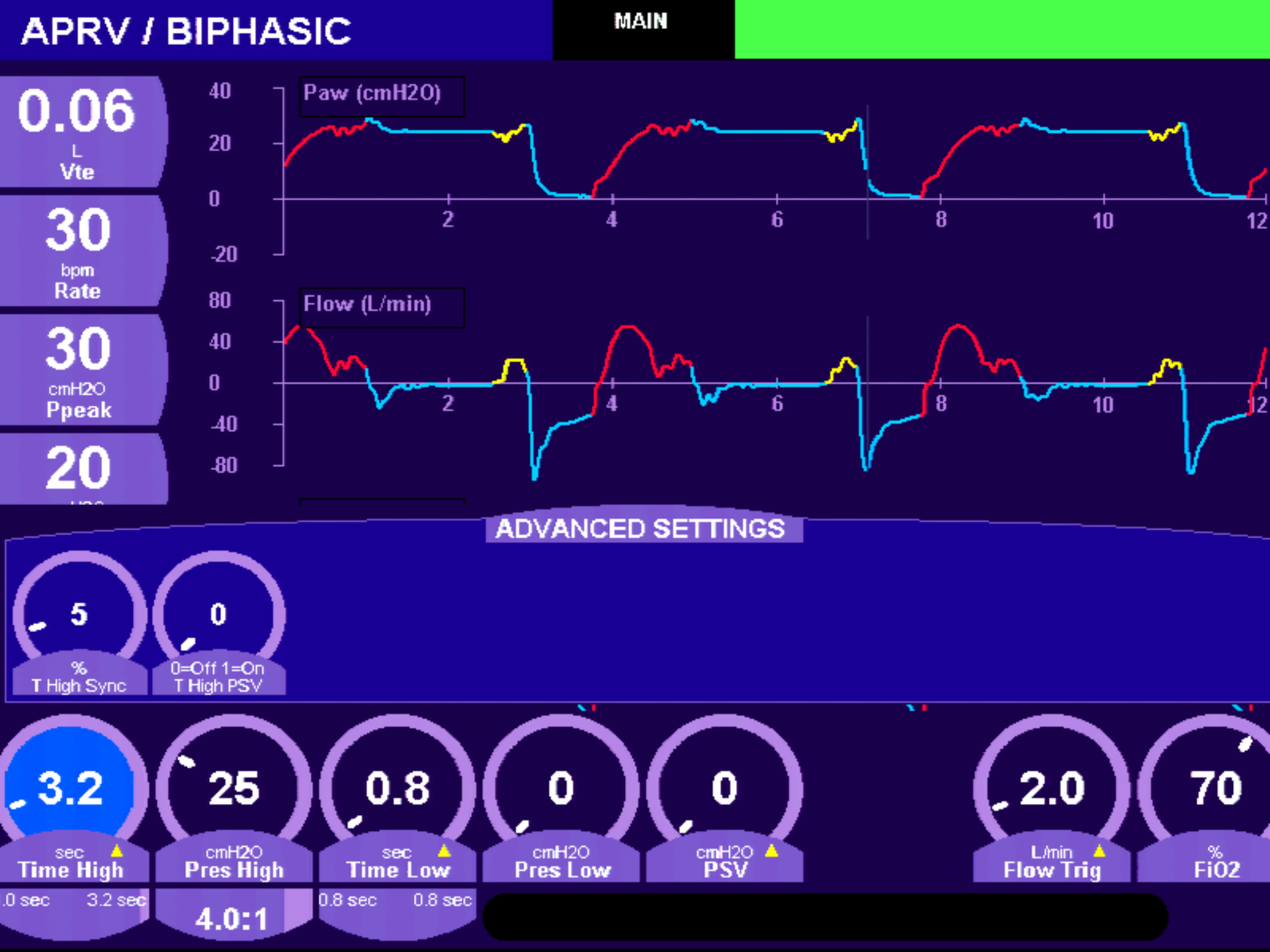
B. Decrease in Compliance

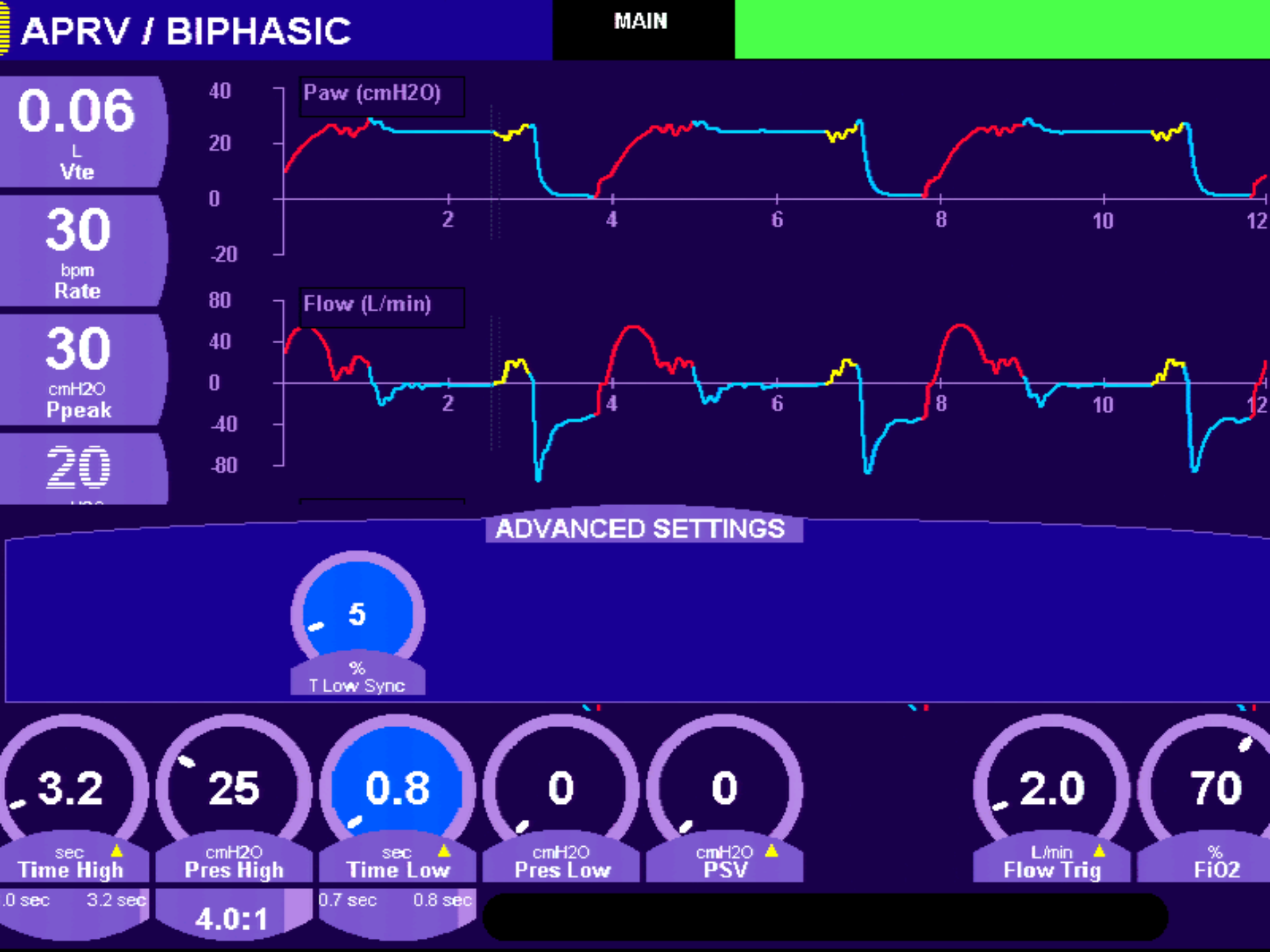
C. Increase in Airway Resistance

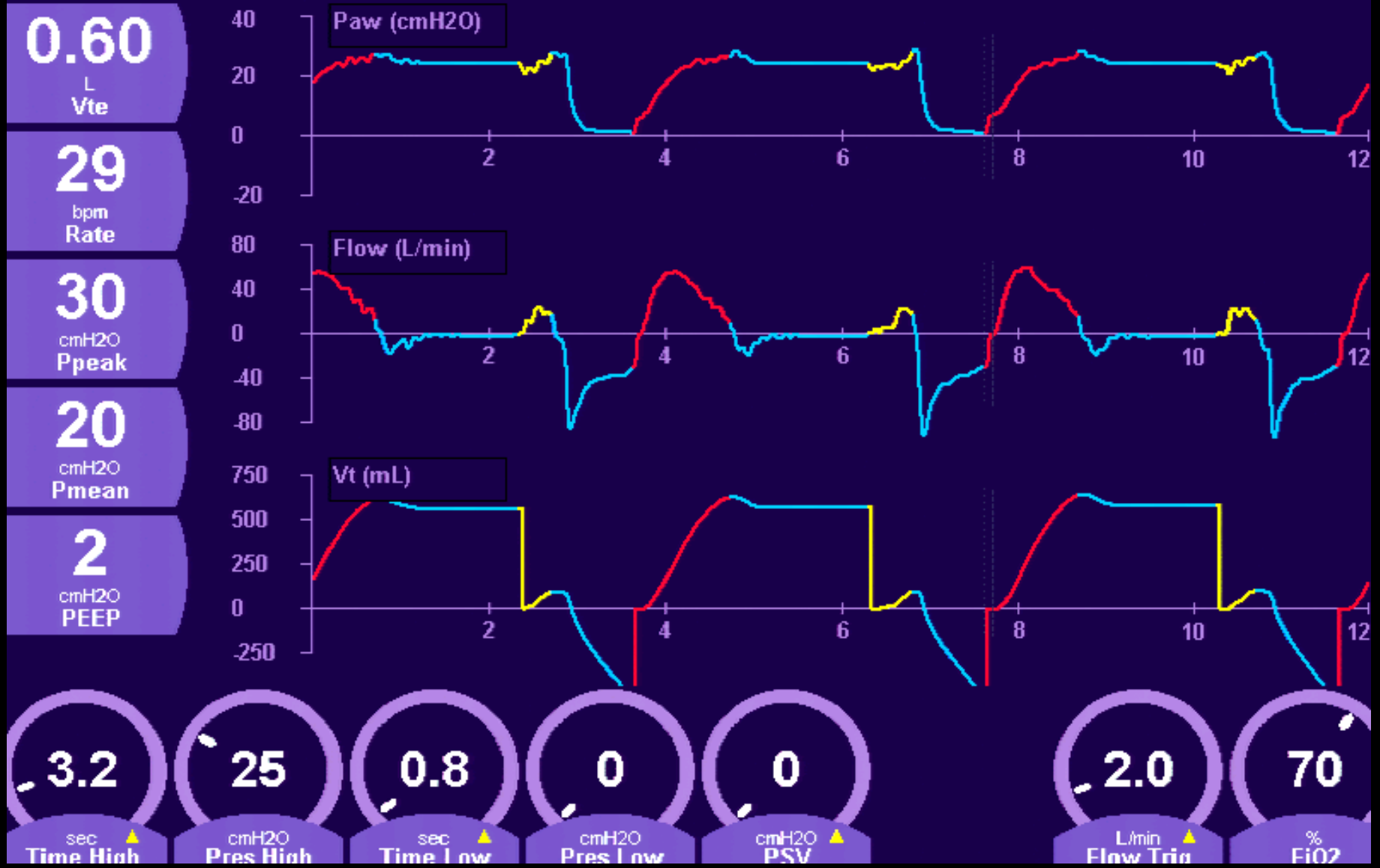
D. Increase in Compliance


APRV / BIPHASIC
MAIN
0.60
L
Vte
29
bpm
Rate
30
cmH2O
Ppeak
20
cmH2O
Pmean
2
cmH2O
PEEP
Paw (cmH2O)
40
20
0
-20
2
4
6
8
10
12
Flow (L/min)
80
40
0
-40
-80
Vt (mL)
750
500
250
0
-250
3.2
sec
Time High
.2 sec
3.2 sec
25
cmH2O
Pres High
4.0:1
0.8
sec
Time Low
0.8 sec
0.8 sec
0
cmH2O
Pres Low
0
cmH2O
PSV
2.0
L/min
Flow Trig
70
%
FiO2

