LAC+USC TRAUMA

TENSION PNEUMOTHORAX AND NEEDLE DECOMPRESSION

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LAC+USC Medical Center

DISCLOSURES

- ✓None

OBJECTIVES

- ✓ What is Tension Pneumothorax
- ✓ Treatment and Pitfalls
- ✓ New directions

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- ✓ Treatment and Pitfalls
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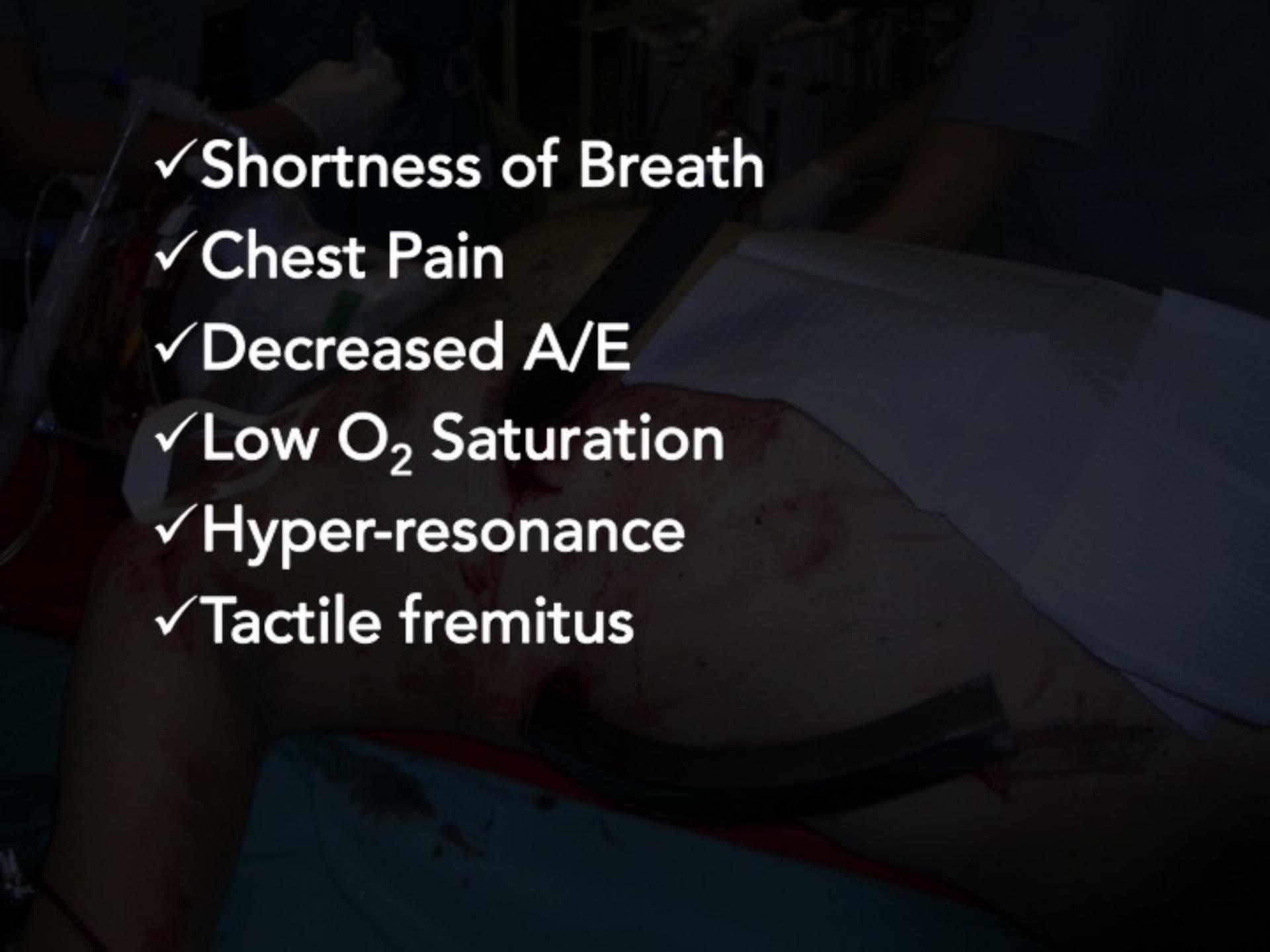
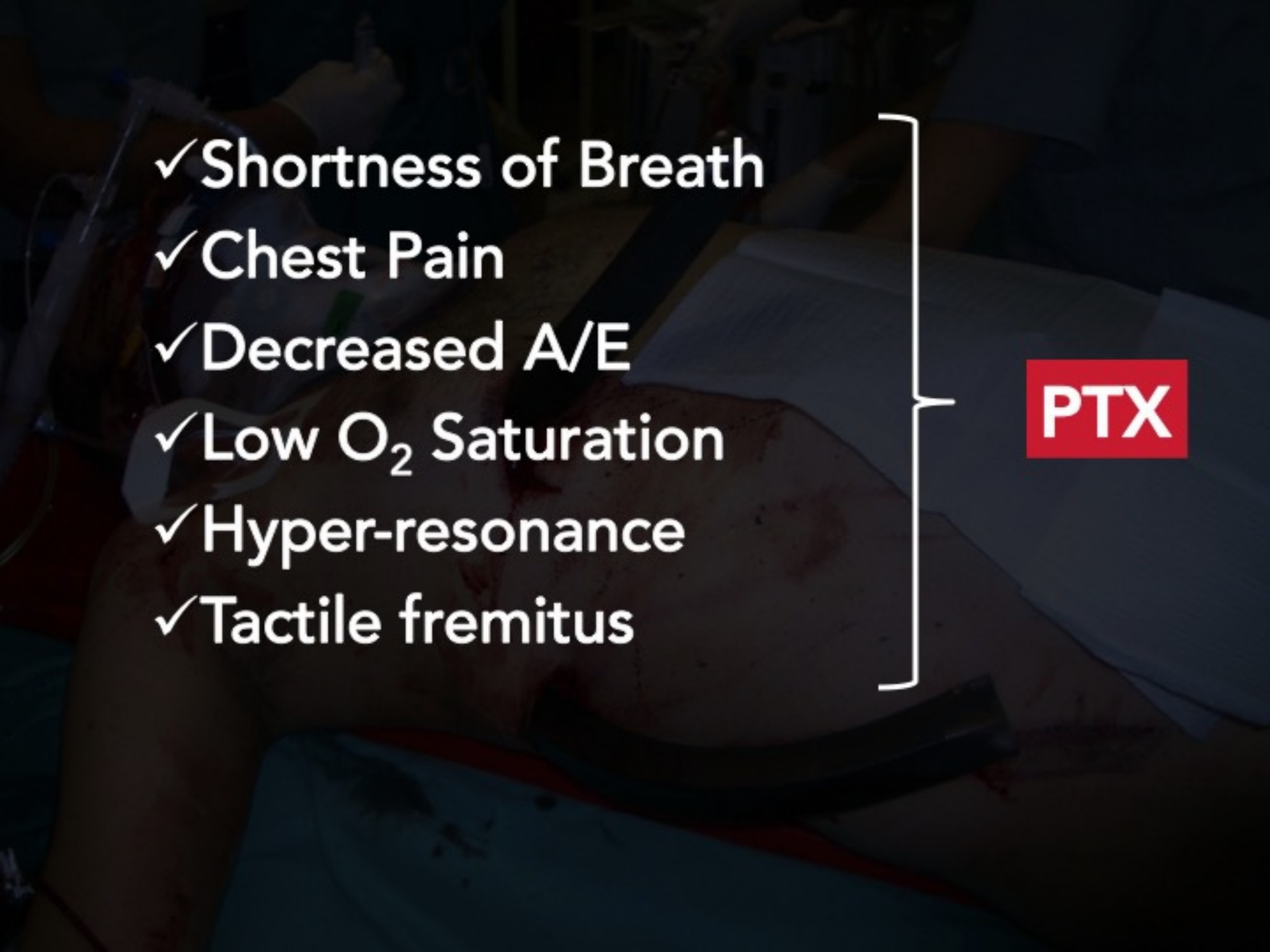

