Ventilator Emergencies

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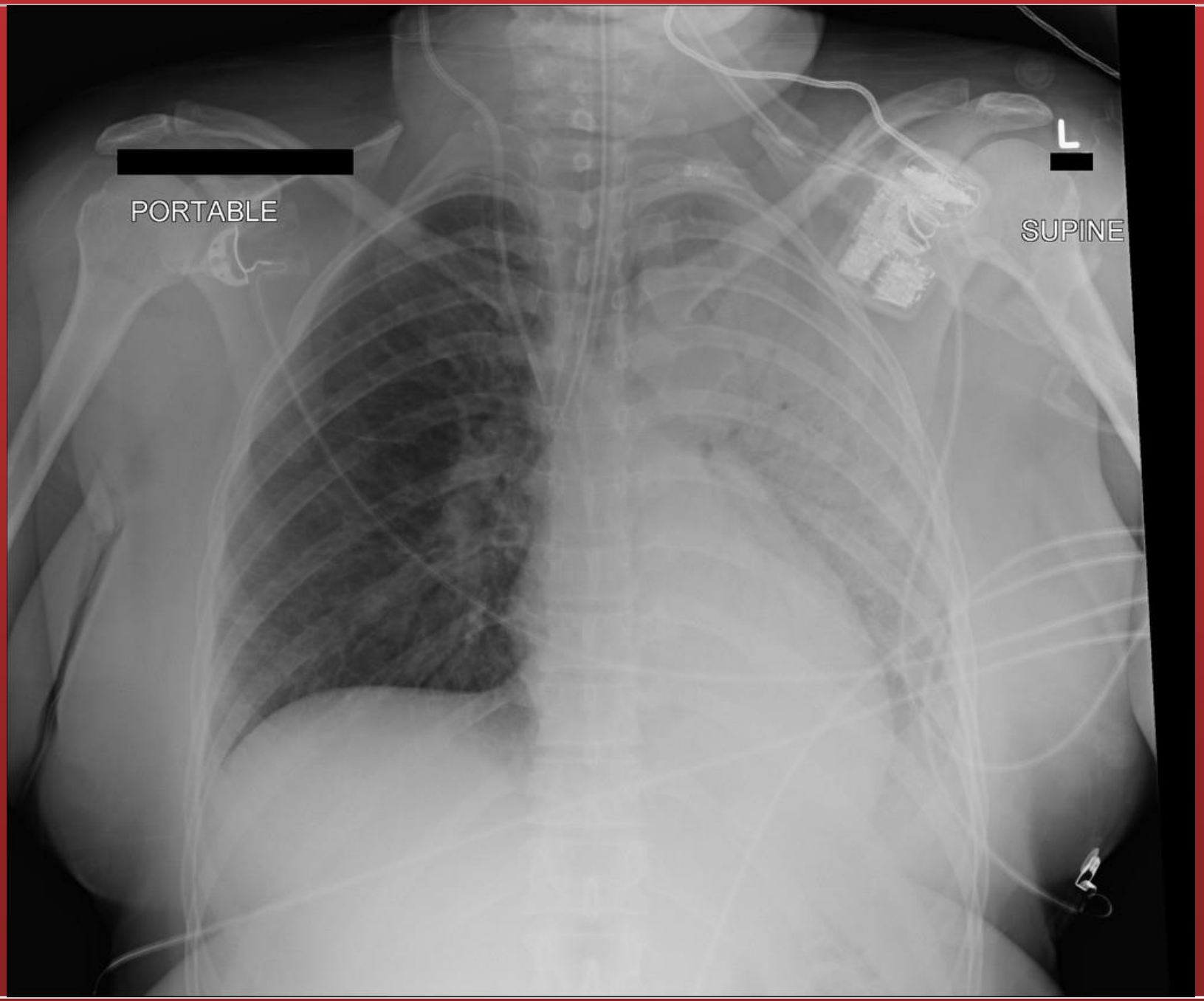
PGY-V CRITICAL CARE FELLOW

Disclaimers

- Care of the ventilated patient is a team sport!
- Heed the advice of your critical care nurses & respiratory therapists
- Always take note of your patient's breath sounds, equipment, and ventilator settings

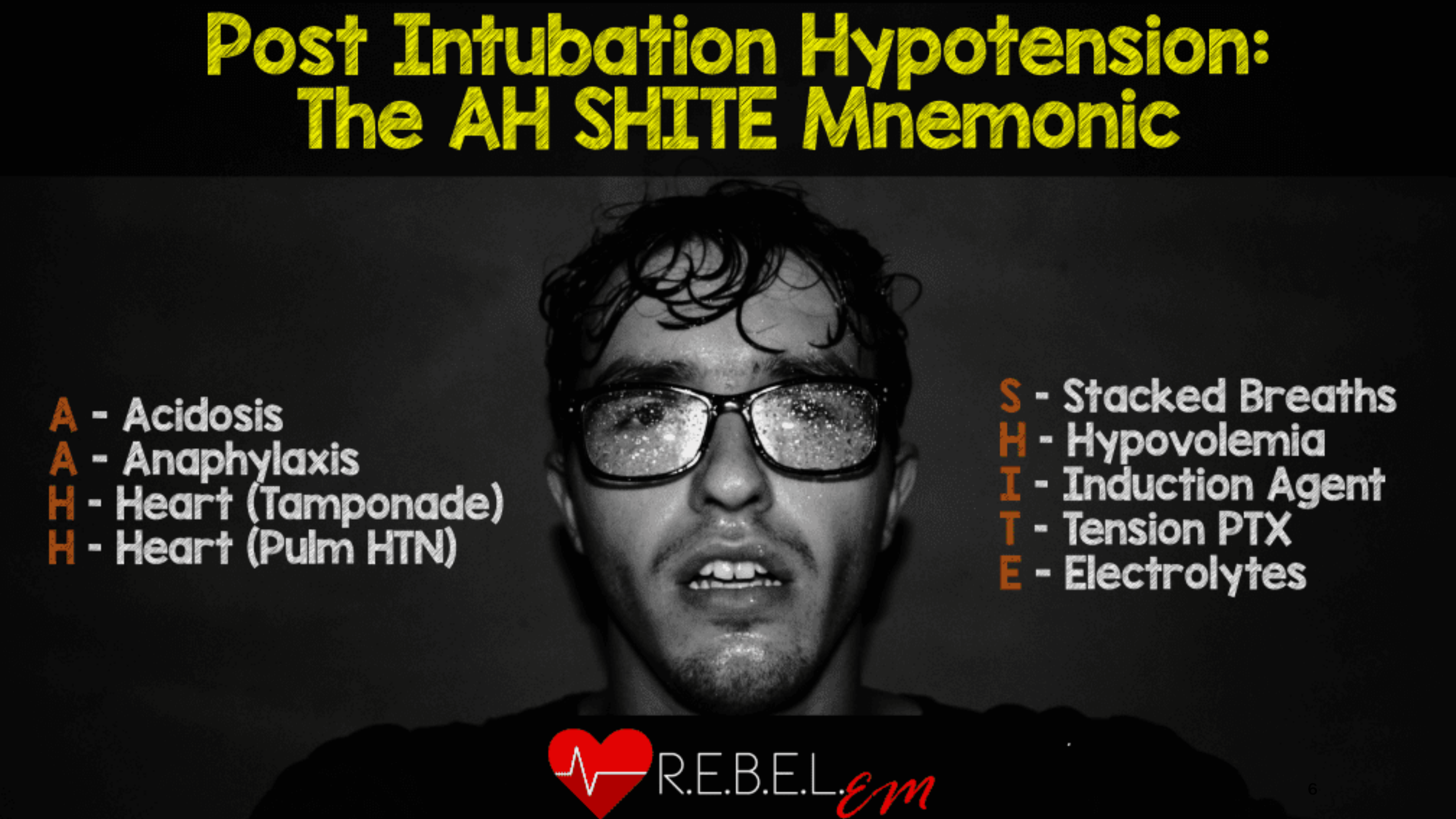
Endotracheal Intubation Complications

- Dental trauma
- Aspiration
- Laryngeal damage
- Bronchospasm
- Esophageal intubation
- RMB intubation


PORTABLE
L
SUPINE


Supine
L
C P
Mobile

Post Intubation Hypotension: The AH SHITE Mnemonic



Post-Intubation Hypotension

- Commonly due to ↑ ITP
- Augmented by RSI agents
- Fluid bolus if hypovolemic
- Medication optimization
- Vasopressors
- Monitor, re-assess

DOPES then DOTTS

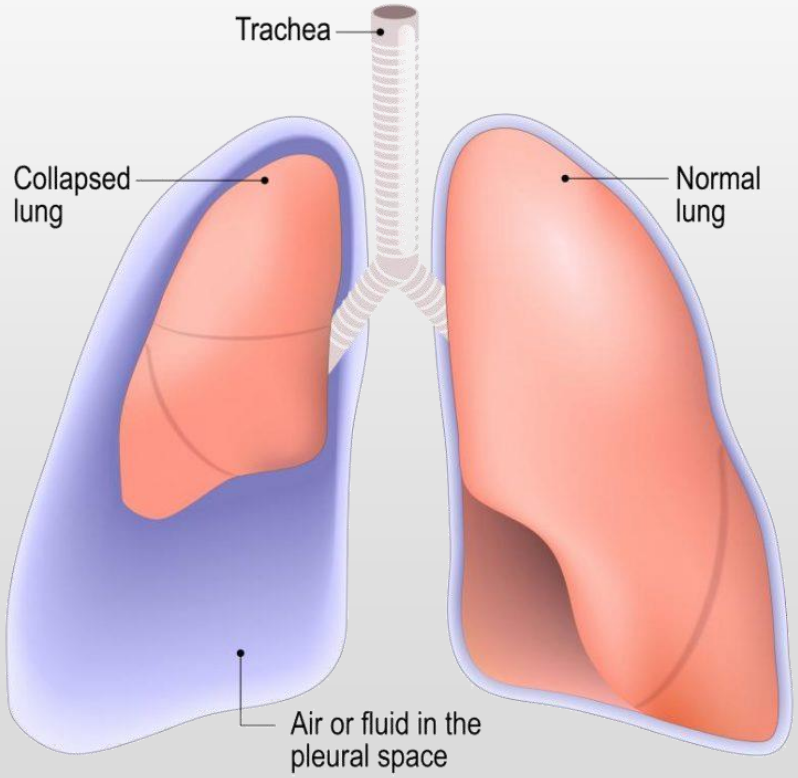
- DOPES
  - Displaced ETT/cuff
  - Obstructed ETT
  - Pneumothorax
  - Equipment check
  - Stacked breaths (auto-PEEP)
- DOTTS
  - Disconnect from vent.
  - O_2 – 100% BVM
    - Look, listen, feel
  - Tube position/function
  - Tweak vent.
  - Sonography

