Pt was recently intubated, set on SIMV/Vt 500/RR 12/PEEP 5/FiO2 100%, breathing 28 bpm
• Patient looks incredibly uncomfortable. Pox is 93%, ETCO2 is 35
a) Paralyze the patient
b) Increase the PEEP
c) Increase the Vt
d) Sedate the patient
e) Add Pressure Support

Ans: E.
a) Paralyze the patient
– Don't do this unless you know what you're doing
b) Increase the PEEP
– Oxygenation is OK. Don't need to do this
c) Increase the Vt
– Ventilation is OK. Don't need to do this
d) Sedate the patient
– Maybe…
e) SIMV with Pressure Support
• Never use SIMV without pressure support
• Remember SIMV only gives you the set RR
• The pt is only getting 12 mechanical breaths
• 16 breaths are pt-generated… against all the resistance of the tubing!!!!
Torture!

Pt was recently intubated, set on AC/Vt 600/RR 18/PEEP 5/FiO2 100%, breathing 28 bpm
• RT tells you that the ABG: 7.65/12/400/24/98% and asks you what you want done.
a) Increase the PEEP
b) Decrease the RR
c) Increase the Tidal Volume
d) Give Bicarbonate
e) Decrease Tidal Volume
f) None of the above

a) Increase the PEEP
– Don't need to, oxygenation is fine
b) Decrease the RR
– Most common choice. Most common error
c) Increase the Tidal Volume
– Probably already too high
d) Give Bicarb
– Pt is already markedly alkalotic
e) Decrease Tidal Volume
– Maybe. Tidal volume should not be more than 10 cc/kg IBW. Set Vt at 8cc/kg IBW
f) None of the above
– Maybe. Pt may need sedation/analgesia

Waveforms 5-point assessment
(from the top)

1) Early inspiratory pressure

2) End inspiratory pressure

3) Plateau pressure

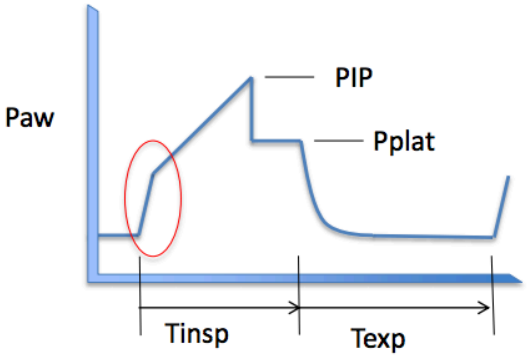
4) Expiratory flow curve

5) AutoPEEP

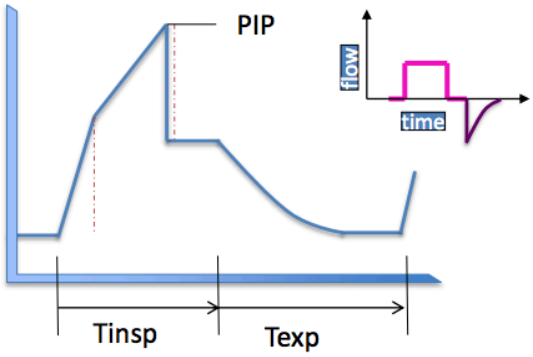
Early Inspiratory Pressure

- The initial pressure generated to overcome resistance in the airways.
- No volume is delivered at this time, simply a rise in pressure enough to start pushing air in.
- An abnormal rise in this pressure is an indication of *increased airway resistance*.

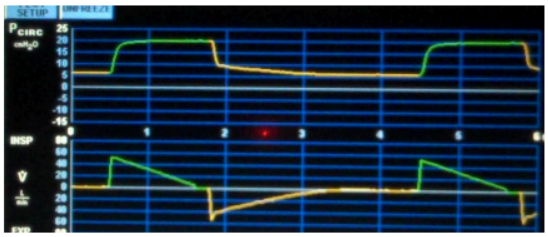
Early Inspiratory Pressure Waveforms



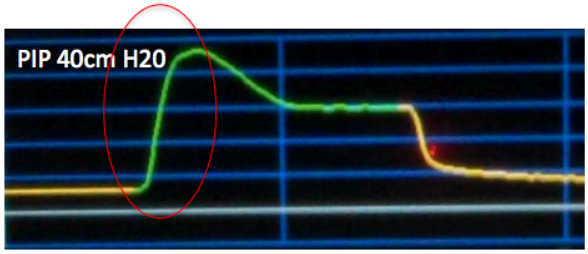
Normal pressure-time curve with square flow pattern



Raised early inspiratory pressure with square flow pattern



Normal pressure-time curve with descending ramp flow pattern

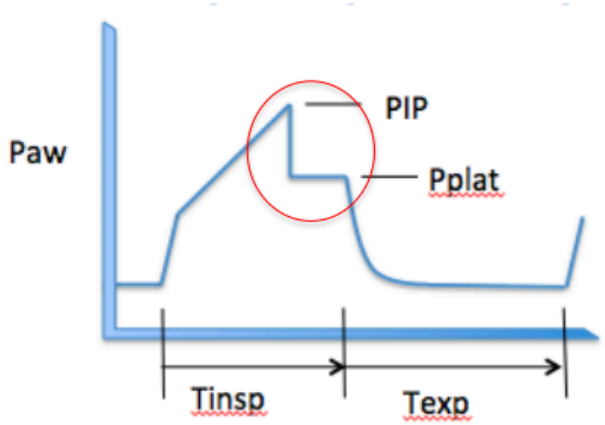


Raised early inspiratory pressure with descending flow pattern

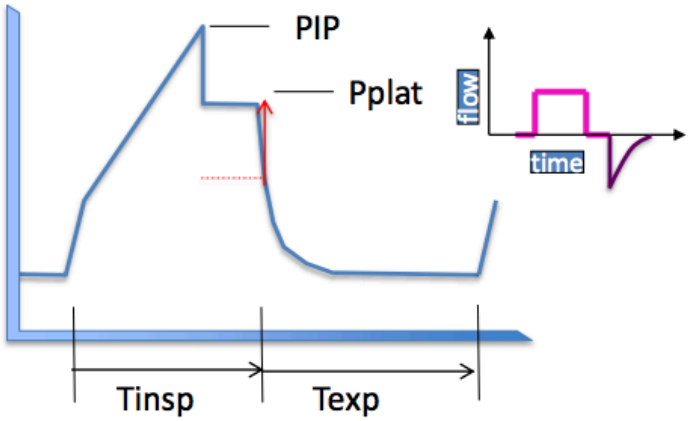
End Inspiratory Pressure

- The pressure generated to overcome lung compliance.
- Added on top of Pres.
- An abnormal rise in this pressure is an indication of *decreased lung compliance*.