✓Shortness of Breath
✓Chest Pain
✓Decreased A/E
✓Low O_2 Saturation
✓Hyper-resonance
✓Tactile fremitus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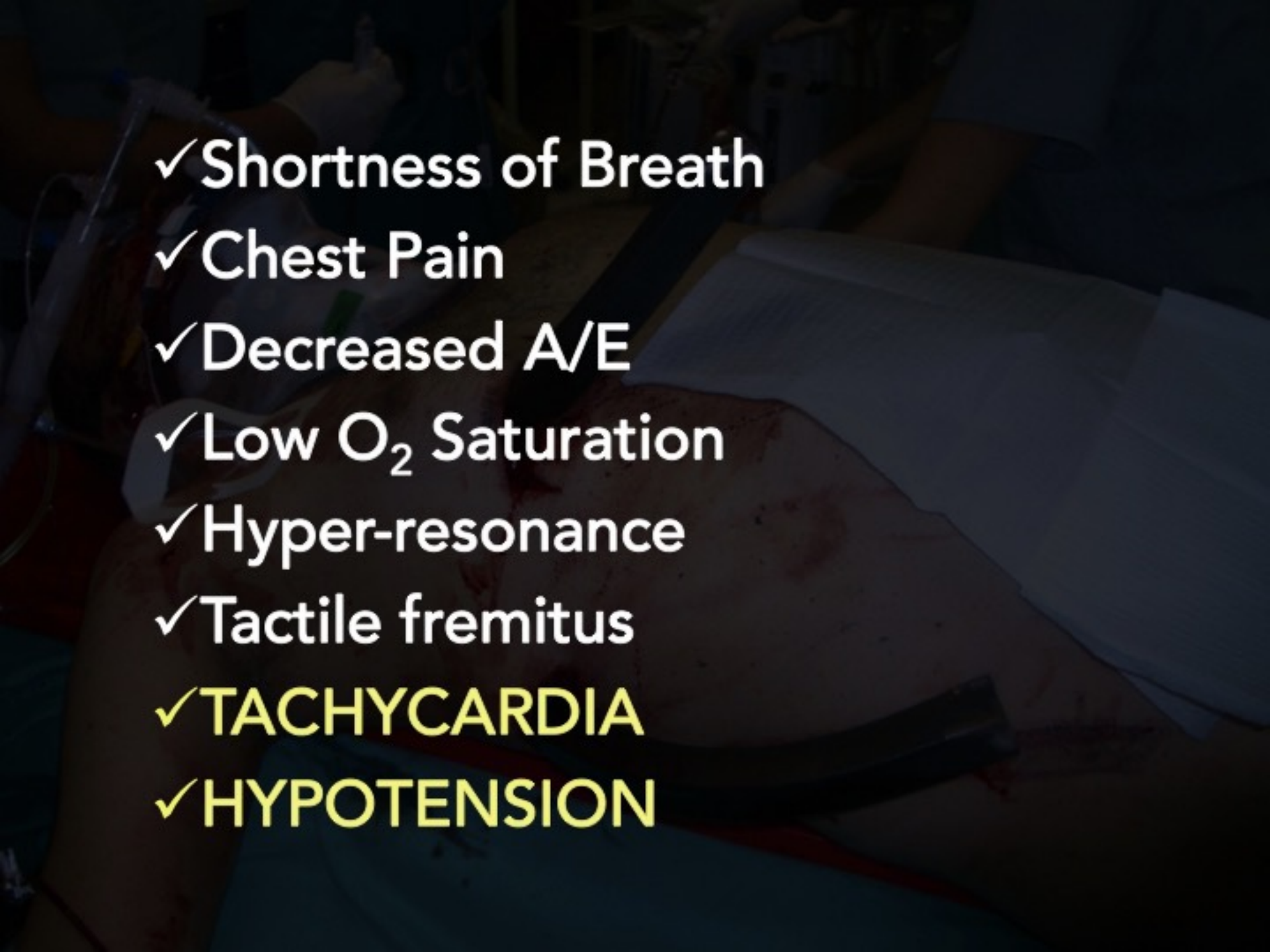
PTX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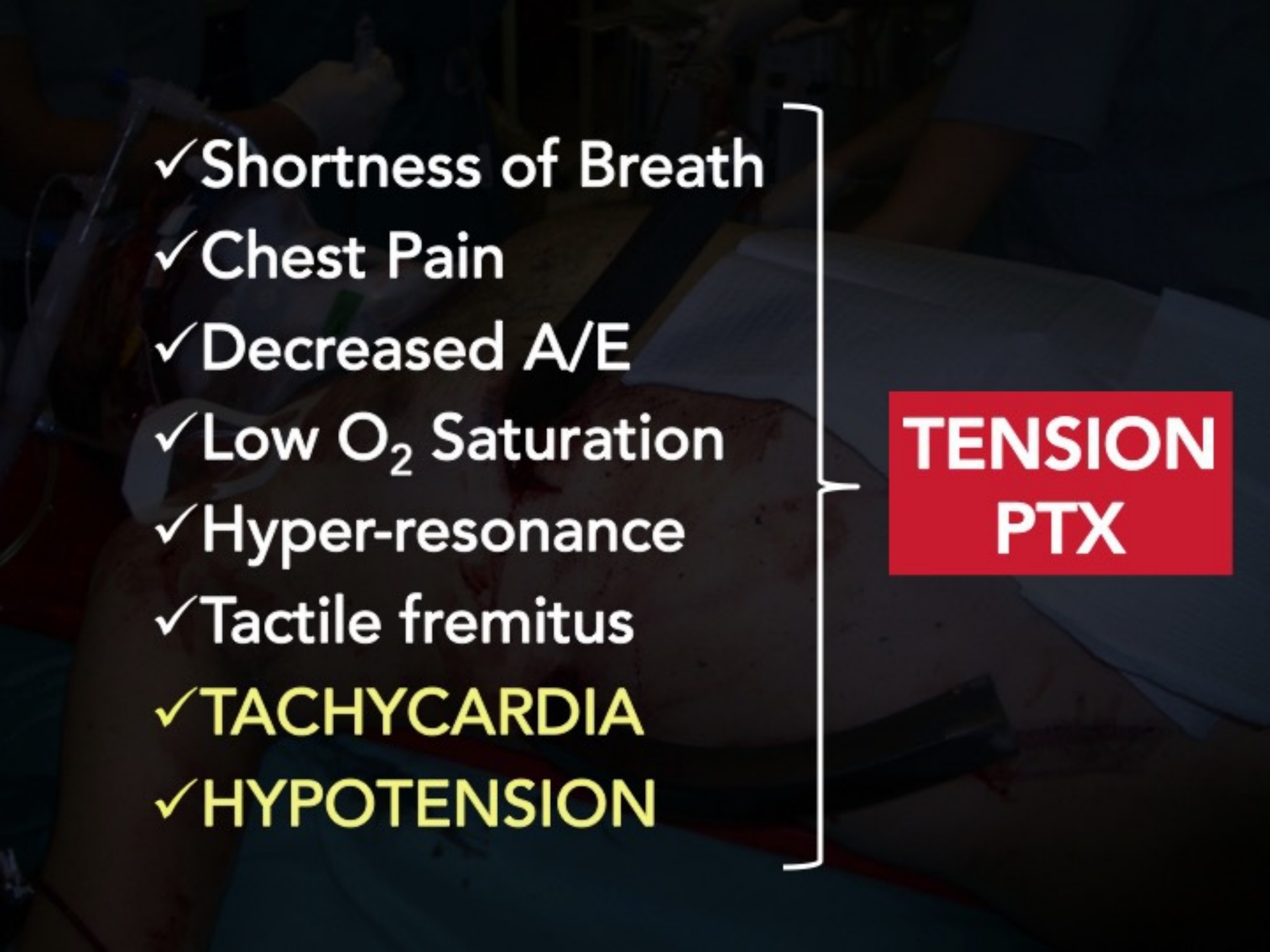