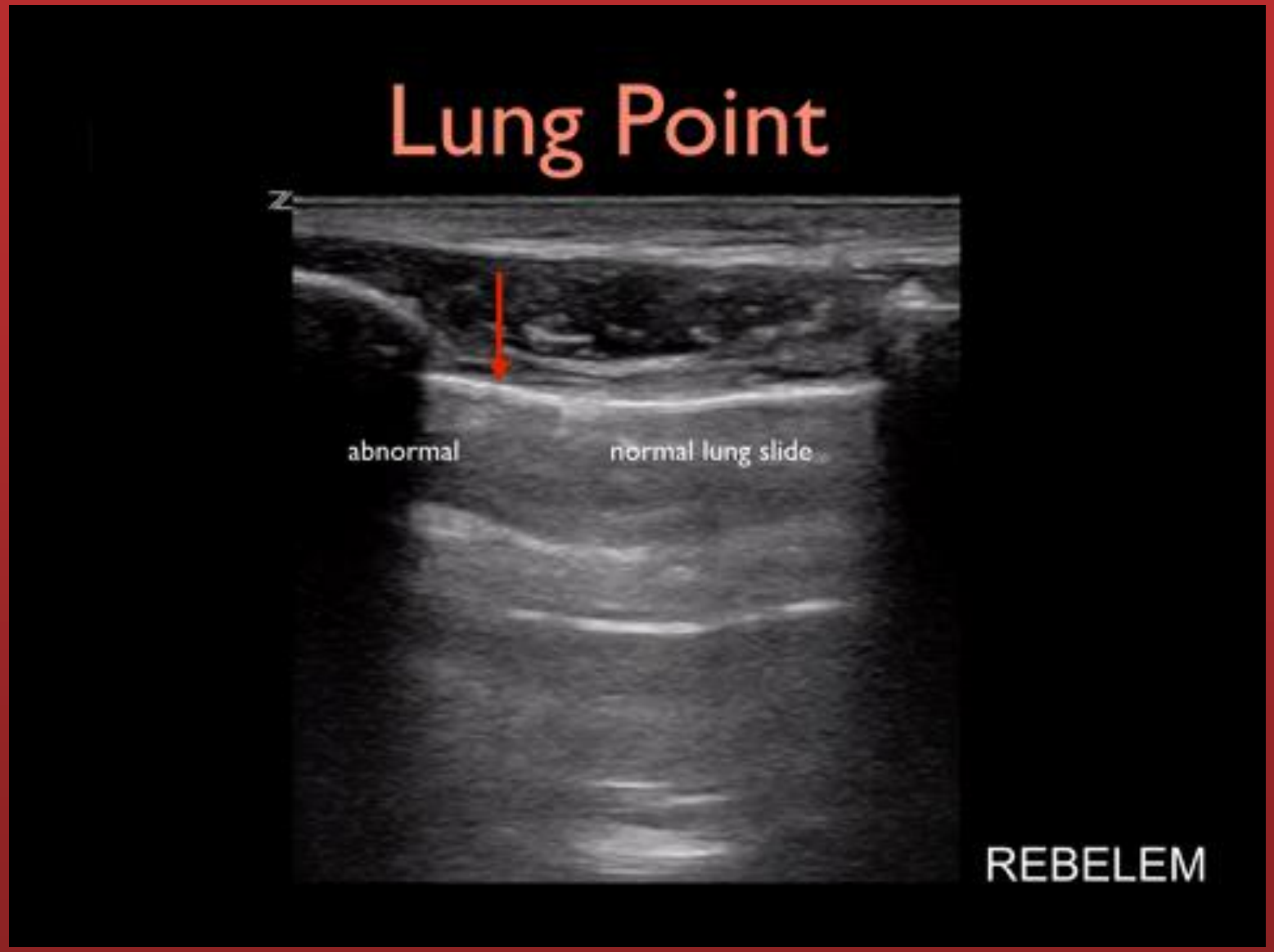
Hypoxia in Ventilated Patients

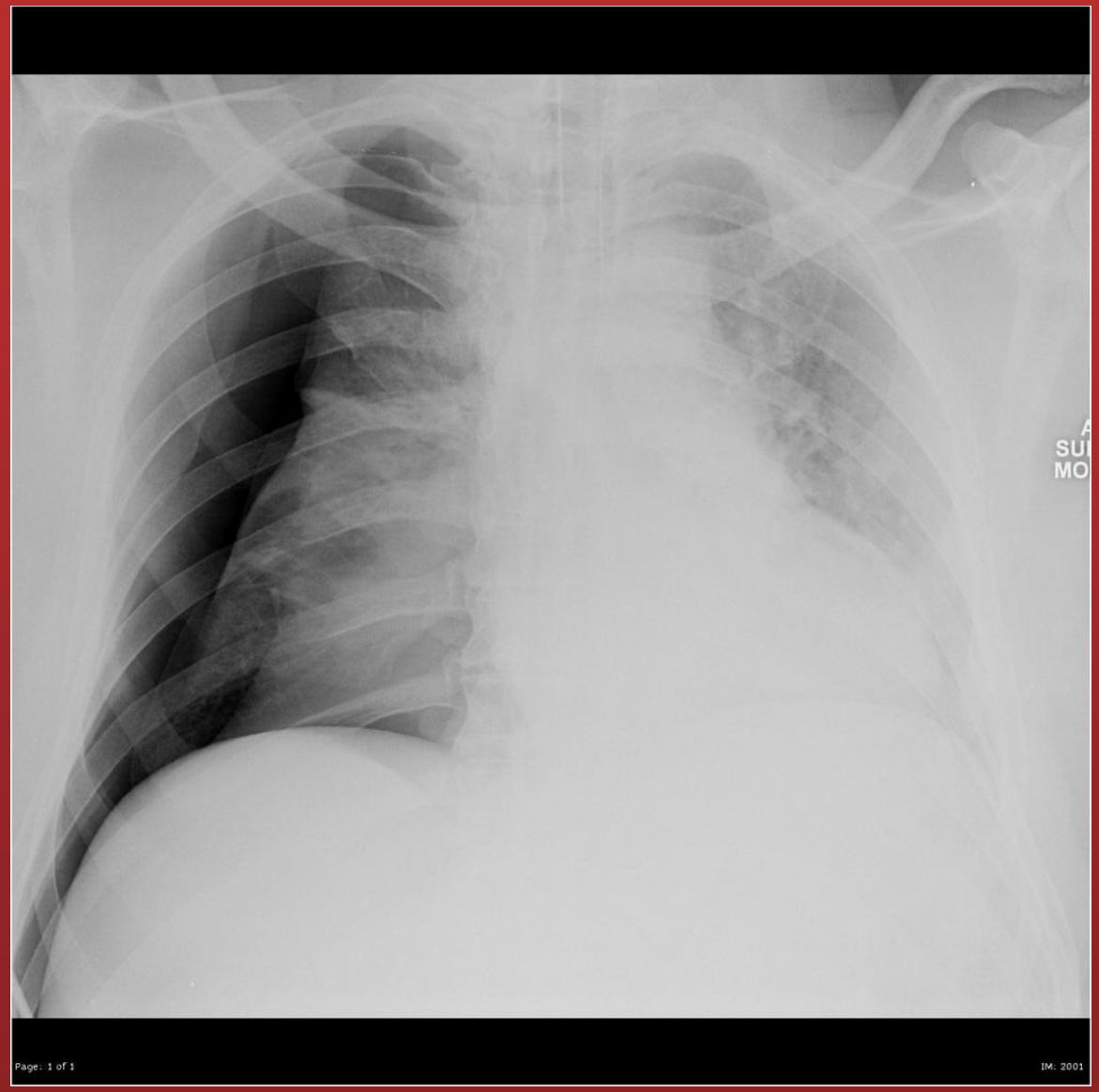
	Problem	Action
D	Displacement	Verify the tube with end-tidal CO_2 (qualitative or quantitative)
O	Obstruction	Insert a suction catheter through ET tube
P	Pneumothorax	Ultrasound, chest X-ray
E	Equipment	Disconnect ventilator, administer breaths through bag-valve-mask hooked up to oxygen
S	Stacked breaths (mostly in asthmatics)	Disconnect the ventilator

Pneumothorax

- Can be difficult to recognize
- More common with underlying lung disease
- Signs:
  - Unilateral ↓ breath sounds
  - Pulsus paradoxus
  - Hemodynamic instability
  - Contralateral tracheal deviation
  - ↑ in airway pressures