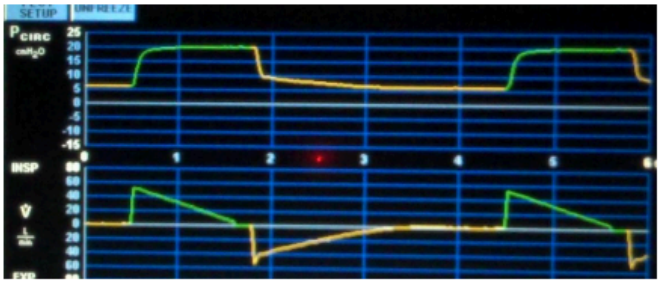
End Inspiratory Pressure Waveforms



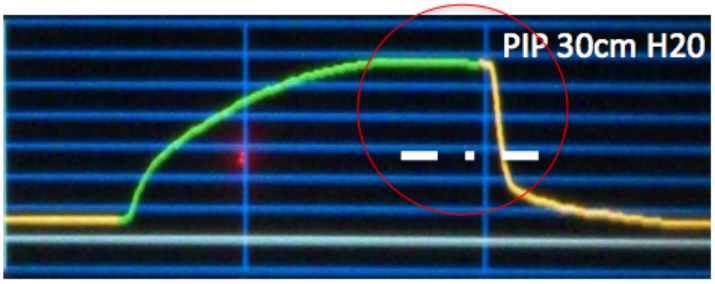
Normal pressure-time curve with square flow pattern



Raised end inspiratory pressure with square flow pattern



Normal pressure-time curve with descending ramp flow pattern



Raised end inspiratory pressure with descending flow patterm

Plateau Pressure

- An increase in pressure at end inspiration as a result of decreased compliance.
- Measured by performing an 'inspiratory hold' on the ventilator.
- Causes of increased Pplat include: lung, pleura, chest wall, patient-ventilator dyssynchrony.

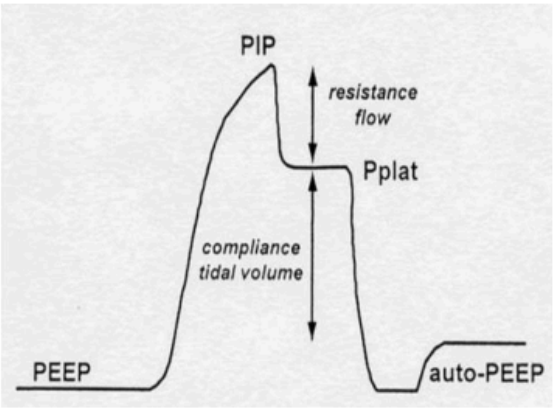
Plateau Pressure Waveforms

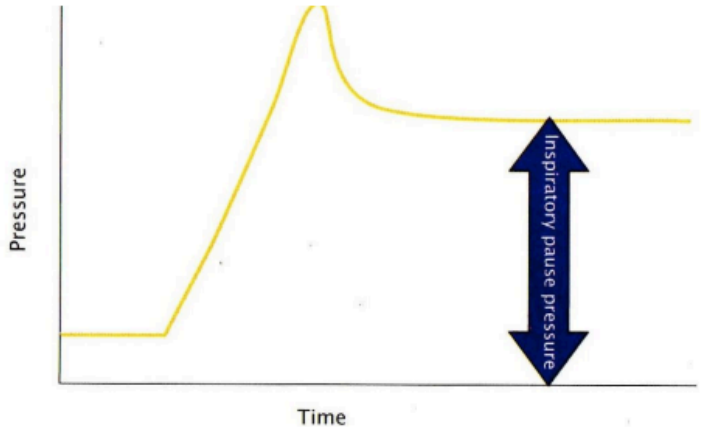
- Measured at the end of inspiration when there is no flow.

- Airway pressure = (flow x resistance) + alveolar pressure
  = (0 x resistance) + alveolar pressure
  = alveolar pressure

Flow x Resistance + Alveolar pressure

- High alveolar pressure may be due to excessive VT, gas-trapping, PEEP, decreased compliance.





Expiratory Flow Waveforms

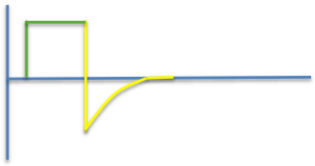
- Expiratory flow is a passive process reliant on the natural recoil of the lungs and chest wall.

- Like the pressure waveform the expiratory flow curve too can illustrate resistance and compliance.

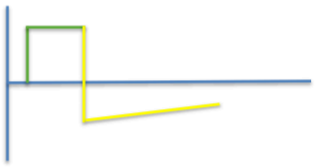
- Essentially increased resistance is a linear expiratory waveform and decreased compliance is a concave expiratory waveform.

Expiratory flow shapes

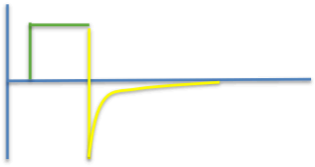
- Normal:
  - Expiratory flow curve triangular (shallow curve returning to baseline).
  - >80% gas expired in first second of expiration.



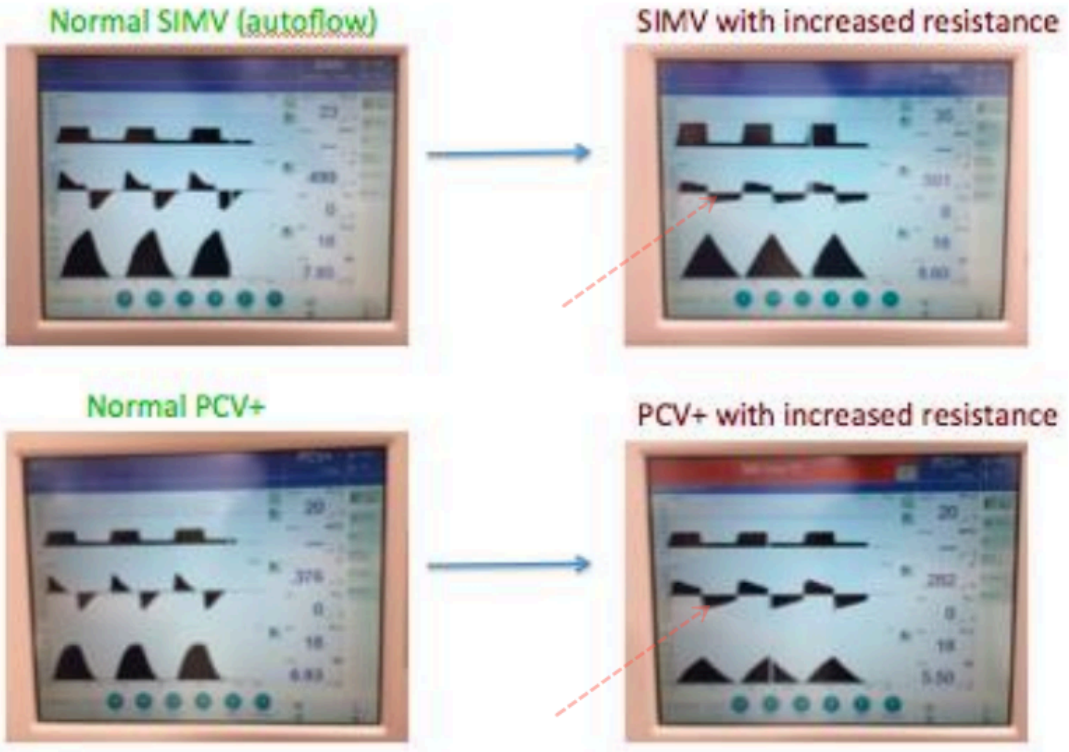
- Increased resistance:
  - Expiratory flow curve horizontal/linear.
  - <80% gas expired in first second of expiration.
  - Resistance constant, may not return to baseline.