✓HYPOTENSION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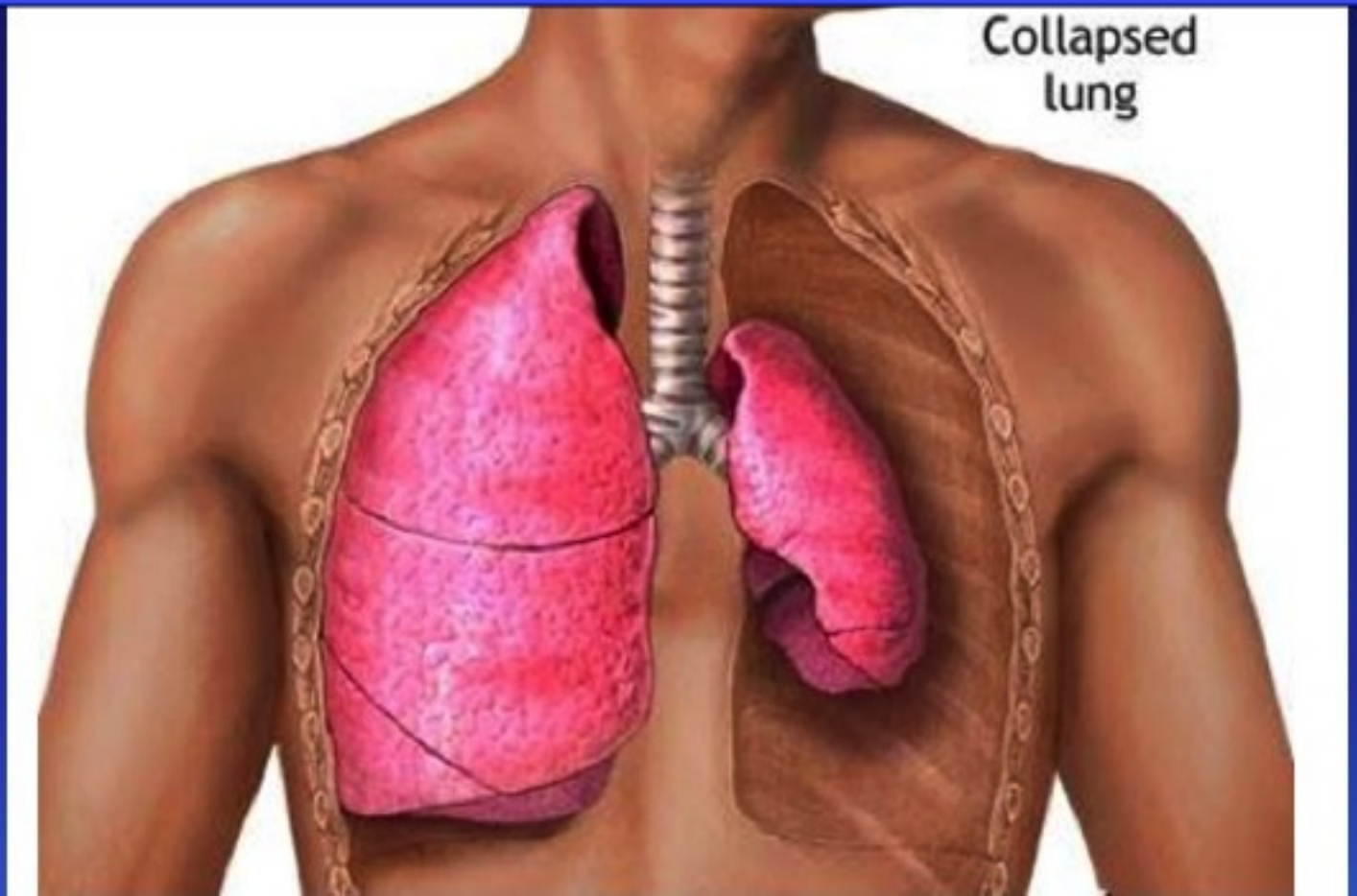
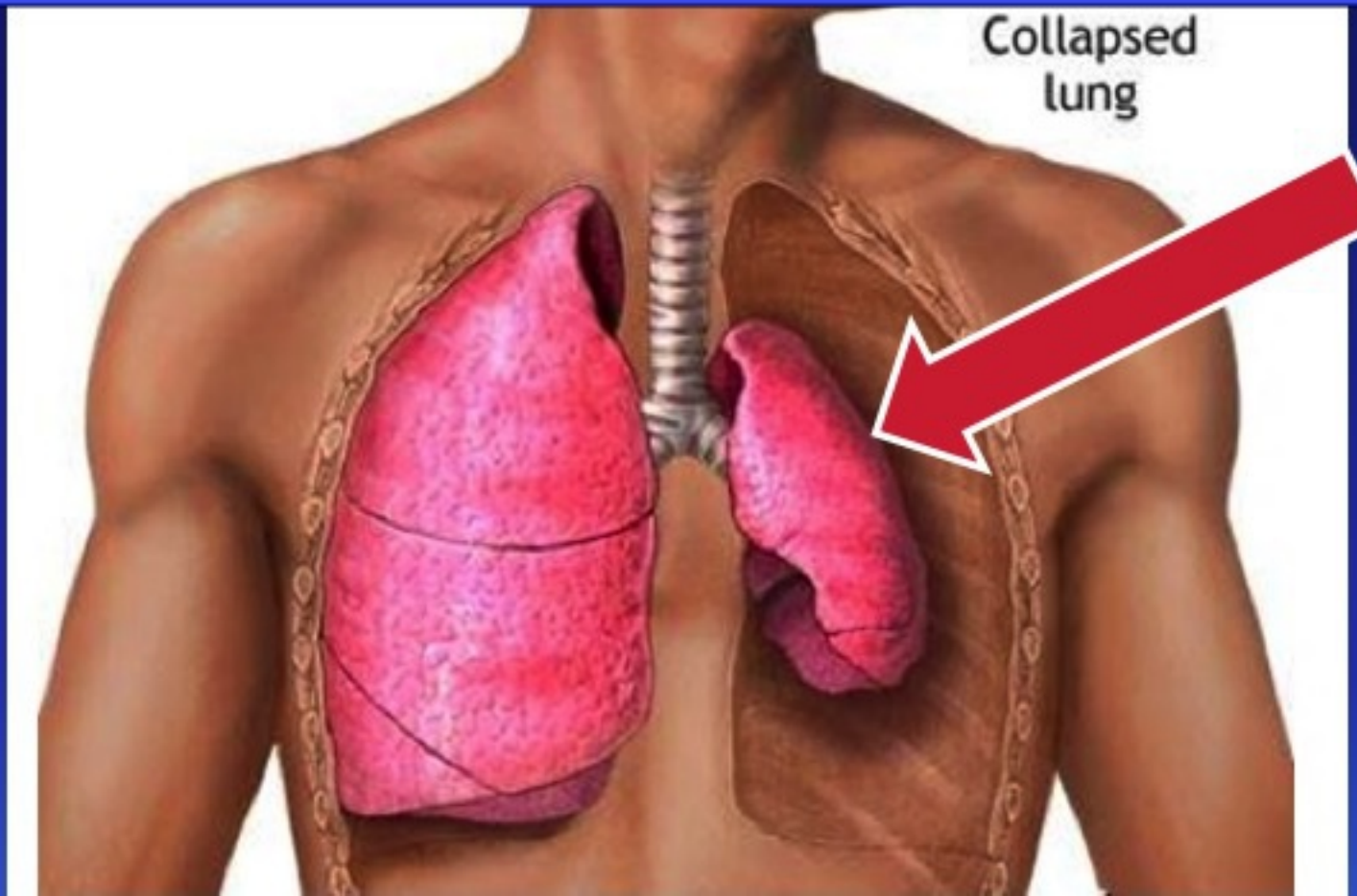
TENSION PTX