Lung Point
abnormal
normal lung slide
REBELEM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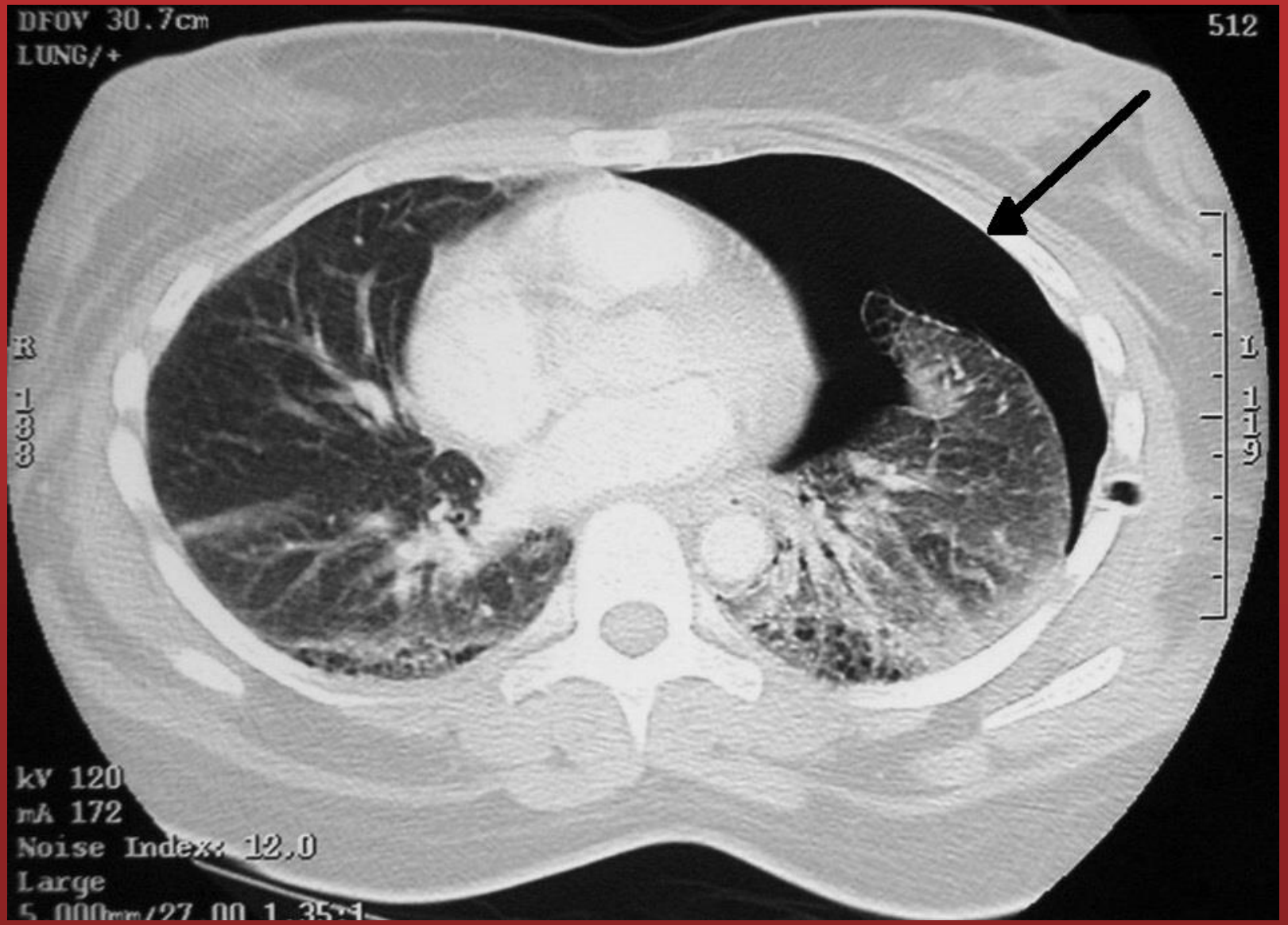
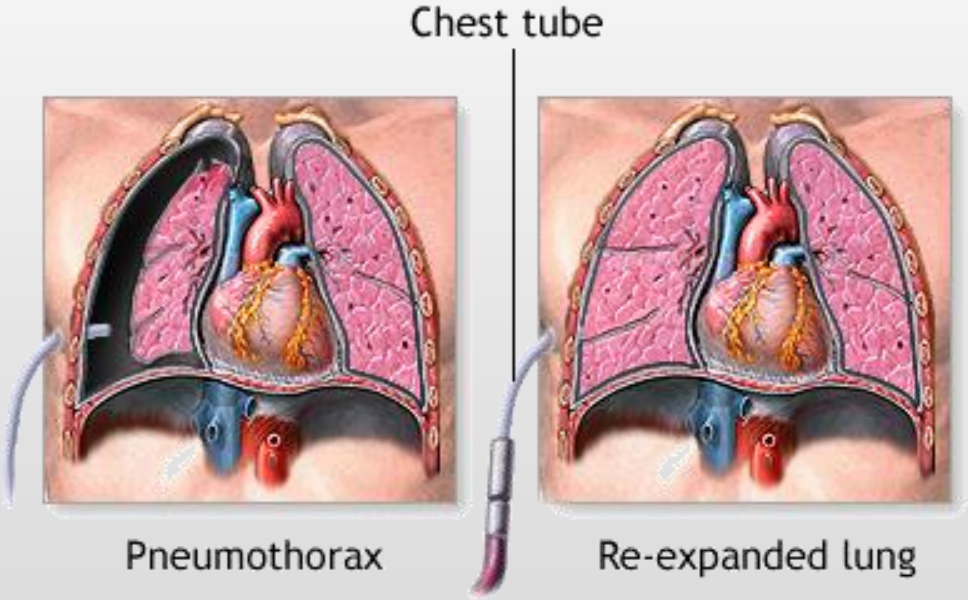

DFOV 30.7cm
LUNG/+
512
kV 120
mA 172
Noise Index: 12.0
Large

Pneumothorax Management

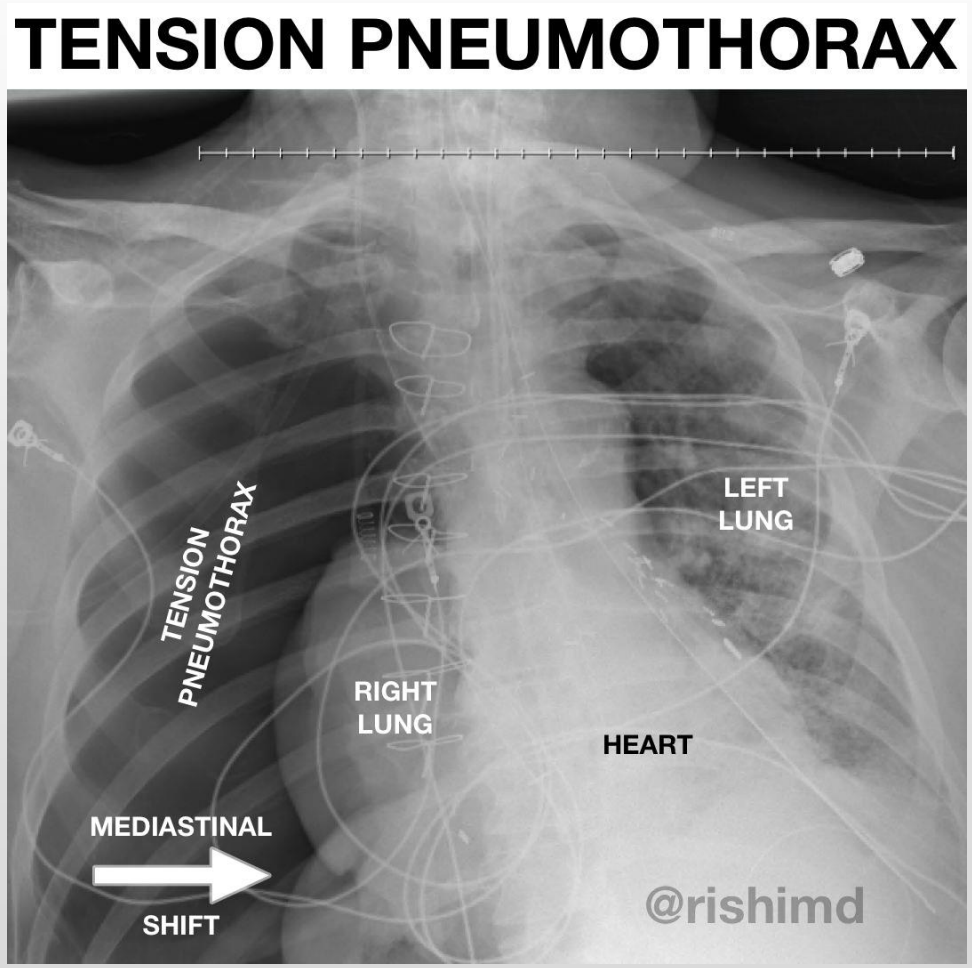
- Standard practice = chest tube
- (+) pressure can expand pneumothorax into tension
- Small-bore chest tubes
  - Fewer complications
  - Work well
- Manual aspiration not recommended
  - Not been studied in critically ill patients
- After placement: confirm, ↓ pressures, ↑ O_2 (?)