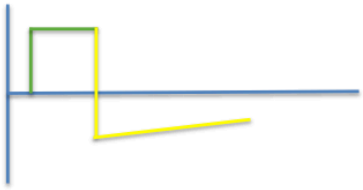
- Decreased compliance:
  - Expiratory flow curve is deep and concave.
  - <80% gas expired in first second of expiration.
  - Resistance increases as lung volume decreases.



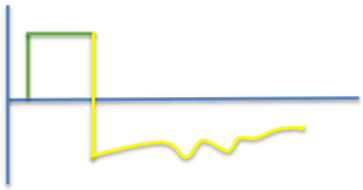
Increased Airway Resistance



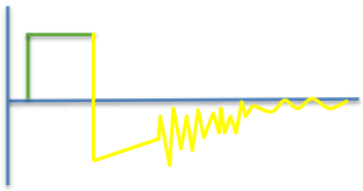
Increased Resistance Characteristics



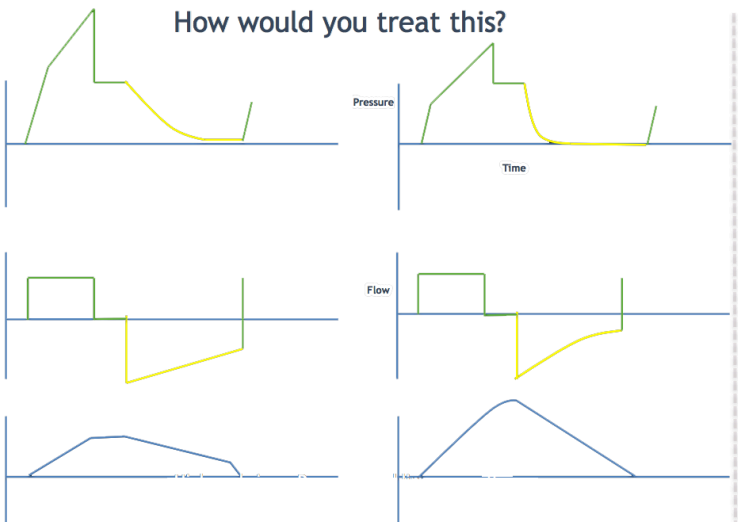
- Linear expiratory flow due to constant resistance.

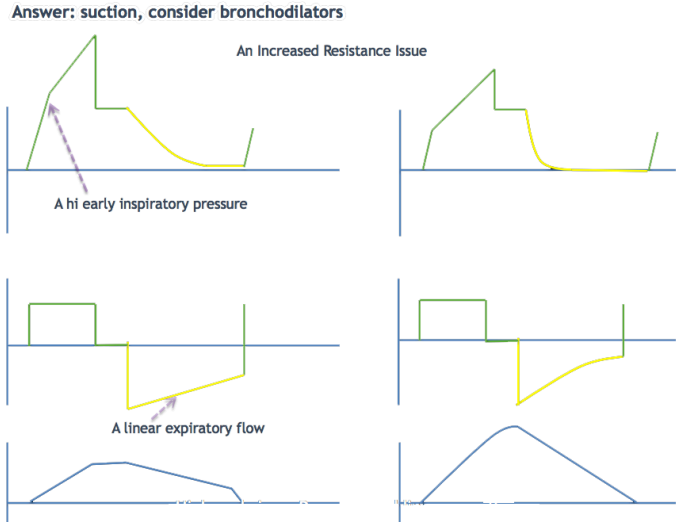


- The smaller the flow triangle the worse the resistance. Assess PEV1.
- End expiratory flow may not return to baseline- gas trapping- perform expiratory hold.



- Turbulent expiratory flow pattern due to obstruction eg tumour.
- Rain out and cardiac pulsations.



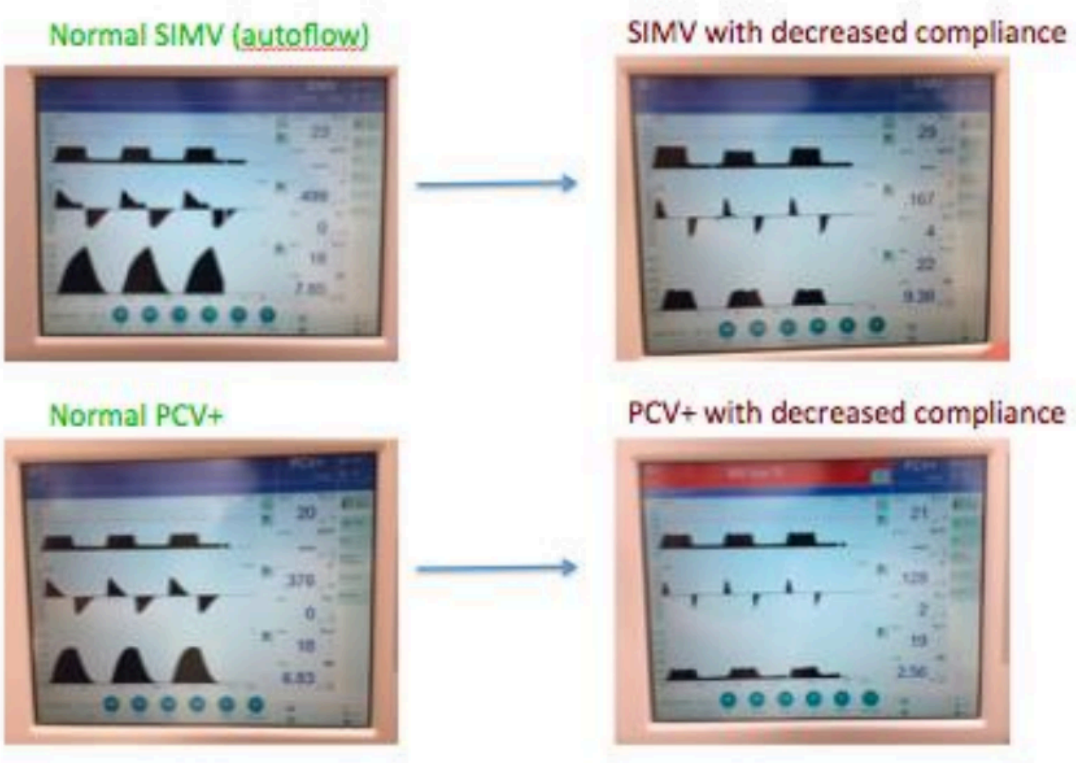


Troubleshooting increased resistance…

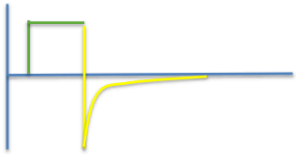
- **May be due to:**
  - ETT eg too small, kinked, blocked/clogged with secretions/sputum, patient biting, inline suction catheter not fully removed
  - Bronchospasm, airway pathology, disease process
  - Malplaced ETT eg dislodgment, bronchial intubation
  - Kinked/blocked ventilator tubing (secretions/condensation)