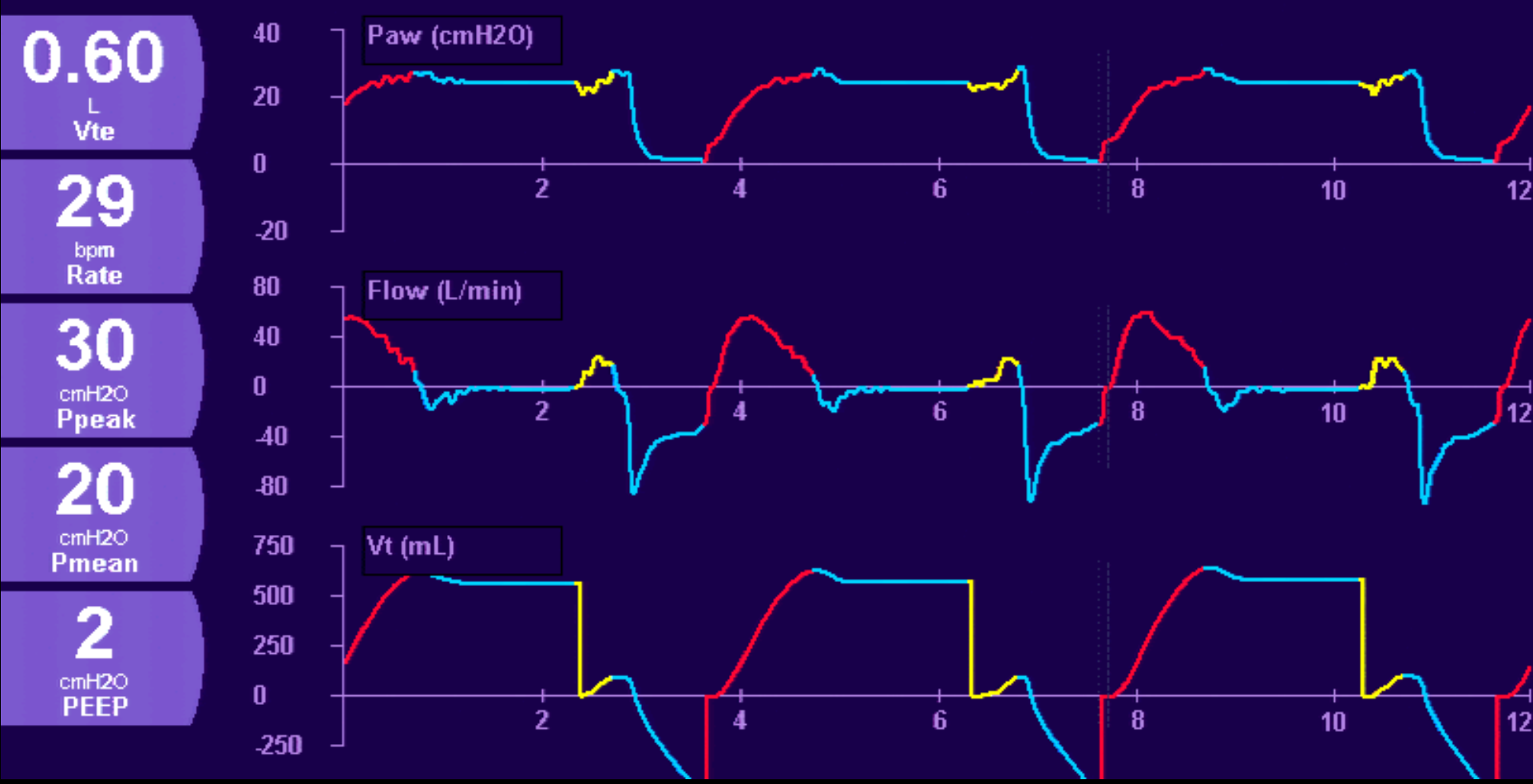

APRV / BIPHASIC
MAIN
0.06
L
Vte
30
bpm
Rate
31
cmH2O
Ppeak
20
cmH2O
Pmean
25
cmH2O
PEEP
Paw (cmH2O)
40
20
0
-20
2
4
6
8
10
12
Flow (L/min)
80
40
0
-40
-80
Vt (mL)
750
500
250
0
-250
3.2
sec
Time High
.2 sec
3.2 sec
25
cmH2O
Pres High
4.0:1
0.8
sec
Time Low
0.8 sec
0.8 sec
0
cmH2O
Pres Low
0
cmH2O
PSV
2.0
L/min
Flow Trig
70
%
FiO2


APRV / BIPHASIC
MAIN
0.06
L
Vte
30
bpm
Rate
30
cmH2O
Ppeak
20
Paw (cmH2O)
40
20
0
-20
2
4
6
8
10
12
Flow (L/min)
80
40
0
-40
-80
2
4
6
8
10
12
ADVANCED SETTINGS
5
%
T High Sync
0
0=Off 1=On
T High PSV
3.2
sec
Time High
.0 sec
3.2 sec
25
cmH2O
Pres High
4.0:1
0.8
sec
Time Low
0.8 sec
0.8 sec
0
cmH2O
Pres Low
0
cmH2O
PSV
2.0
L/min
Flow Trig
70
%
FiO2