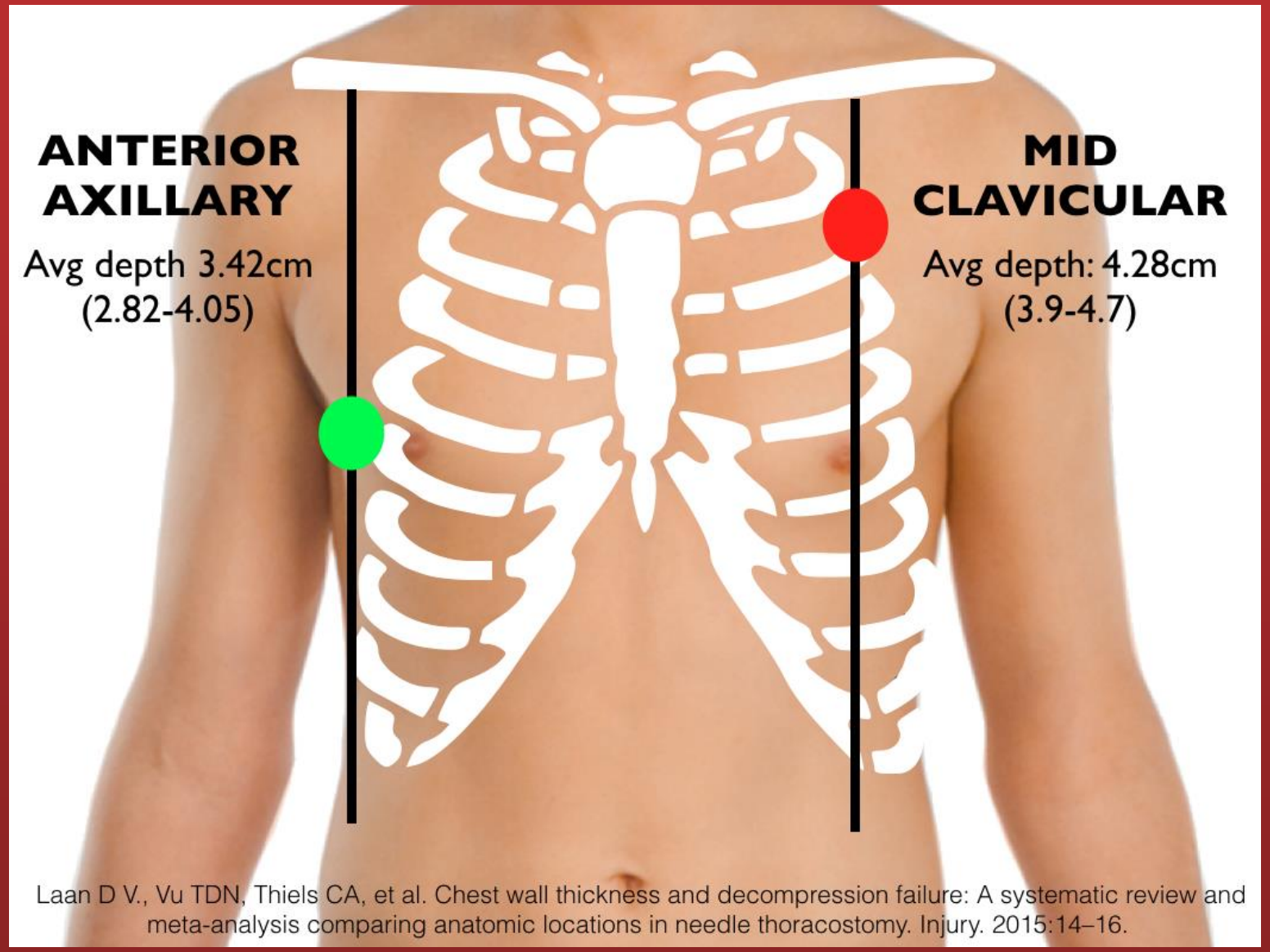


A.D.A.M.

Tension Pneumothorax

- Suspect in those
  - Rapidly decompensating
  - Undergone CPR
  - Chest tube in place from prior pneumothorax
- STAT needle decompression
  - May US, don't wait for XR
  - 14/16g needle, 2nd AIS MCL
  - Place tube ASAP

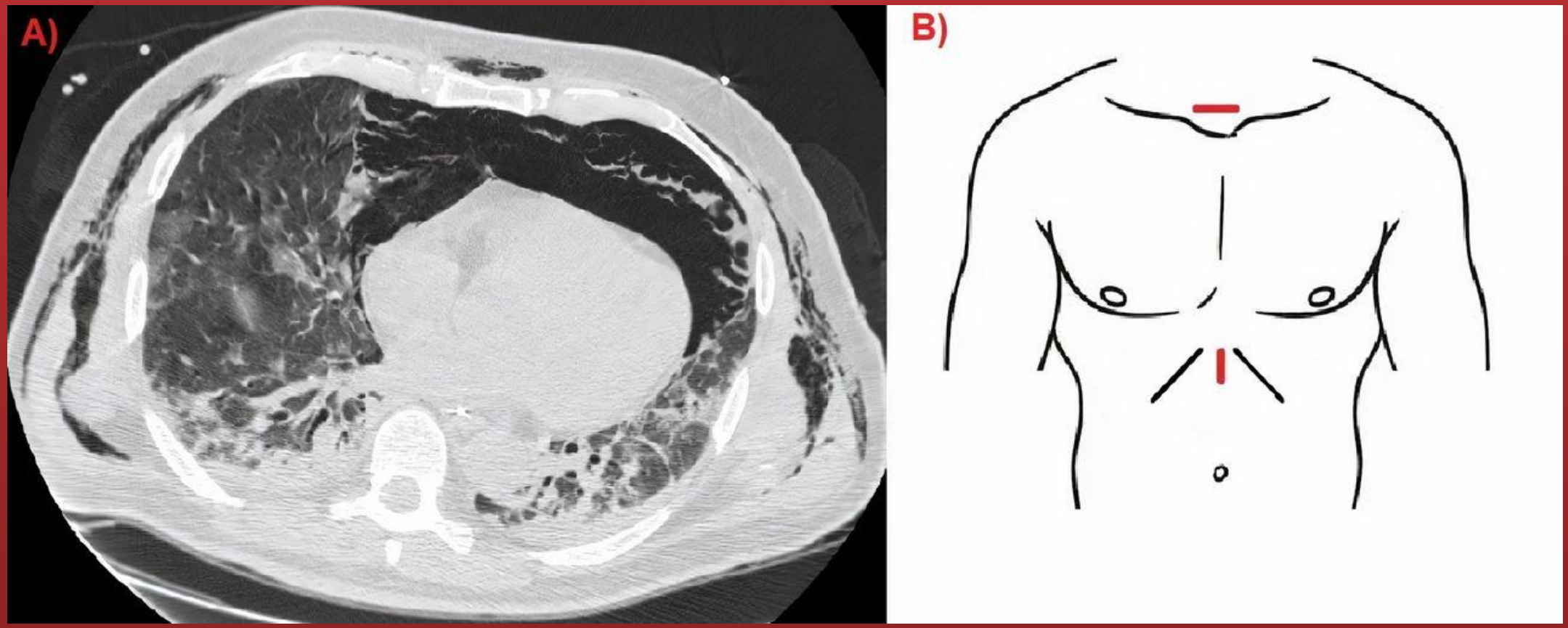




Laan D V., Vu TDN, Thiels CA, et al. Chest wall thickness and decompression failure: A systematic review and meta-analysis comparing anatomic locations in needle thoracostomy. Injury. 2015:14–16.

Pneumomediastinum

- Diagnosed by CXR, possibly incidental
  - Free air around normal structures
- Verbal patients: dyspnea, chest pain, neck pain
- Exam: tachycardia, tachypnea, hypertension, Hamman's crunch, subcutaneous emphysema
- Can → tension pneumomediastinum
  - Cardiovascular collapse

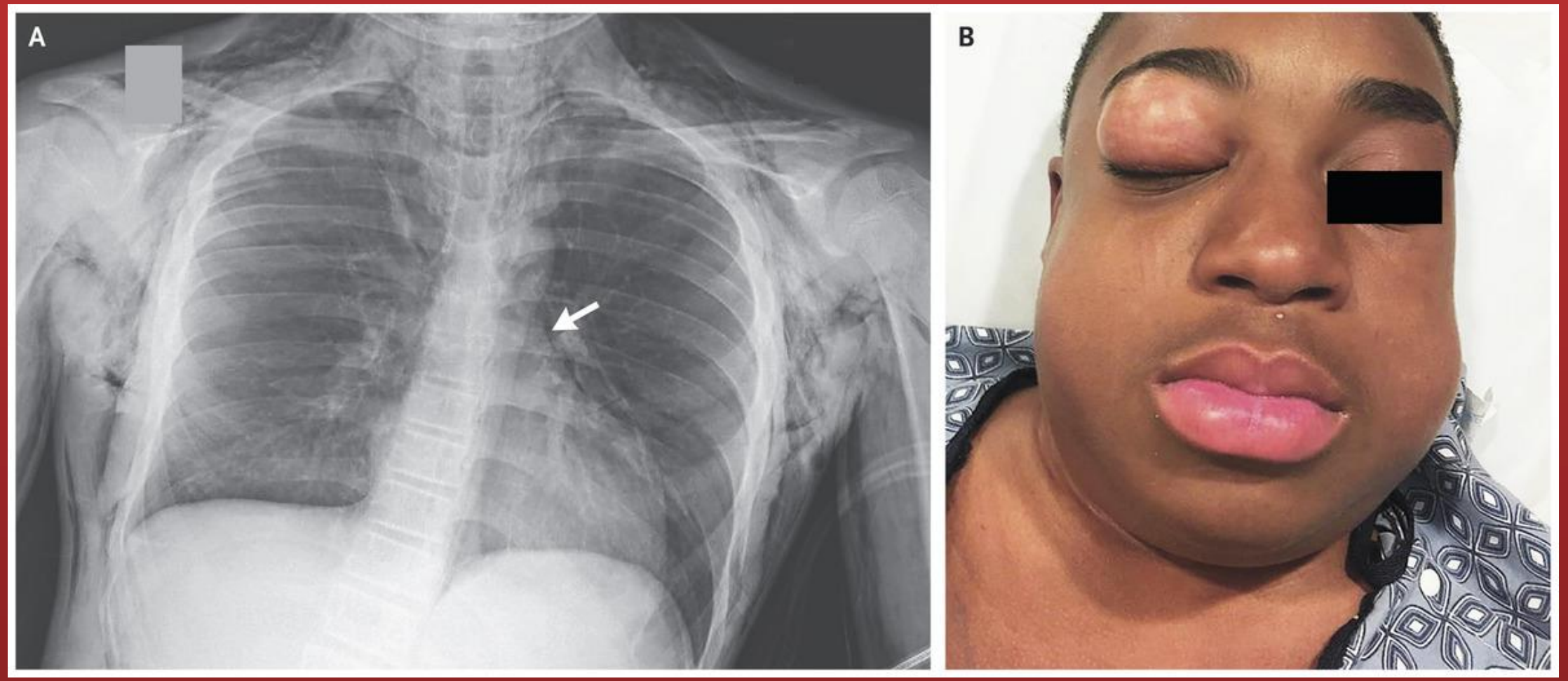

A)
B)