- **May require:**
  - Checking of circuit/ETT for kinks/obstructions
  - Suctioning
  - Increased sedation/analgesia, bronchodilators
  - Diagnostics eg CXR, bronchoscopy
  - Change of ETT/trache

Decreased Lung Compliance



Decreased Compliance Characteristics



- Deep concave curve.
- The smaller the flow triangle the worse the compliance. Assess PEV1.
- May or may not return to baseline, gas-trapping- perform expiratory hold.
- Pressure waveform has raised end expiratory pressure and Pplat.

Troubleshooting decreased compliance…

- **May be due to:**
  - Lung e.g. collapse, consolidation, pulmonary oedema, asthma, COPD, ARDS
  - Pleura e.g. pleural effusion, pneumo/haemothorax
  - Chest wall e.g. abdominal distention, obesity, kyphoscoliosis
  - Patient-ventilator dysynchrony, coughing
- **May require:**
  - CXR
  - Bronchodilators, chest drain
  - Repositioning eg sitting upright, lateral lie to favour lung, proning
  - Change in ventilation strategy

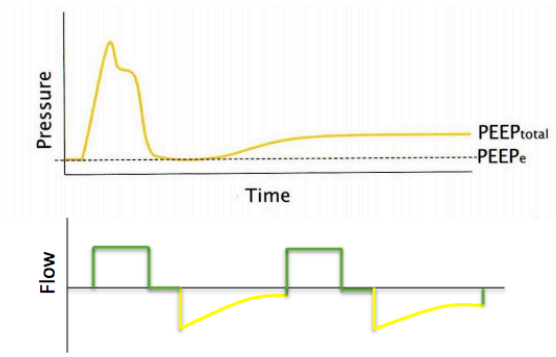
iPEEP

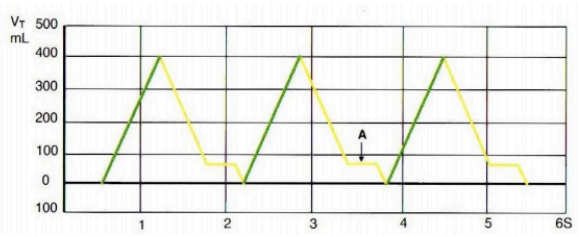
- Also known as autoPEEP, gas/air trapping, dynamic hyperinflation.
- An increase in pressure at end expiration due to baseline lung volume that is greater than the FRC as a result of increased Raw and insufficient expiratory time.
- Measured by performing an 'expiratory hold' on the ventilator.
- Most commonly seen in diseases such as COPD and asthma.