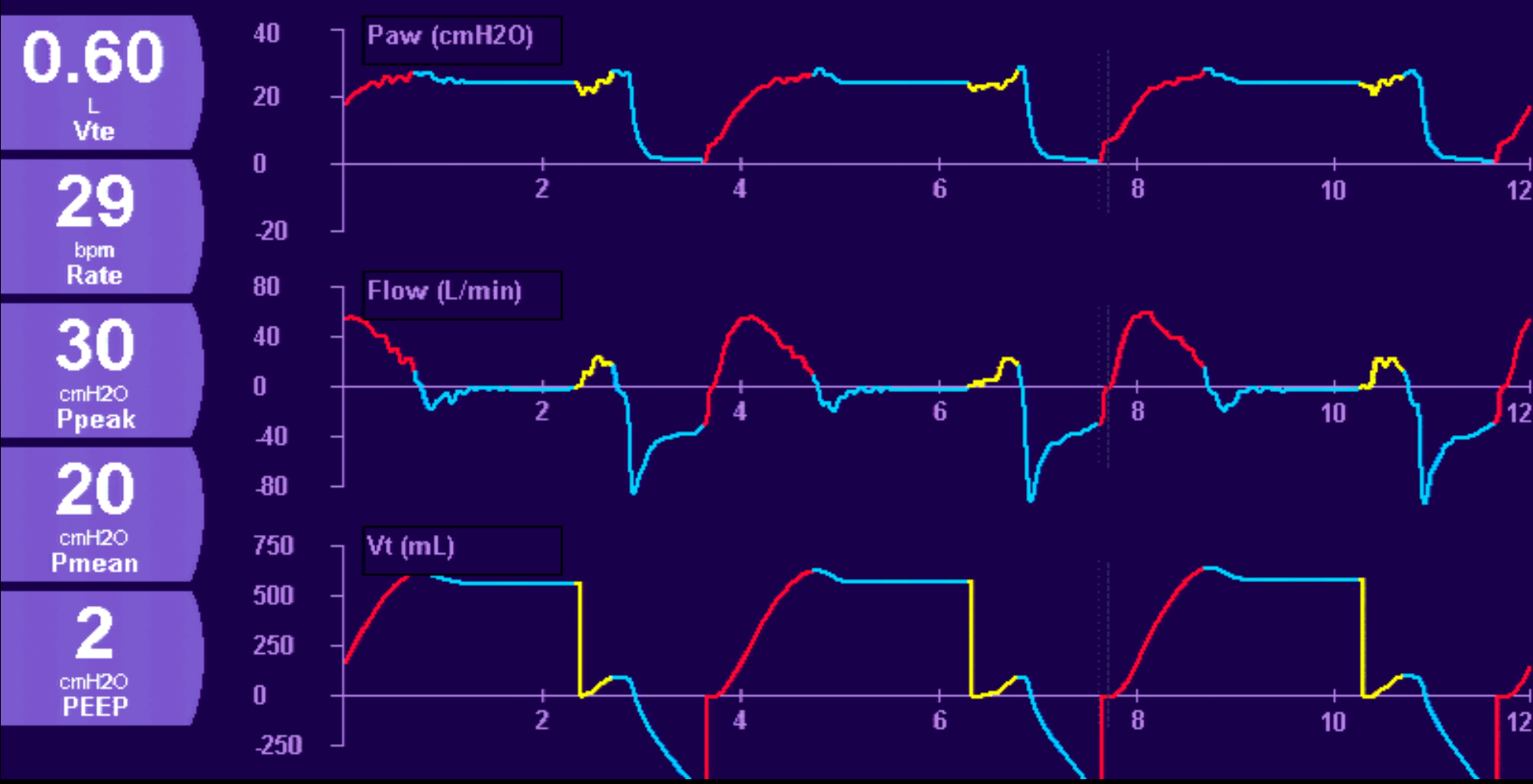

APRV / BIPHASIC
MAIN
0.06
L
Vte
30
bpm
Rate
30
cmH2O
Ppeak
20
Paw (cmH2O)
40
20
0
-20
2
4
6
8
10
12
Flow (L/min)
80
40
0
-40
-80
2
4
6
8
10
12
ADVANCED SETTINGS
5
%
T Low Sync
3.2
sec
Time High
.0 sec
3.2 sec
25
cmH2O
Pres High
4.0:1
0.8
sec
Time Low
0.7 sec
0.8 sec
0
cmH2O
Pres Low
0
cmH2O
PSV
2.0
L/min
Flow Trig
70
%
FiO2