Pneumoperitoneum

- Verbal: abdominal or back pain (retroperitoneal)
- Exam: abdominal TTP, distension, tympany
- Can ↑ abdominal compartment syndrome
- Can be seen on XR, best evaluated by CT
- Usually self-limited, resolves w/ ↓ pressures
- Decompression if abdominal compartment syndrome

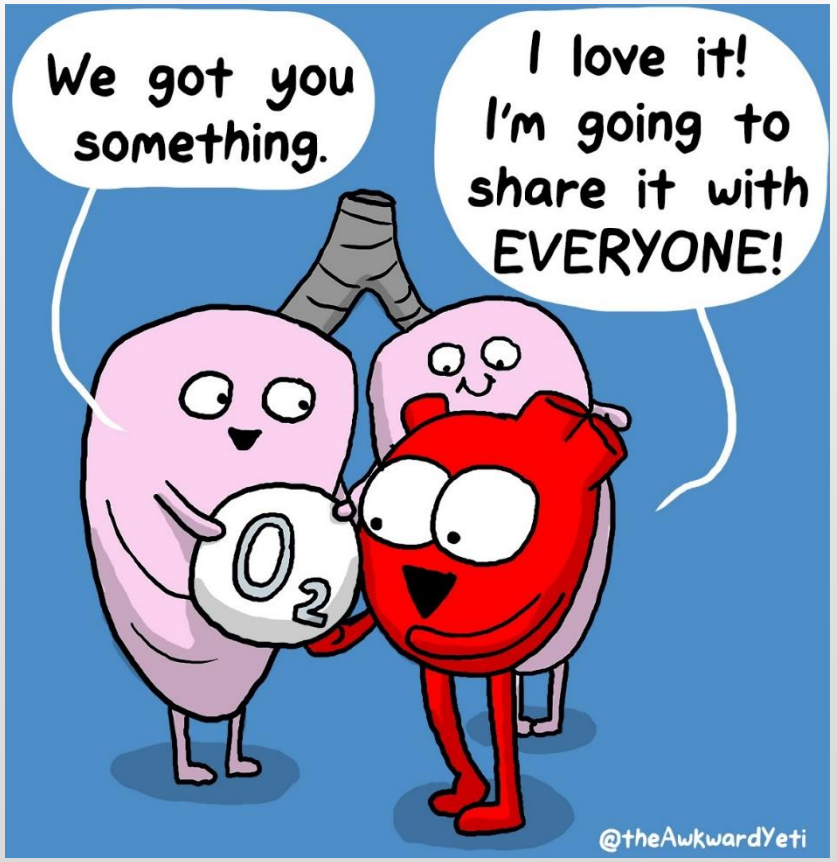
Subcutaneous Emphysema

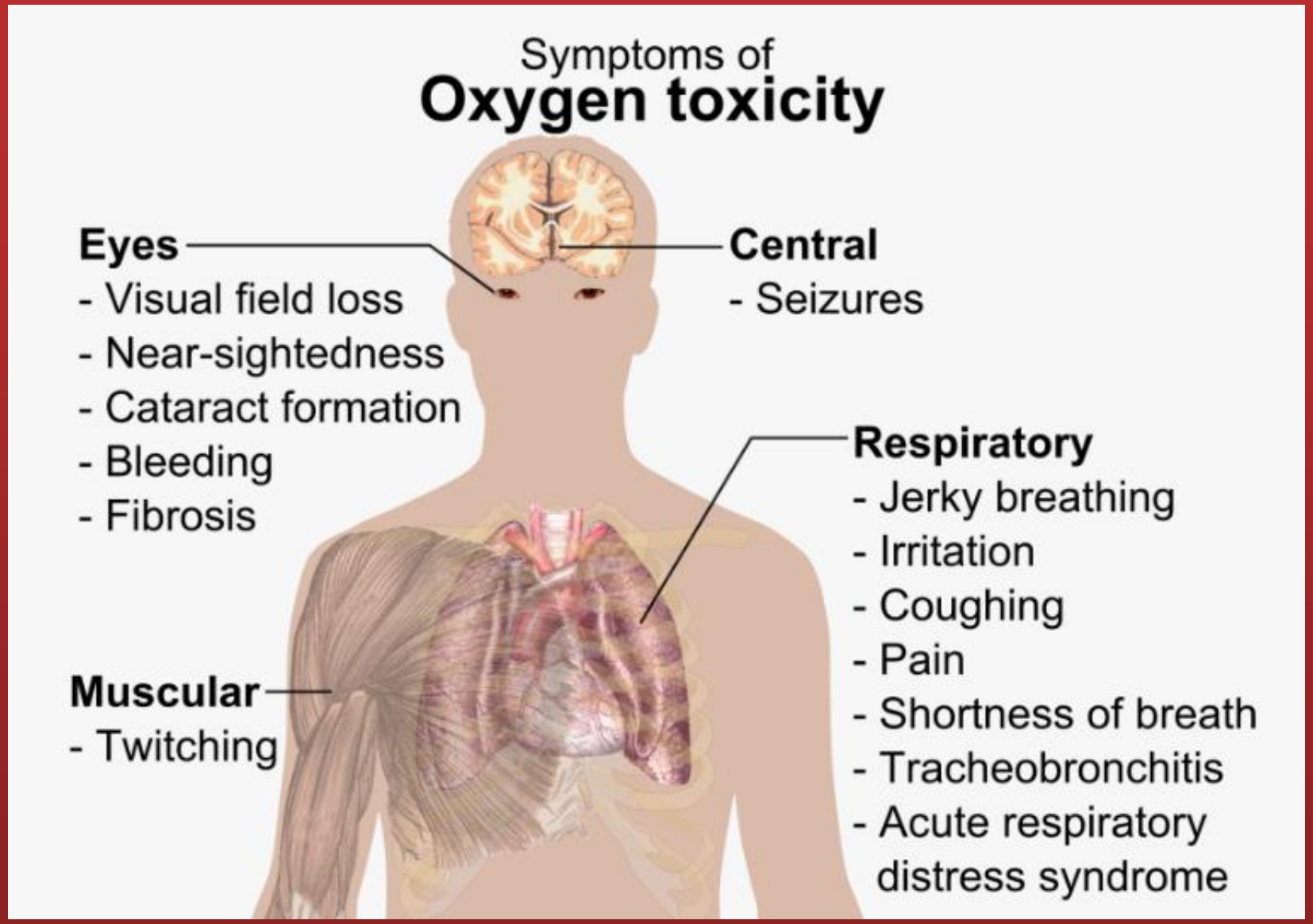
- Exam: crepitus
- Can be seen on XR or CT
- Usually self-limited and managed w/ pressure reduction, monitoring, supportive care
- Can → compartment syndrome requiring surgical decompression


A
B

Oxygen Toxicity

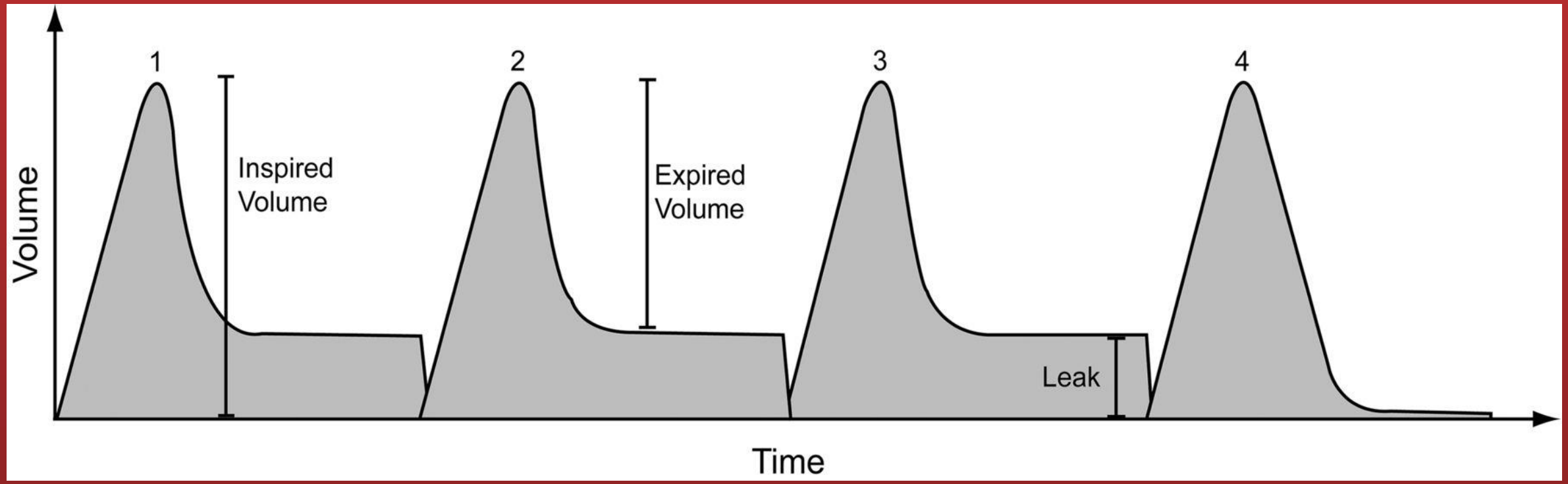
- >60% FiO_2
- Can be seen as early as 24 hrs
- Pulmonary → CNS
  - Tracheobronchial irritation -> pleuritic chest pain, dyspnea, coughing
  - Retinopathy, myopia, tinnitus, nausea, twitching, irritability, seizure
- Atelectasis, DAD, ARDS
- Management: lower O_2