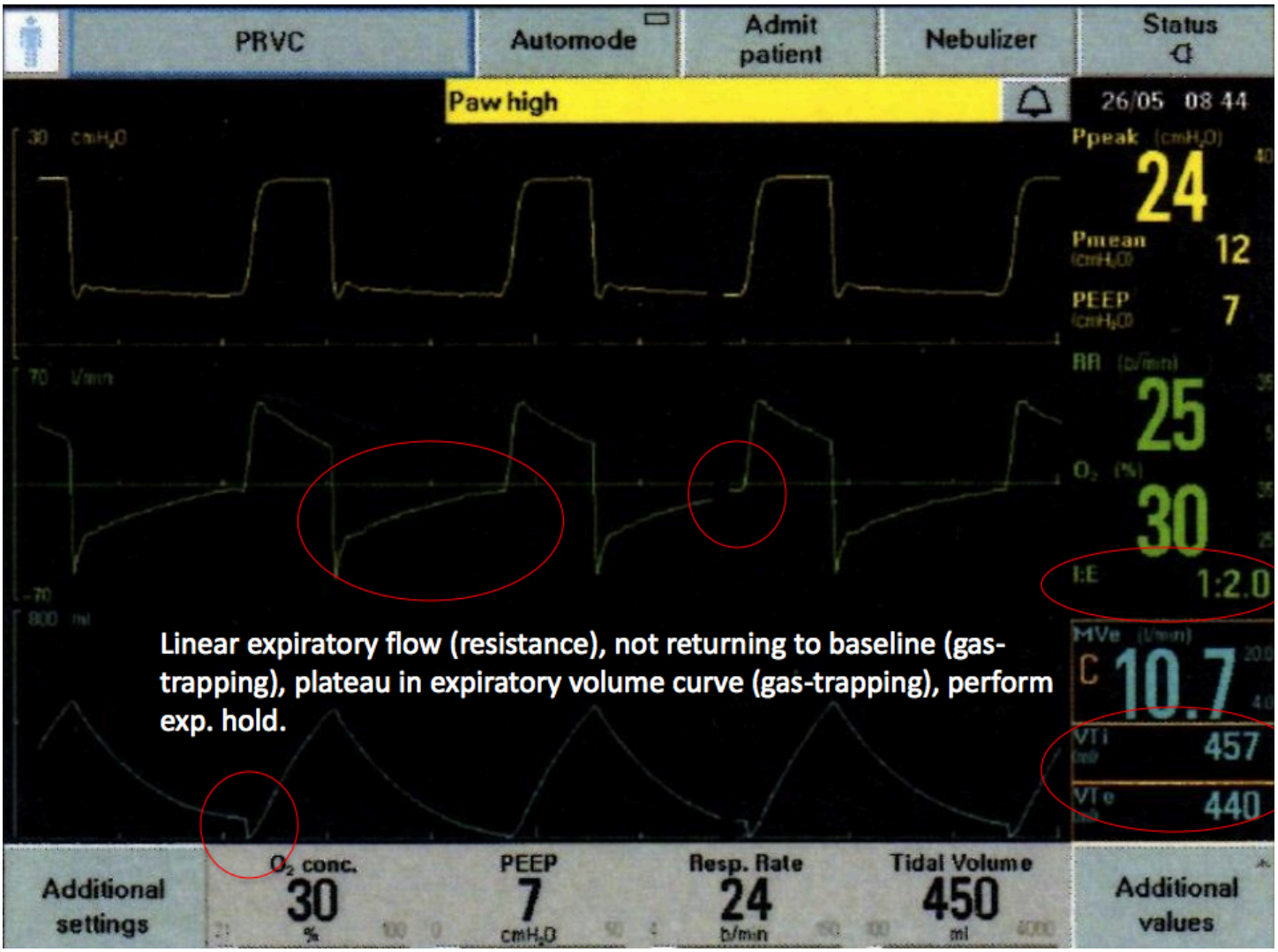
iPEEP = auto-PEEP

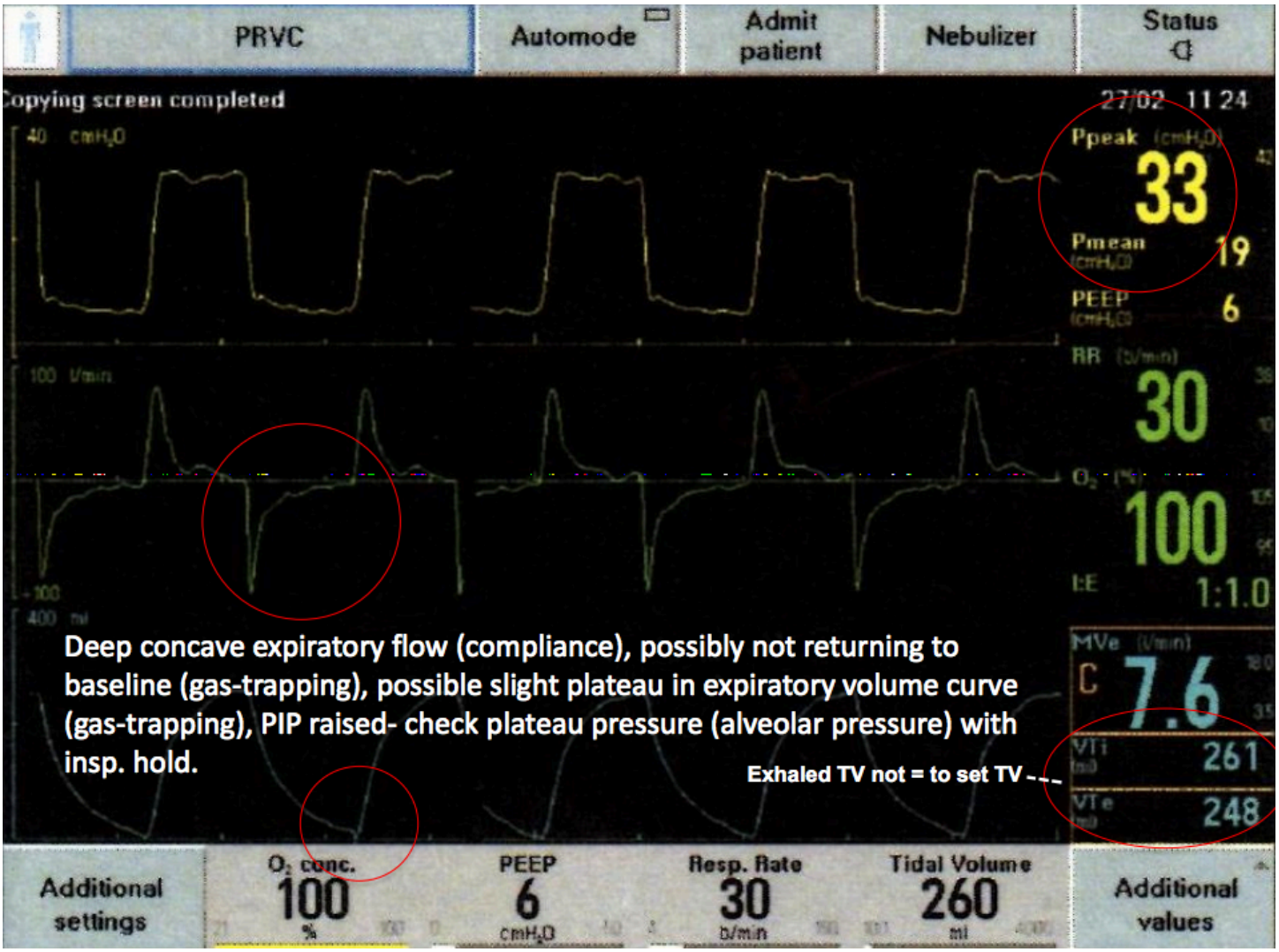
iPEEP Waveforms

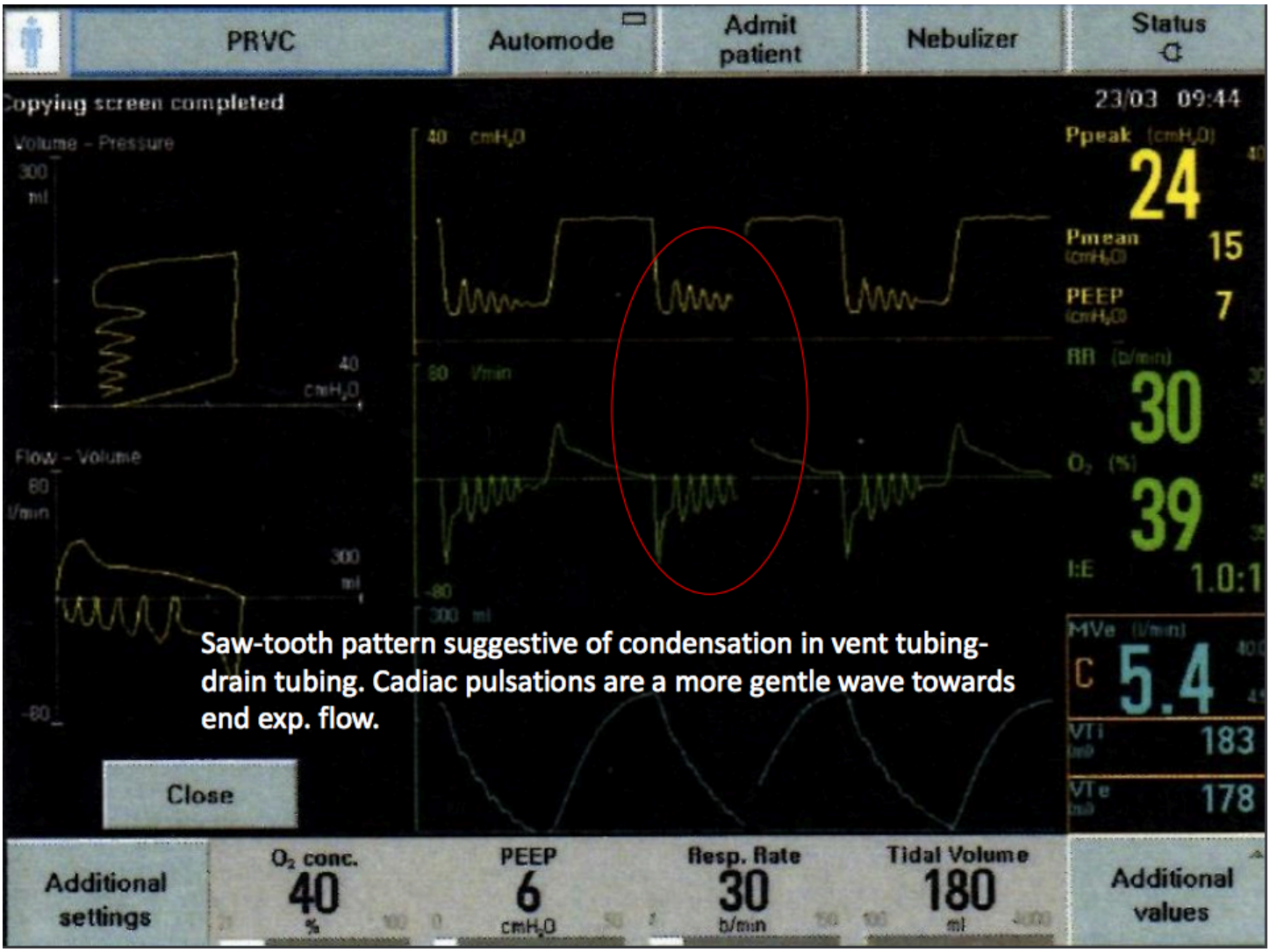
- Pressure rise during expiratory hold.
- Expiratory flow fails to return to baseline.
- Plateau (A) in volume waveform as VTe is less than VT due to gas-trapping.