3. Which of the following changes would you recommend?




A. Decrease in Time Low
B. Decrease in Pressure High
C. Increase in Pressure Low
D. Increase in PSV

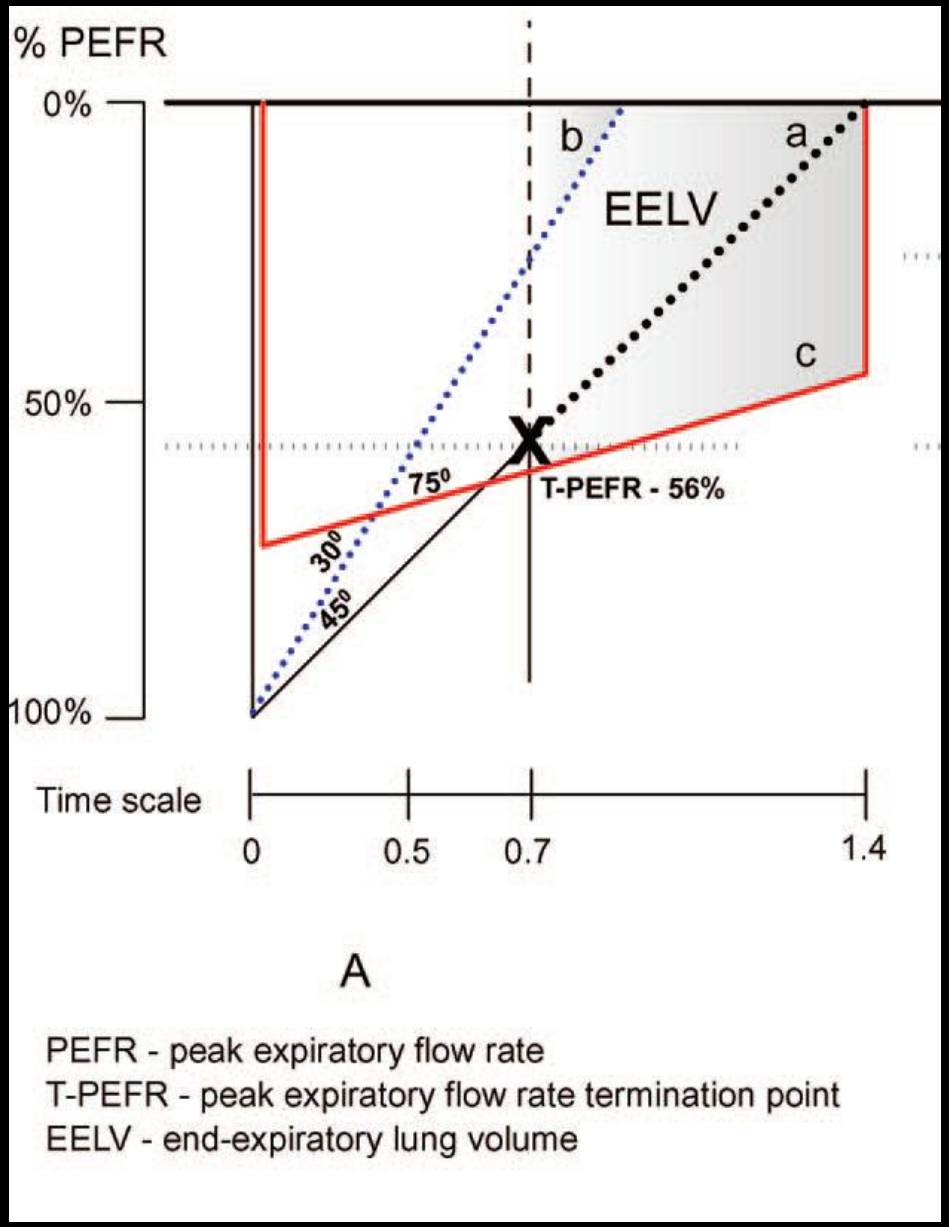



A. Decrease in Time Low

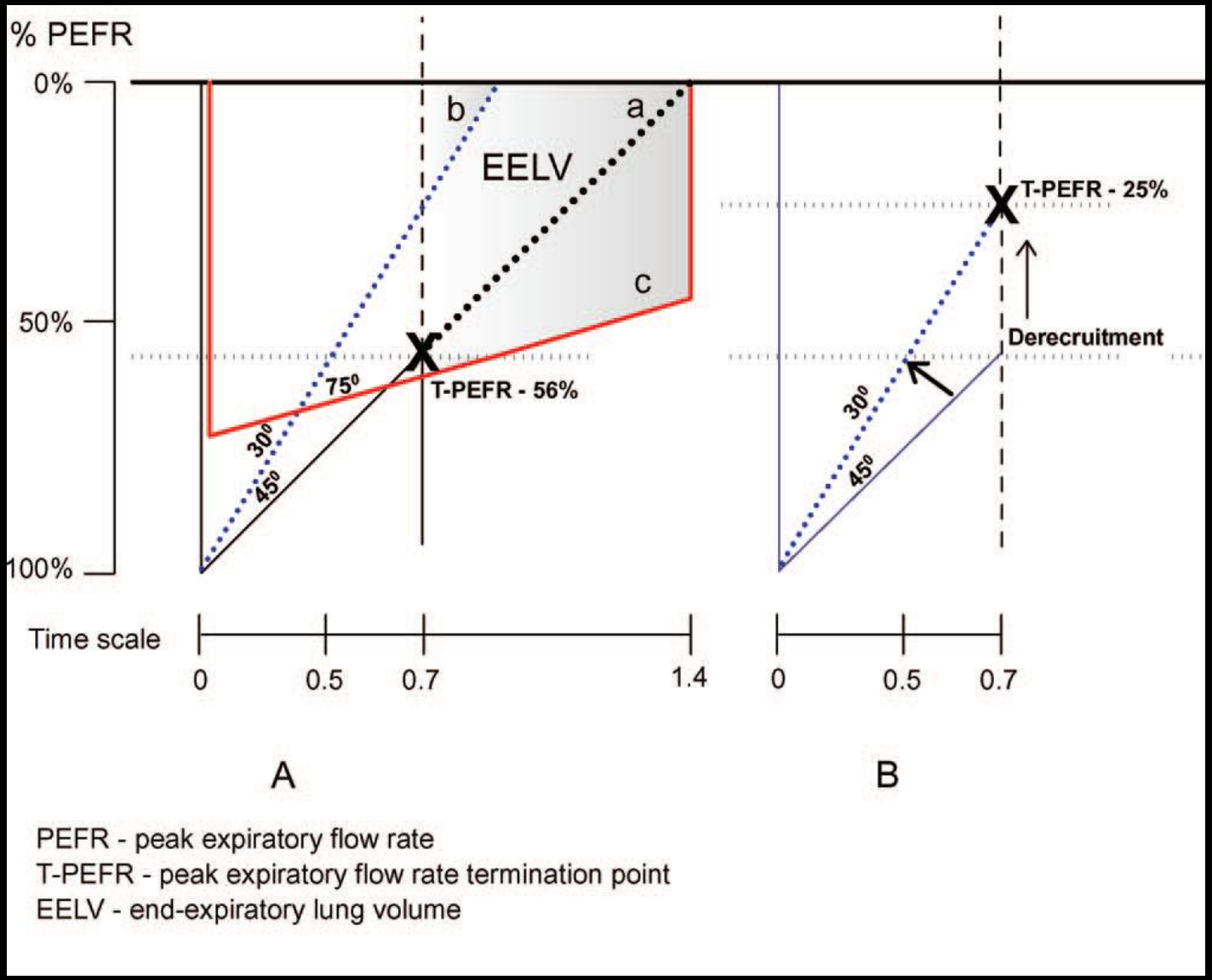
B. Decrease in Pressure High

C. Increase in Pressure Low