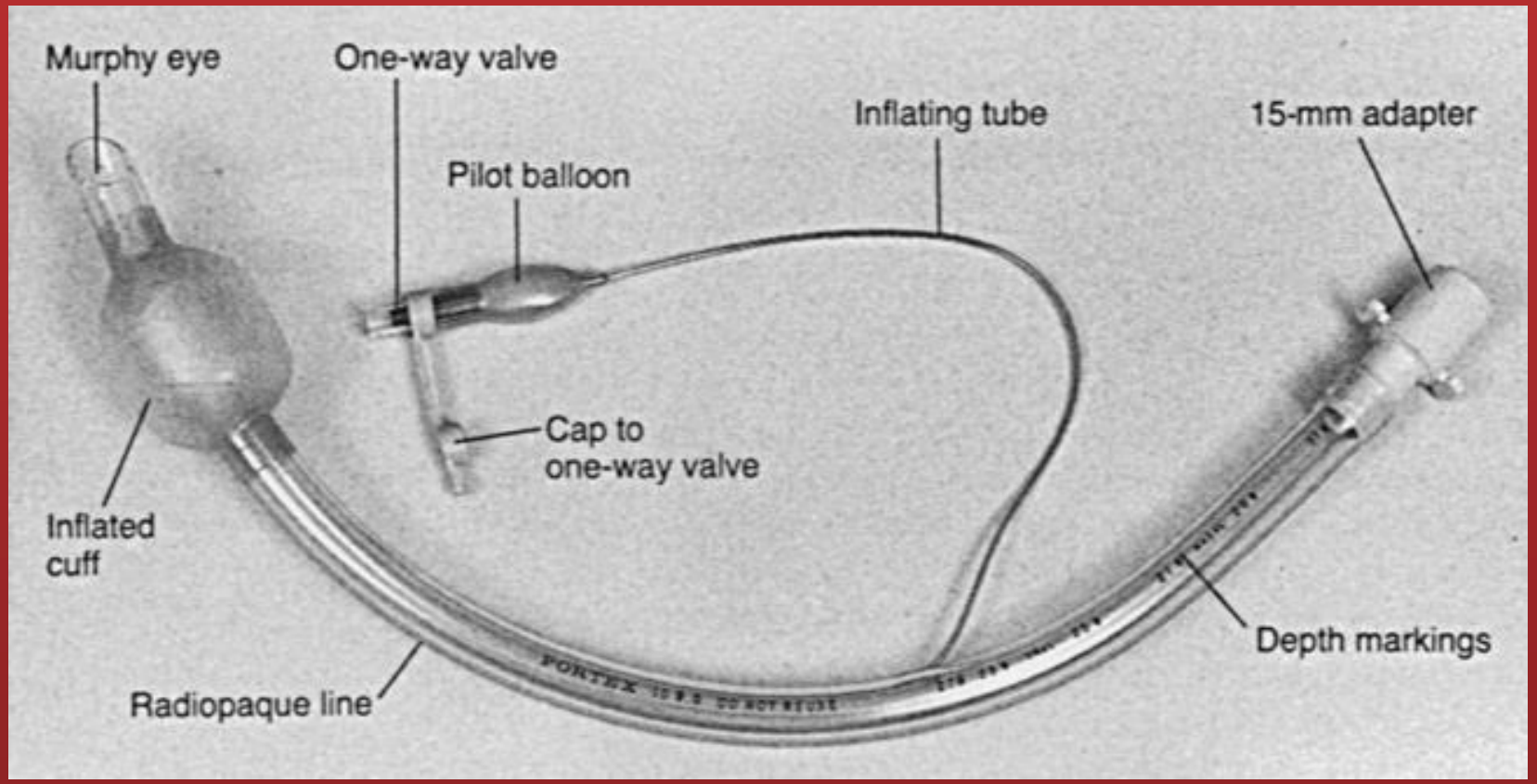



Symptoms of
Oxygen toxicity
Eyes
- Visual field loss
- Near-sightedness
- Cataract formation
- Bleeding
- Fibrosis
Central
- Seizures
Respiratory
- Jerky breathing
- Irritation
- Coughing
- Pain
- Shortness of breath
- Tracheobronchitis
- Acute respiratory distress syndrome
Muscular
- Twitching

Air Leak

- Up to 11% of ICU patients
- Trivial to life-threatening
- Causes
  - Trauma
  - Manufacturing defects
  - Valve, pilot balloon, inflation line, cuff
  - NG tube misplacement
  - Large trachea/small ETT
  - Excess P_{peak}


1
2
3
4
Inspired
Volume
Expired
Volume
Leak
Volume
Time

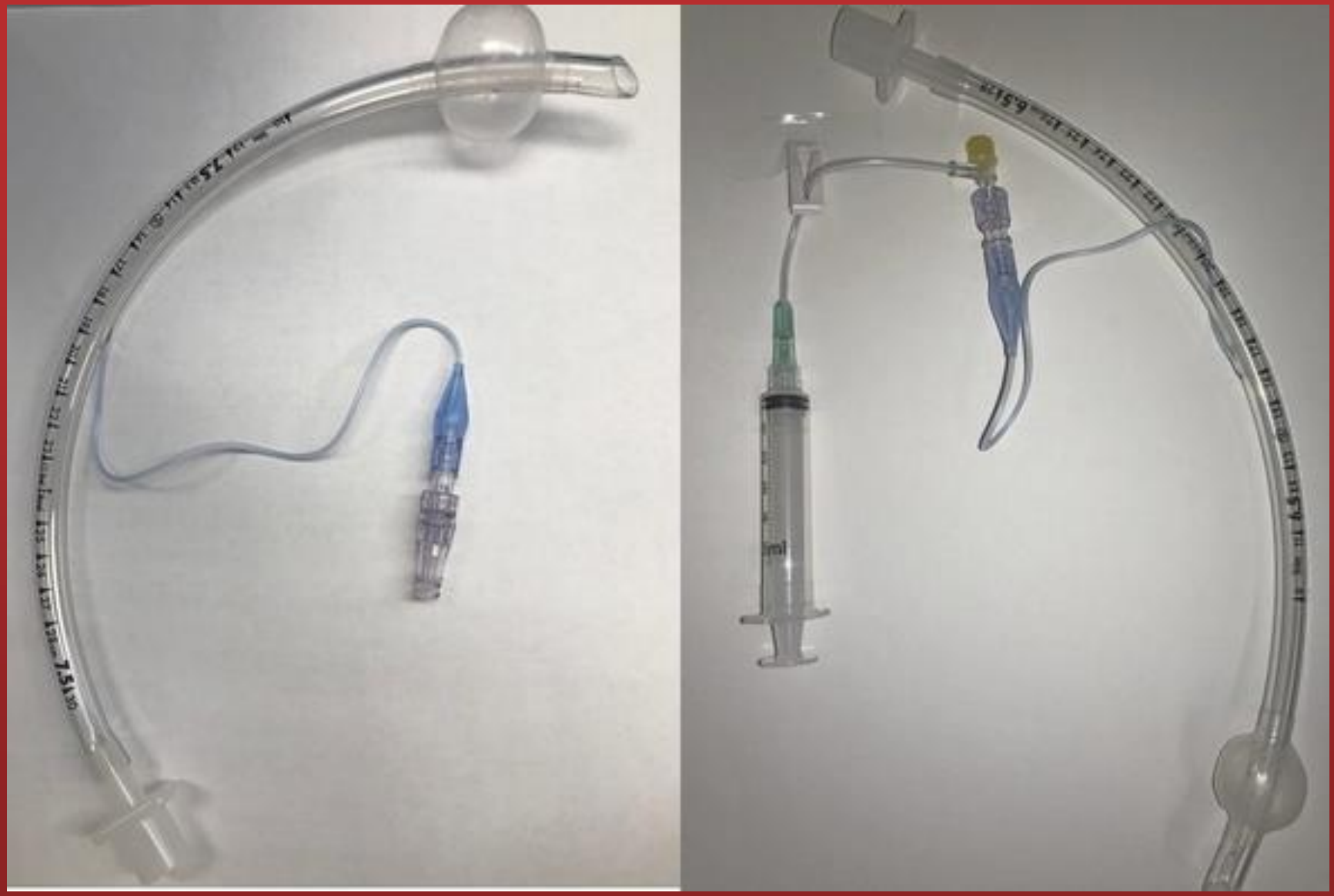

Murphy eye
One-way valve
Inflating tube
15-mm adapter
Pilot balloon
Cap to
one-way valve
Inflated
cuff
Radiopaque line
Depth markings