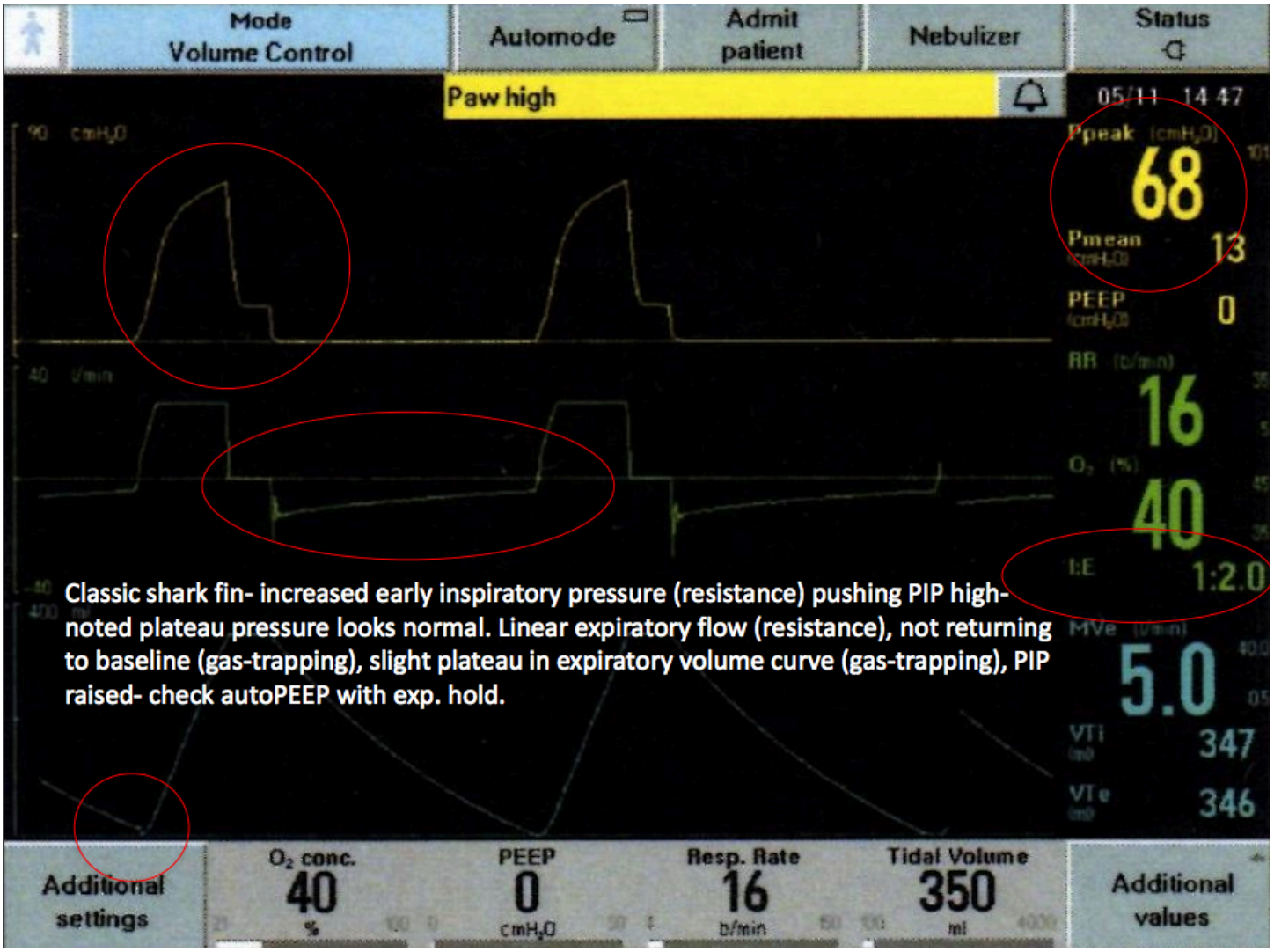


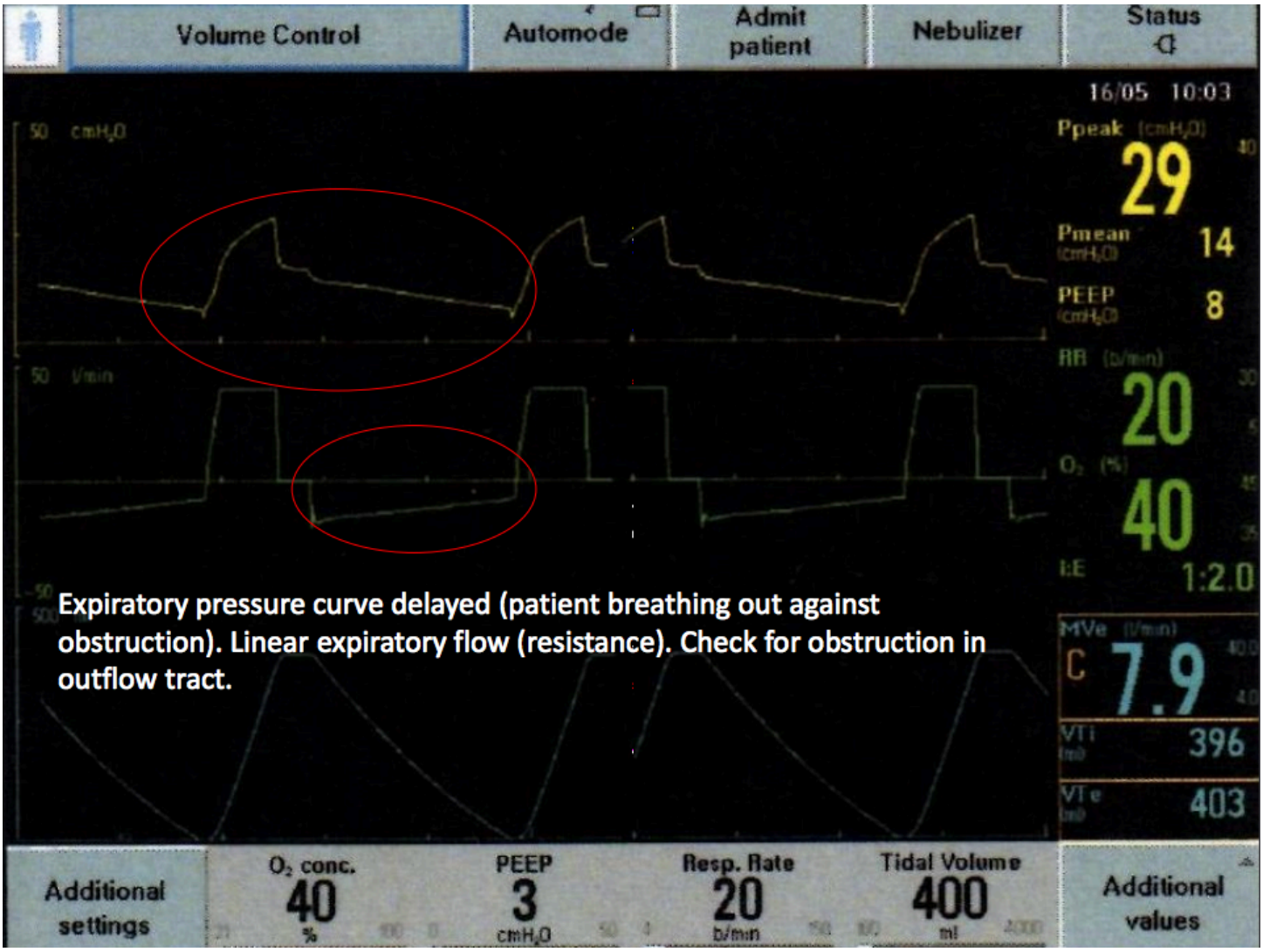


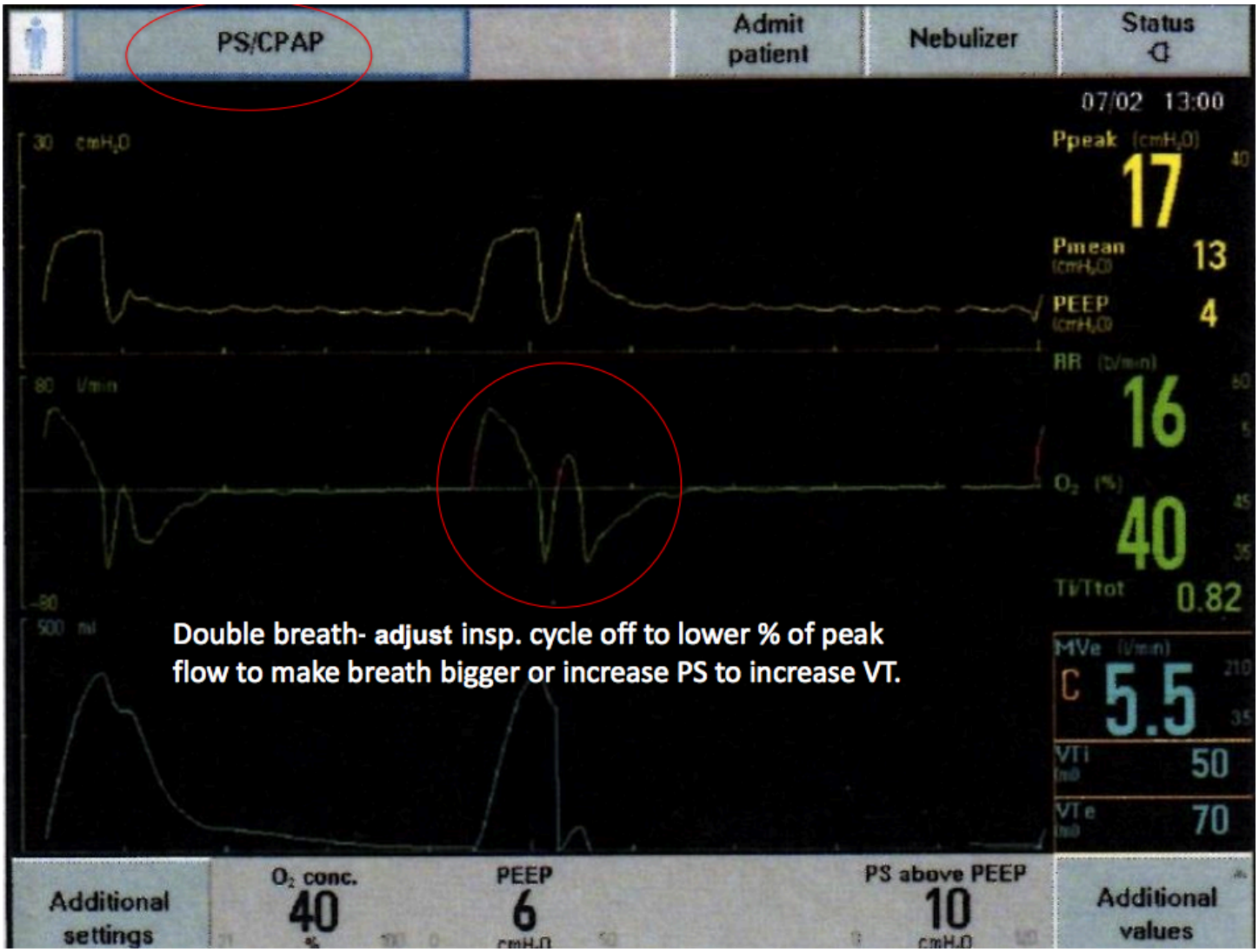

PRVC
Automode
Admit patient
Nebulizer
Status
Paw high
26/05 08 44
Ppeak
24
Pmean
12
PEEP
7
RR
25
30
I:E
1:2.0
MVe
10.7
457
440
Linear expiratory flow (resistance), not returning to baseline (gas-trapping), plateau in expiratory volume curve (gas-trapping), perform exp. hold.
Additional settings
O2 conc.
30
%
PEEP
7
cmH2O
Resp. Rate
24
b/min
Tidal Volume
450
ml
Additional values