Pleural Air



Pleural Air
↓
Compresses lung



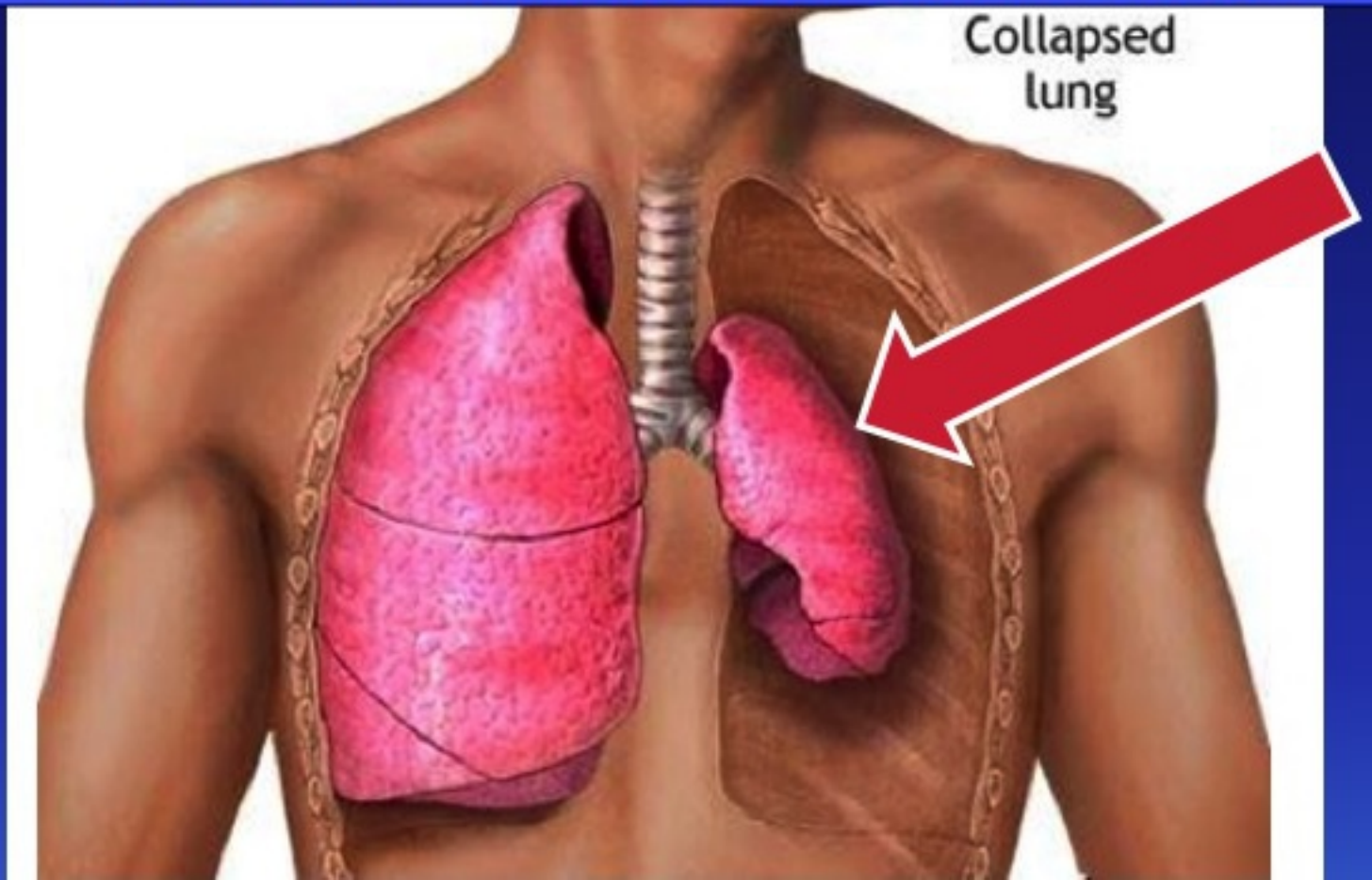
Pleural Air

↓