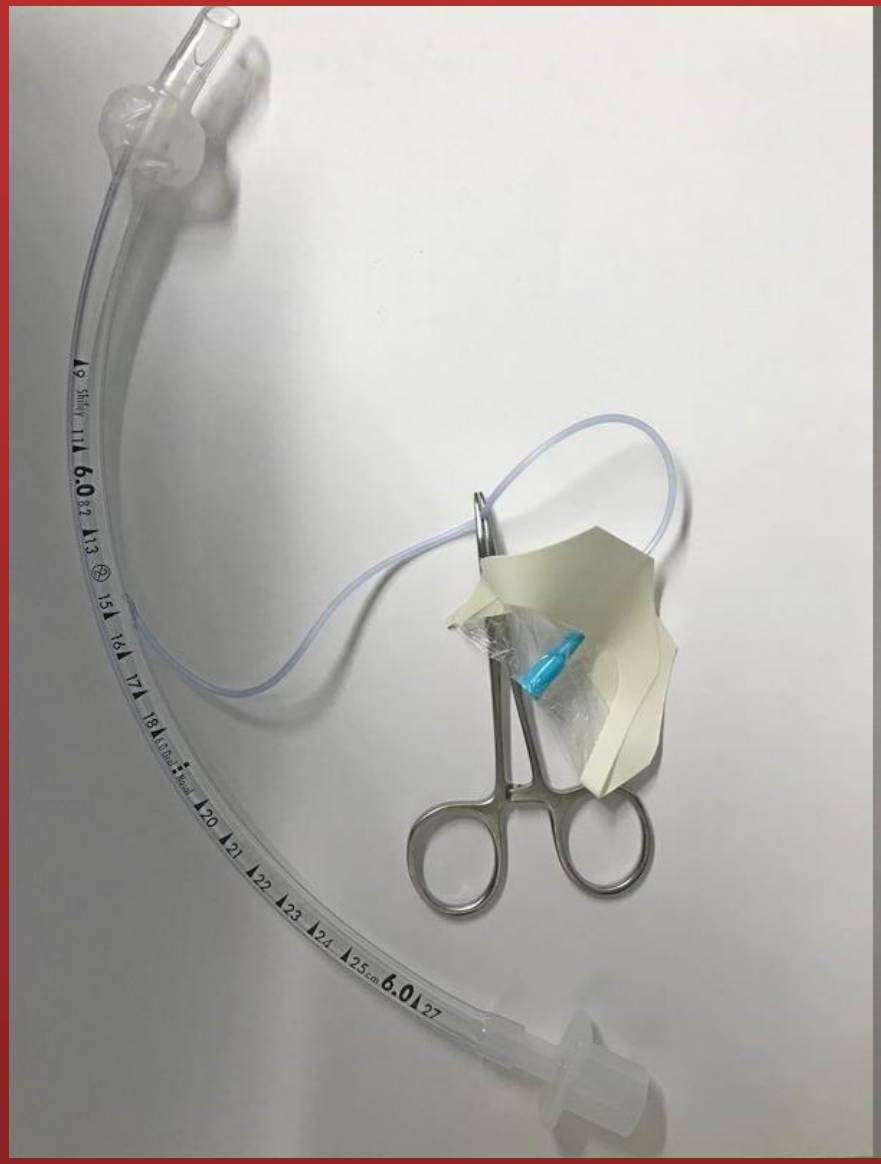
Air Leak (cont.)

- Can → many complications
- Will see
  - ↓ oxygenation, ventilation
  - Gurgling, ↓ TV
  - Malposition tube
- May ultimately require re-intubation
- Many cases resolve with cuff inflation
- Correct underlying cause

Air Leak

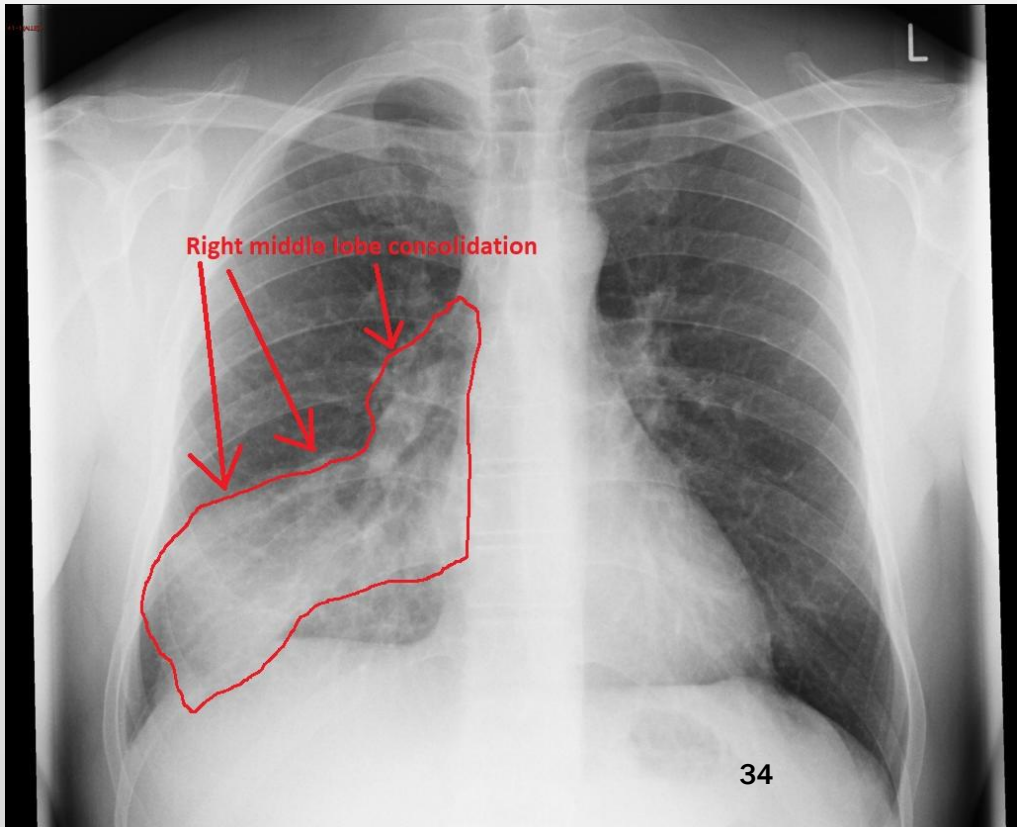
- Adequately inflate cuff
- Ensure ETT adequately positioned
- Ensure gastric tubes adequately positioned
- Troubleshoot ↑ airway pressures
- ETT replacement
  - Standard
  - ETT exchange




6.0
6.0
27

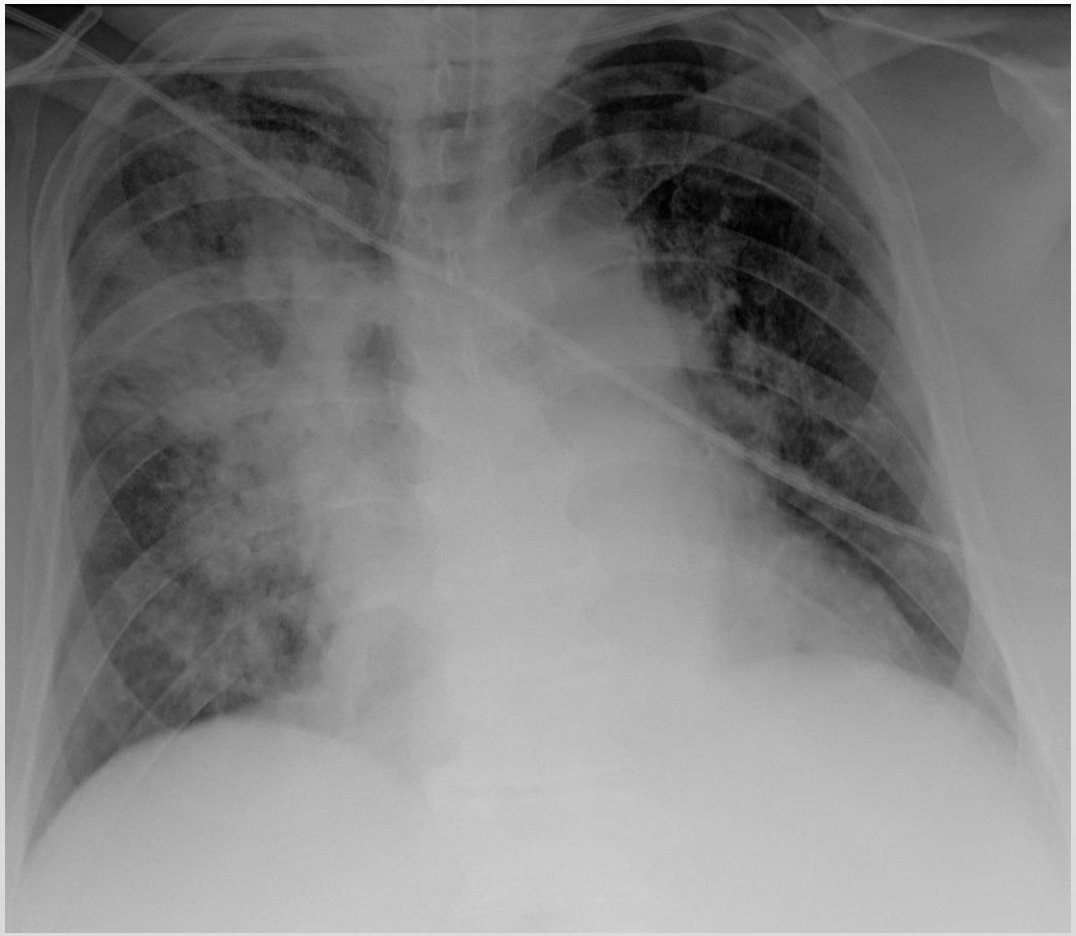

Aspiration Pneumonia vs Pneumonitis

- May occur during/while intubated
- Supportive care - aspiration pneumonitis
- Antibiotics - aspiration pneumonia
- Prevention of aspiration & VAP
  - Wash your hands!
  - Suction oropharynx/oral hygiene
  - Avoid PPIs
  - ↑ HOB
  - Light sedation
  - Pro-kinetics
  - Shallow BVM breaths
  - Good RSI technique



Acute Aspiration

- Minimize further aspiration
- Suction, ↑ HOB
- Empty stomach with NG
- Repeat CXR
- Bronchoscopy
- Chest physiotherapy
- Steroids controversial
- No routine antibiotics