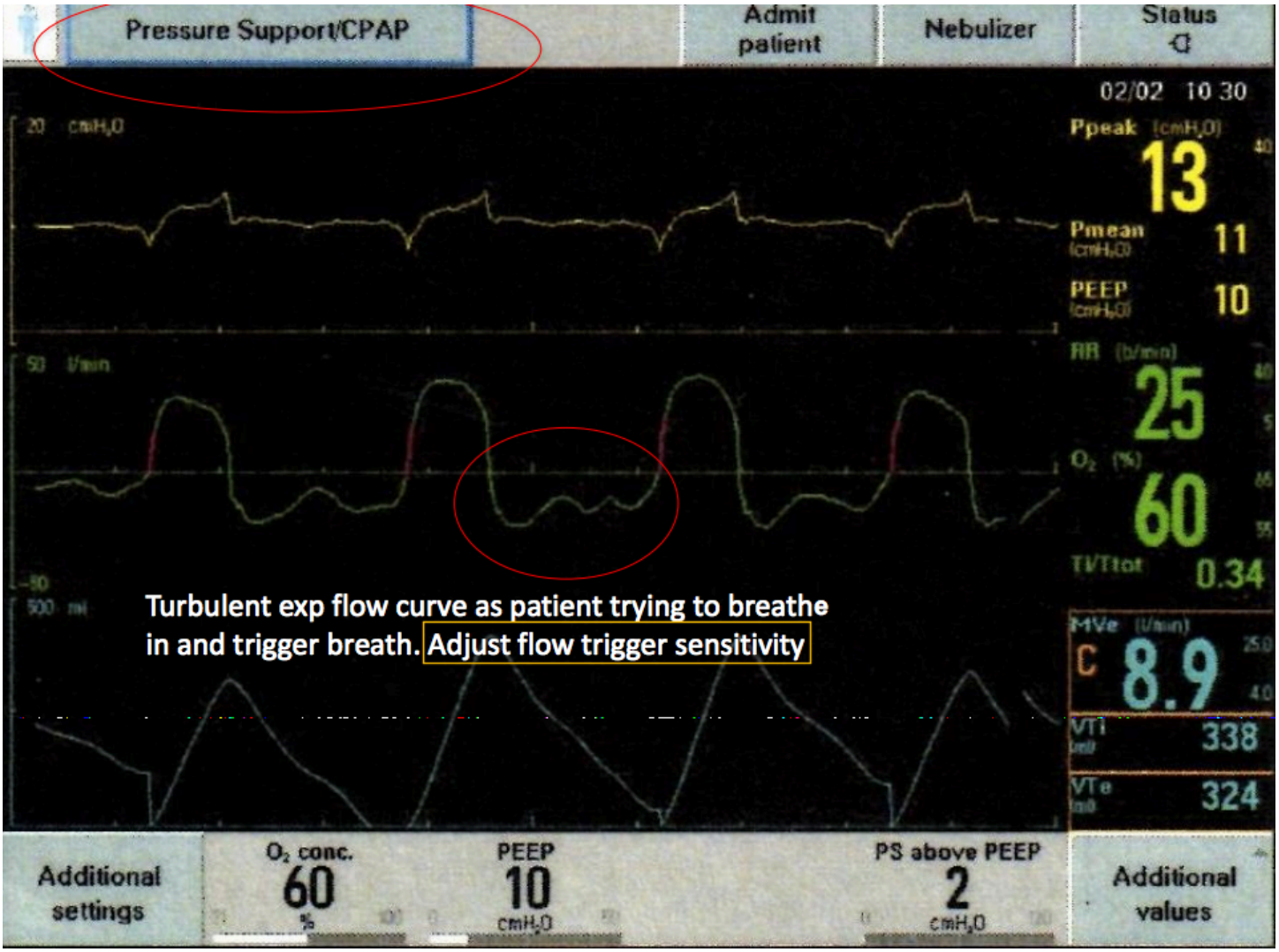

PRVC
Automode
Admit patient
Nebulizer
Status
Copying screen completed
27/02 11 24
Ppeak
33
Pmean
19
PEEP
6
RR
30
100
I:E
1:1.0
MVe
C 7.6
VTi
261
VTe
248
Deep concave expiratory flow (compliance), possibly not returning to baseline (gas-trapping), possible slight plateau in expiratory volume curve (gas-trapping), PIP raised- check plateau pressure (alveolar pressure) with insp. hold.
Exhaled TV not = to set TV
Additional settings
O2 conc.
100
%
PEEP
6
cmH2O
Resp. Rate
30
b/min
Tidal Volume
260
ml
Additional values


PRVC
Automode
Admit patient
Nebulizer
Status
Copying screen completed
23/03 09:44
Volume - Pressure
Flow - Volume
Ppeak
24
Pmean
15
PEEP
7
RR
30
O2 (%)
39
I:E
1.0:1
MVe
5.4
VTi
183
VTe
178
Saw-tooth pattern suggestive of condensation in vent tubing-drain tubing. Cadiac pulsations are a more gentle wave towards end exp. flow.
Close
Additional settings
O2 conc.
40
%
PEEP
6
cmH2O
Resp. Rate
30
b/min
Tidal Volume
180
ml
Additional values


Mode
Volume Control
Automode
Admit patient
Nebulizer
Status
Paw high
05/11 14 47
Ppeak
68
Pmean
13
PEEP
0
RR
16
40
I:E
1:2.0
MVe
5.0
VTi
347
VTe
346
Classic shark fin- increased early inspiratory pressure (resistance) pushing PIP high- noted plateau pressure looks normal. Linear expiratory flow (resistance), not returning to baseline (gas-trapping), slight plateau in expiratory volume curve (gas-trapping), PIP raised- check autoPEEP with exp. hold.
Additional settings
O2 conc.
40
%
PEEP
0
cmH2O
Resp. Rate
16
b/min
Tidal Volume
350
ml
Additional values


Volume Control
Automode
Admit patient
Nebulizer
Status
16/05 10:03
Ppeak
29
Pmean
14
PEEP
8
RR
20
40
I:E
1:2.0
MVe
7.9
396
403
Expiratory pressure curve delayed (patient breathing out against obstruction). Linear expiratory flow (resistance). Check for obstruction in outflow tract.
Additional settings
O2 conc.
40
%
PEEP
3
cmH2O
Resp. Rate
20
b/min
Tidal Volume
400
ml
Additional values


PS/CPAP
Admit patient
Nebulizer
Status
07/02 13:00
Ppeak
17
Pmean
13
PEEP
4
RR
16
O2 (%)
40
Ti/Ttot
0.82
MVe
C 5.5
VTi
50
VTe
70
Double breath- adjust insp. cycle off to lower % of peak flow to make breath bigger or increase PS to increase VT.
Additional settings
O2 conc.
40
PEEP
6
PS above PEEP
10
Additional values


Pressure Support/CPAP
Admit patient
Nebulizer
Status
02/02 10 30
Ppeak
13
Pmean
11
PEEP
10
RR
25
60
TVTtot
0.34
MVe
8.9
VTi
338
VTe
324
Turbulent exp flow curve as patient trying to breathe in and trigger breath. Adjust flow trigger sensitivity
Additional settings
O2 conc.
60
%
PEEP
10
cmH2O
PS above PEEP
2
cmH2O
Additional values

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