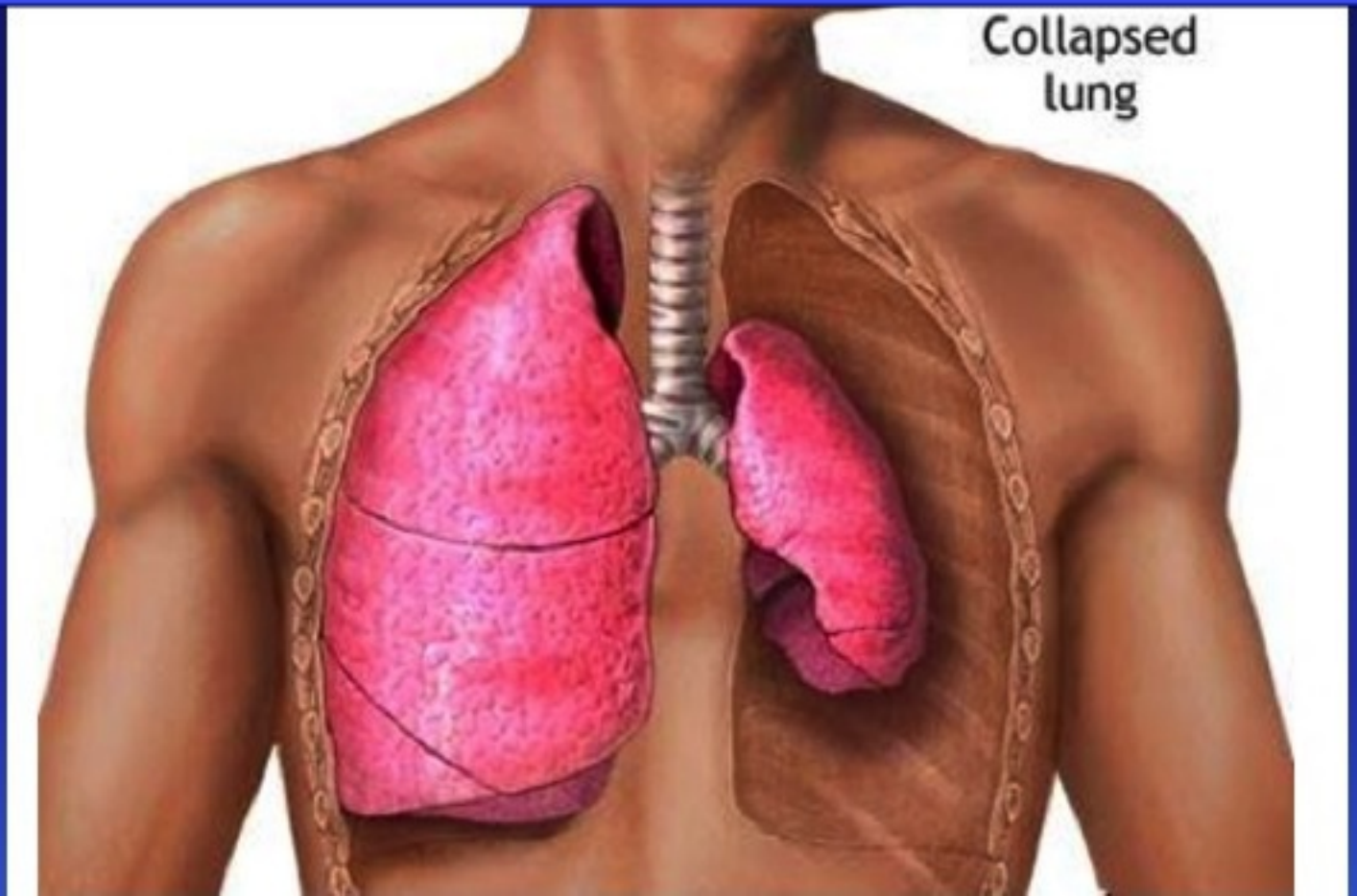
Compresses lung

↓

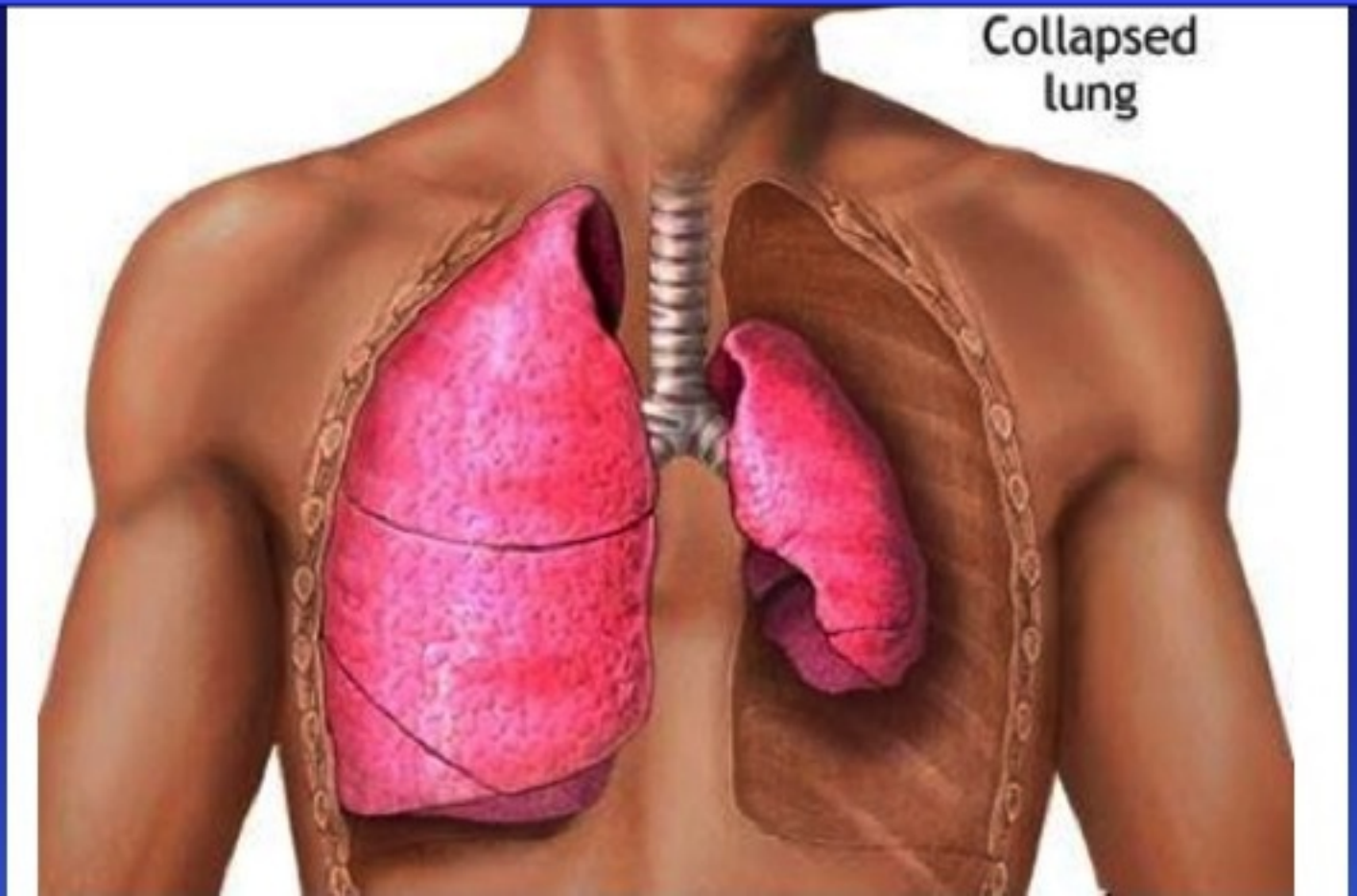
SIMPLE PNEUMOTHORAX