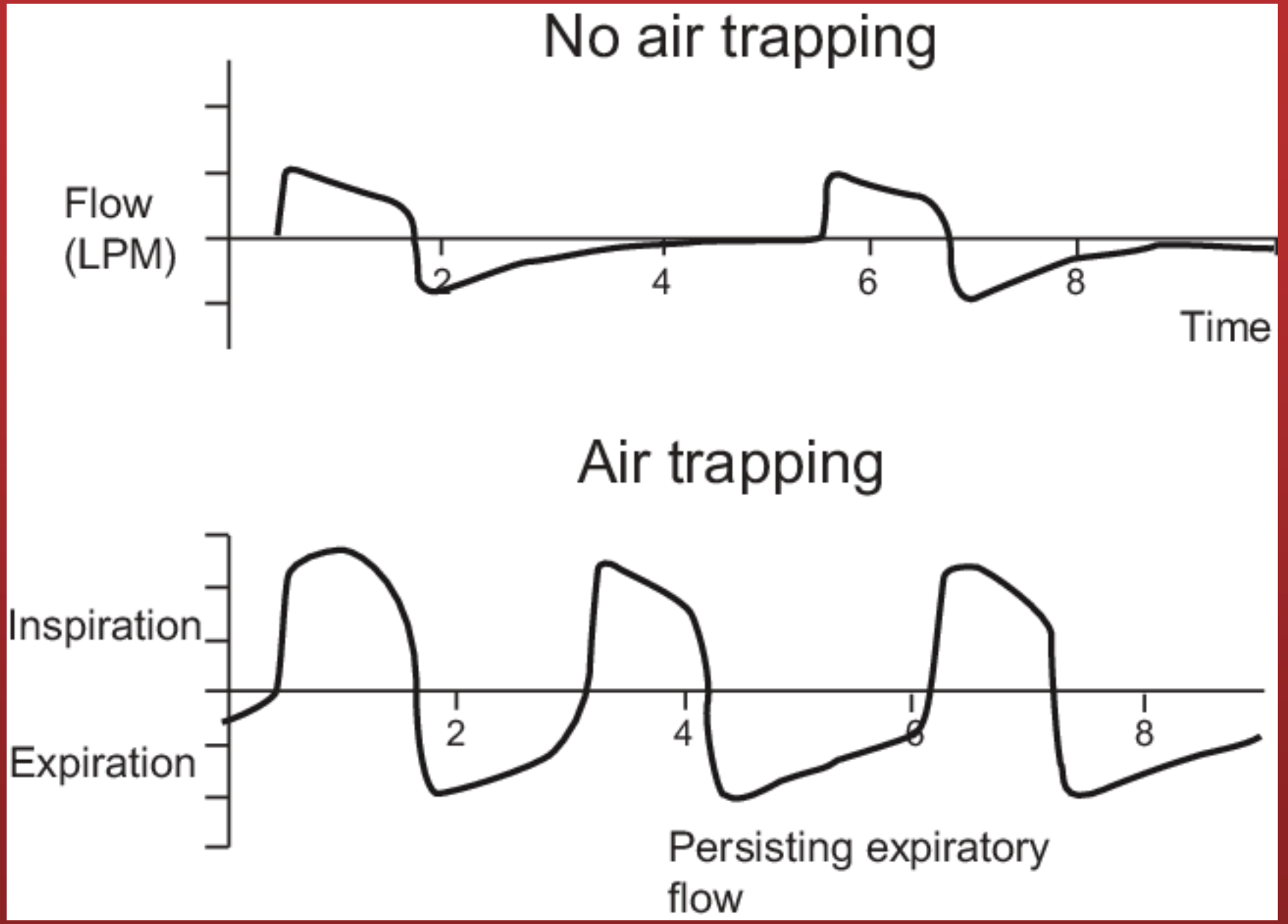


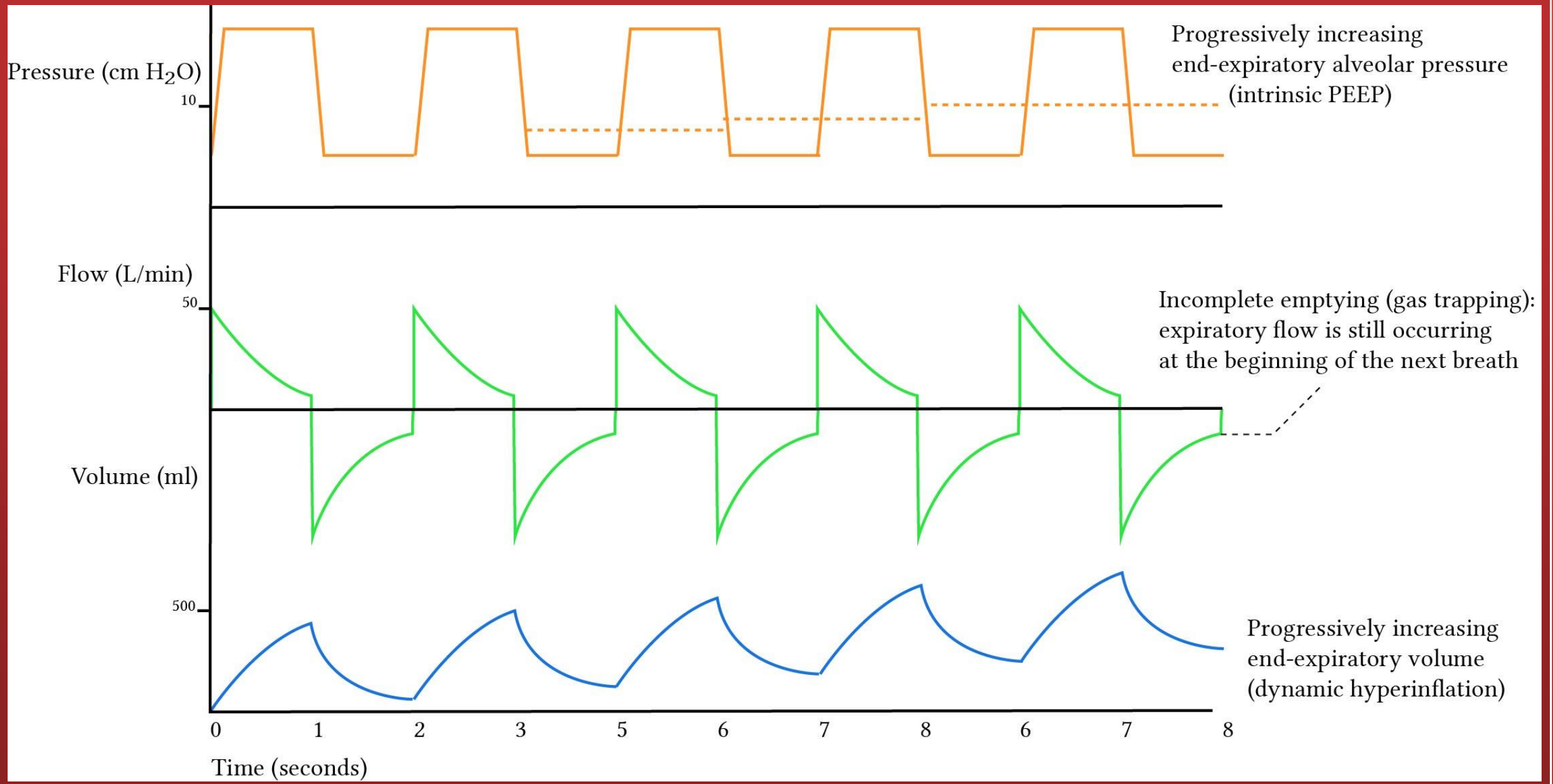
Auto-PEEP (aka intrinsic PEEP)

- (+) airway pressure that occurs at the end of expiration due to incomplete exhalation
  - In addition to PEEP applied by ventilator
- Consequences
  - Barotrauma
  - ↓ venous return
  - Worsened V/Q mismatch
  - Patient/ventilator dys-synchrony
  - ↑ WOB

How does auto-PEEP develop?

- High minute ventilation
  - High TV and/or high RR
- Expiratory flow limitation
  - High airway resistance
- Expiratory resistance not due to intrinsic airway resistance
  - Kinked ETT
  - Patient-ventilator dyssynchrony


No air trapping
Flow
(LPM)
2
4
6
8
Time
Air trapping
Inspiration
Expiration
2
4
6
8
Persisting expiratory
flow


Pressure (cm H_2O)
10
Progressively increasing
end-expiratory alveolar pressure
(intrinsic PEEP)
Flow (L/min)
50
Incomplete emptying (gas trapping):
expiratory flow is still occurring
at the beginning of the next breath
Volume (ml)
500
Progressively increasing
end-expiratory volume
(dynamic hyperinflation)
0
1
2
3
5
6
7
8
6
7
8
Time (seconds)

How do we treat auto-PEEP?

- Address the underlying cause
  - ↑ MV
    - ↓ RR, TV, I:E ratio
  - Expiratory flow limitation
    - Bronchodilators, secretion management, ↑ applied PEEP
  - Expiration resistance
    - ↑ ETT, ↑ sedation, paralyze

Patient-Ventilator Dyssynchrony

- A state in which the patient's cycle of respiration does not match that of the ventilator
  - "Fighting the vent," "bucking the vent"
  - Not always a *patient* problem
- Consequences
  - Subjective dyspnea
  - ↑ WOB
  - Prolongation of MV
  - Perceived need for more sedatives

Signs of PVD

- ↑ HR
- ↑ RR
- ↑ Expiratory muscle activity
- ↓ O2 saturation
- Coughing
- Agitation
- Inspiratory effort w/o triggering the ventilator

Phase of Respiration	Types and Subtypes of Dyssynchrony
Inspiration	**Trigger Dyssynchrony** Trigger Delay Missed Trigger Auto-Triggering Double-Triggering
	Flow Dyssynchrony
Expiration	**Cycling Dyssynchrony** (a.k.a. Termination Dyssynchrony) Premature Termination Delayed Termination

PVD Management

- Can switch to pressure support
- Treat any underlying causes
- Address patient factors (pain, hunger, nutrition)
- Correct ETT problems (kinking, secretions)
- Correct ventilator problems
- Sedation if necessary

In summary…

- Keep calm and follow a stepwise approach
- Utilize the knowledge of RTs and RNs
- Watch & listen to your patient & the vent
- Think of problems/solutions other than needing more sedation and more fluids
- Not everyone needs an ABG!

References

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...Questions?