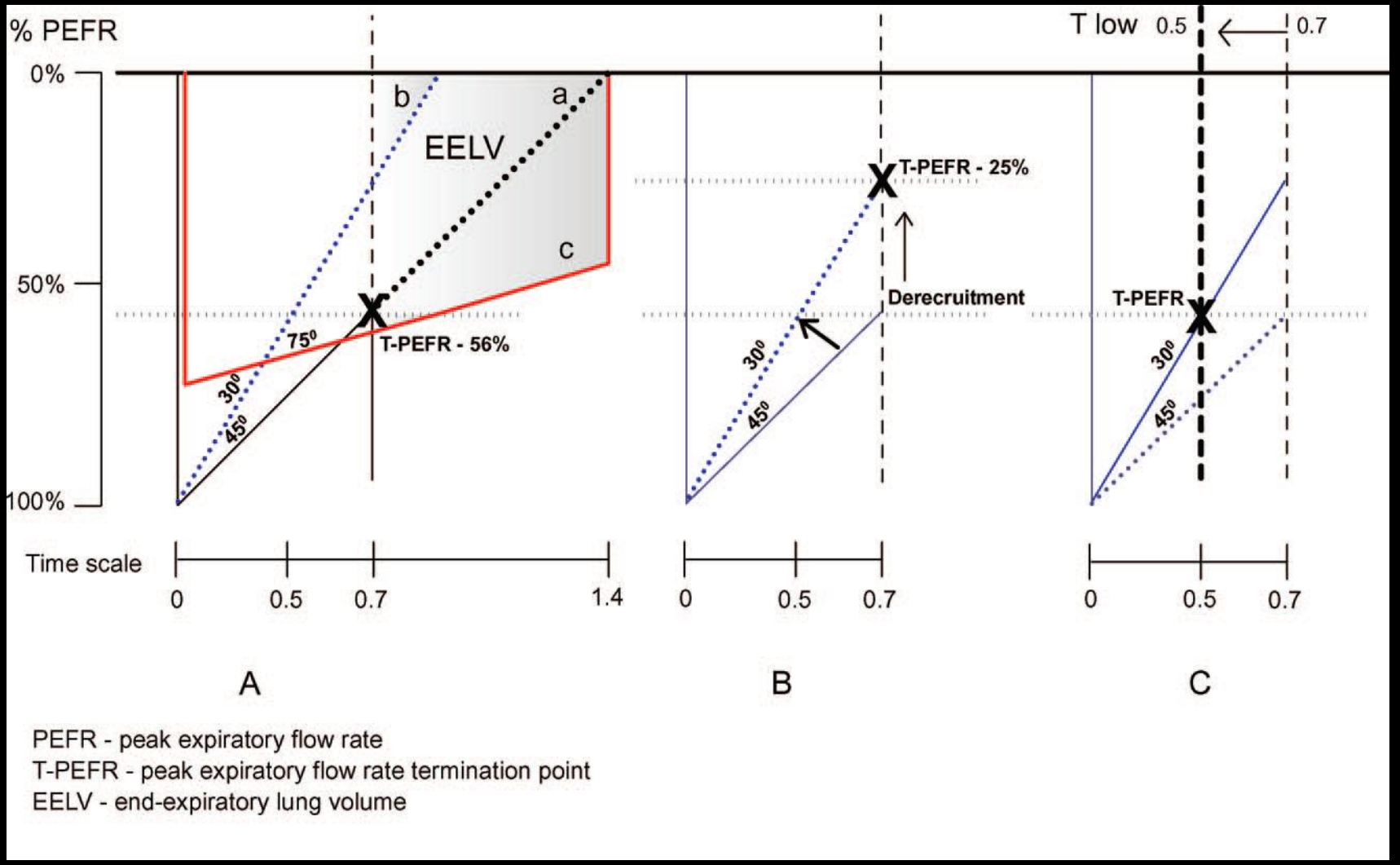
D. Increase in PSV



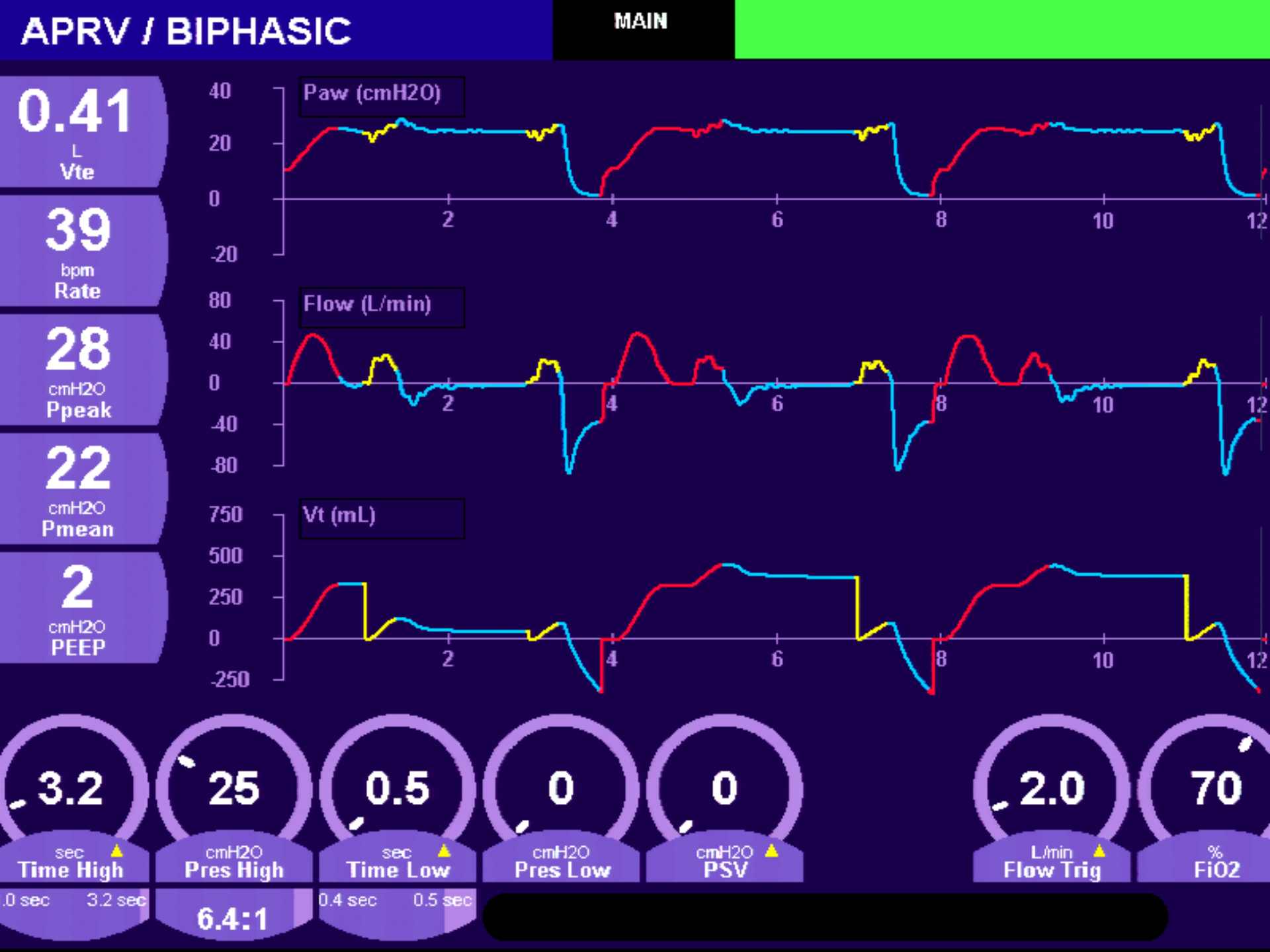

Habashi. Crit Care Med, 2005;33(3):S228-S240

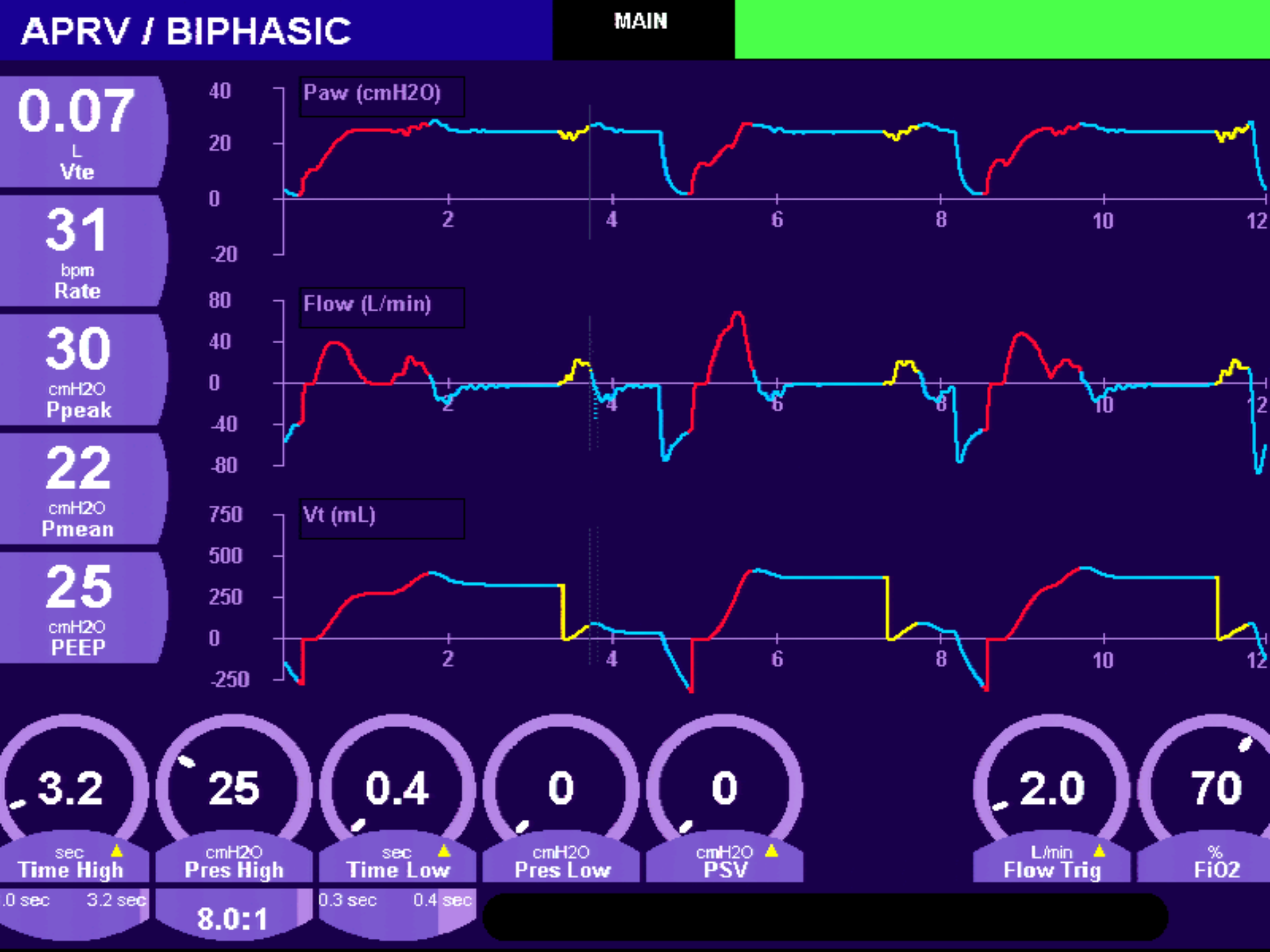



Habashi. Crit Care Med, 2005;33(3):S228-S240




Habashi. Crit Care Med, 2005;33(3):S228-S240


APRV / BIPHASIC
MAIN
0.41
L
Vte
39
bpm
Rate
28
cmH2O
Ppeak
22
cmH2O
Pmean
2
cmH2O
PEEP
Paw (cmH2O)
40
20
0
-20
2
4
6
8
10
12
Flow (L/min)
80
40
0
-40
-80
Vt (mL)
750
500
250
0
-250
3.2
sec
Time High
.0 sec
3.2 sec
25
cmH2O
Pres High
6.4:1
0.5
sec
Time Low
0.4 sec
0.5 sec
0
cmH2O
Pres Low
0
cmH2O
PSV
2.0
L/min
Flow Trig
70
%
FiO2


APRV / BIPHASIC
MAIN
0.07
L
Vte
31
bpm
Rate
30
cmH2O
Ppeak
22
cmH2O
Pmean
25
cmH2O
PEEP
Paw (cmH2O)
40
20
0
-20
2
4
6
8
10
12
Flow (L/min)
80
40
0
-40
-80
Vt (mL)
750
500
250
0
-250
3.2
sec
Time High
.0 sec
3.2 sec
25
cmH2O
Pres High
8.0:1
0.4
sec
Time Low
0.3 sec
0.4 sec
0
cmH2O
Pres Low
0
cmH2O
PSV
2.0
L/min
Flow Trig
70
%
FiO2


4. If his respiratory acidosis worsens, which one of the following changes would you recommend?


A. Increase in Pressure Low

B. Increase in Pressure High

C. Decrease in Time High

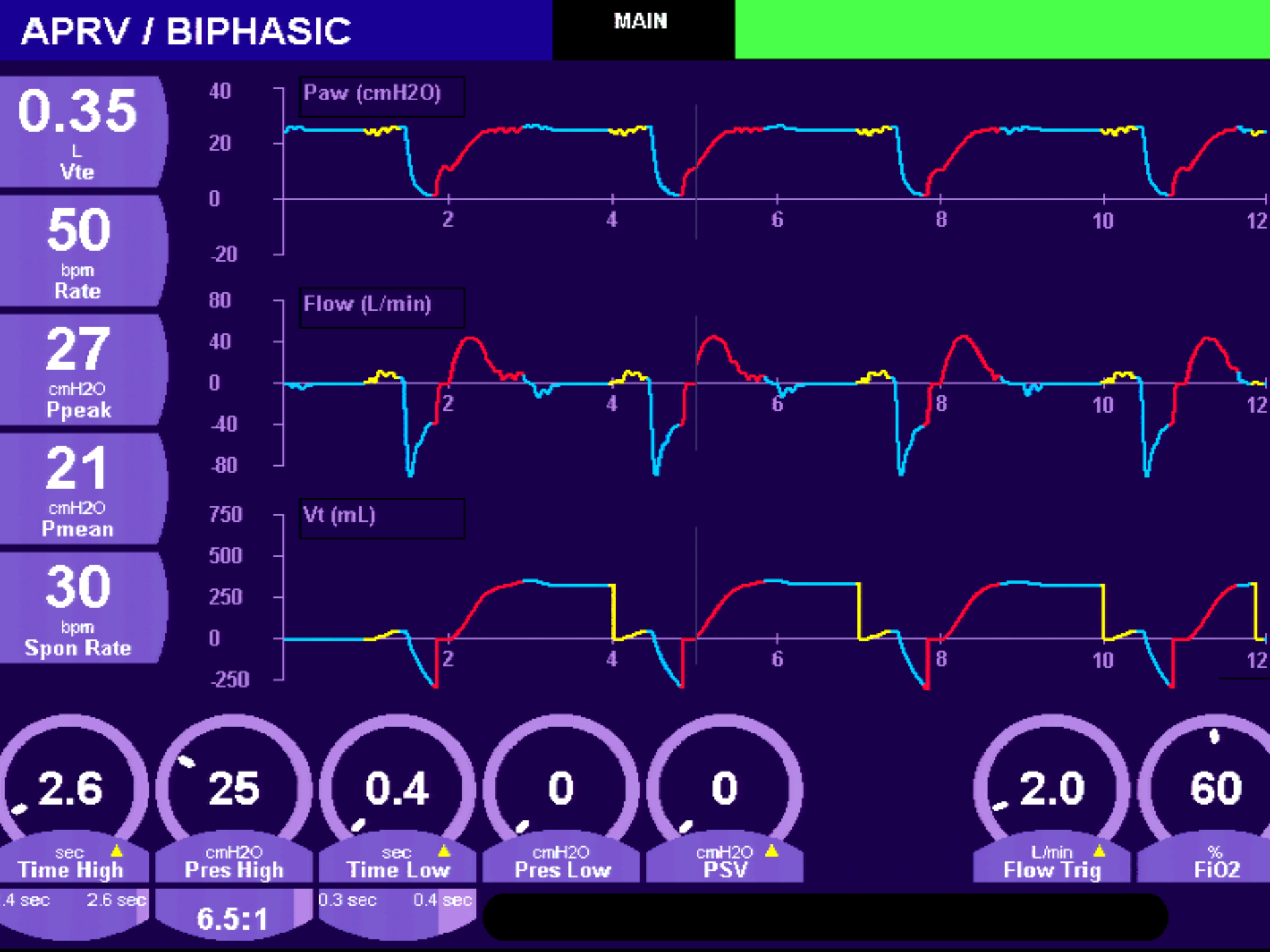
D. Decrease in Time Low


A. Increase in Pressure Low

B. Increase in Pressure High

C. Decrease in Time High

D. Decrease in Time Low


APRV / BIPHASIC
MAIN
0.35
L
Vte
50
bpm
Rate
27
cmH2O
Ppeak
21
cmH2O
Pmean
30
bpm
Spon Rate
Paw (cmH2O)
40
20
0
-20
2
4
6
8
10
12
Flow (L/min)
80
40
0
-40
-80
Vt (mL)
750
500
250
0
-250
2.6
sec
Time High
.4 sec
2.6 sec
25
cmH2O
Pres High
6.5:1
0.4
sec
Time Low
0.3 sec
0.4 sec
0
cmH2O
Pres Low
0
cmH2O
PSV
2.0
L/min
Flow Trig
60
%
FiO2

# Conclusion

- It is important to be knowledgeable of the equipment you use and adapt it to the patient’s pathophysiology.

# Thank You

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