Air Increases



Air Increases
↓
Compresses Lung Even More



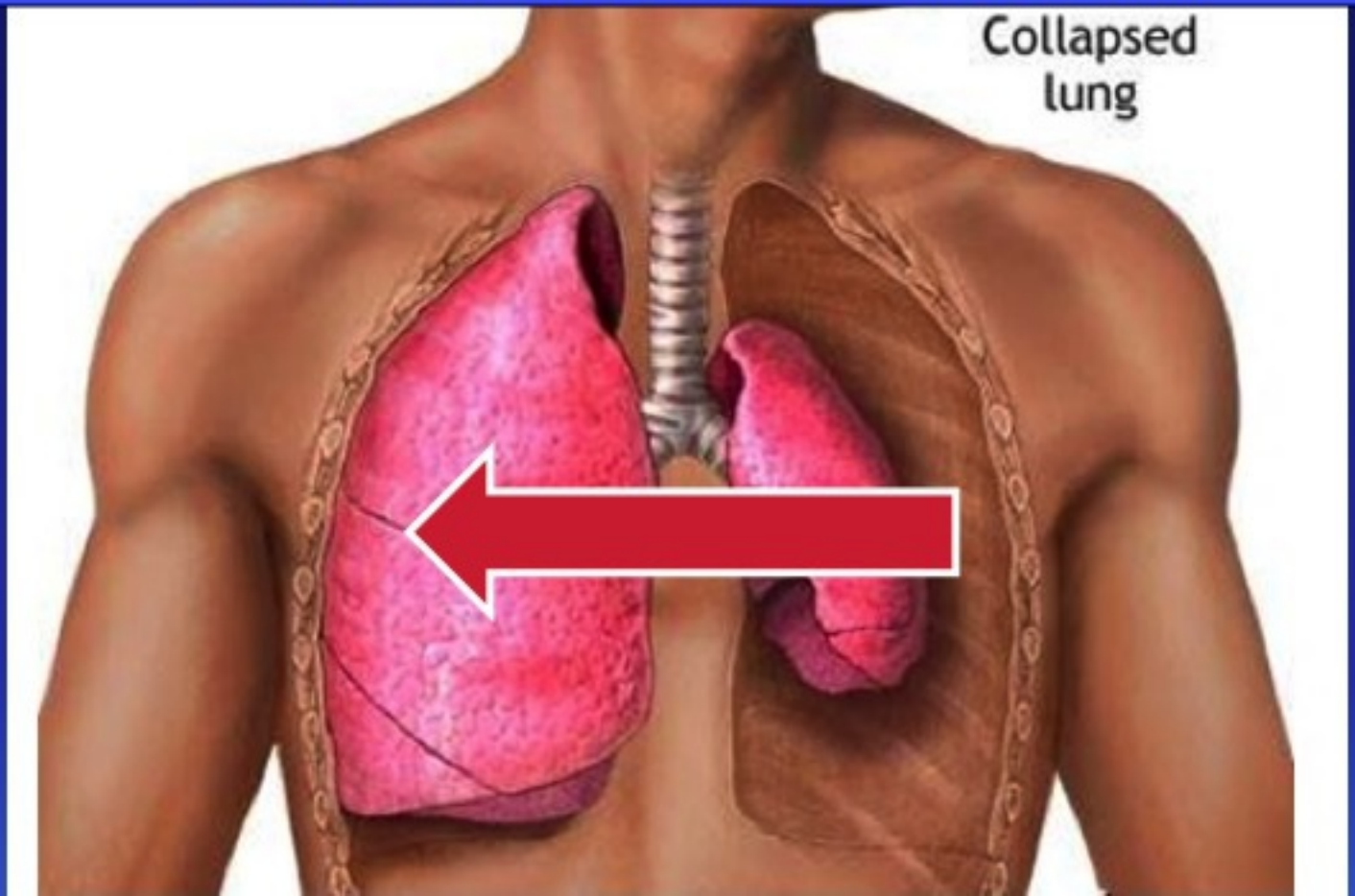
Air Increases

↓

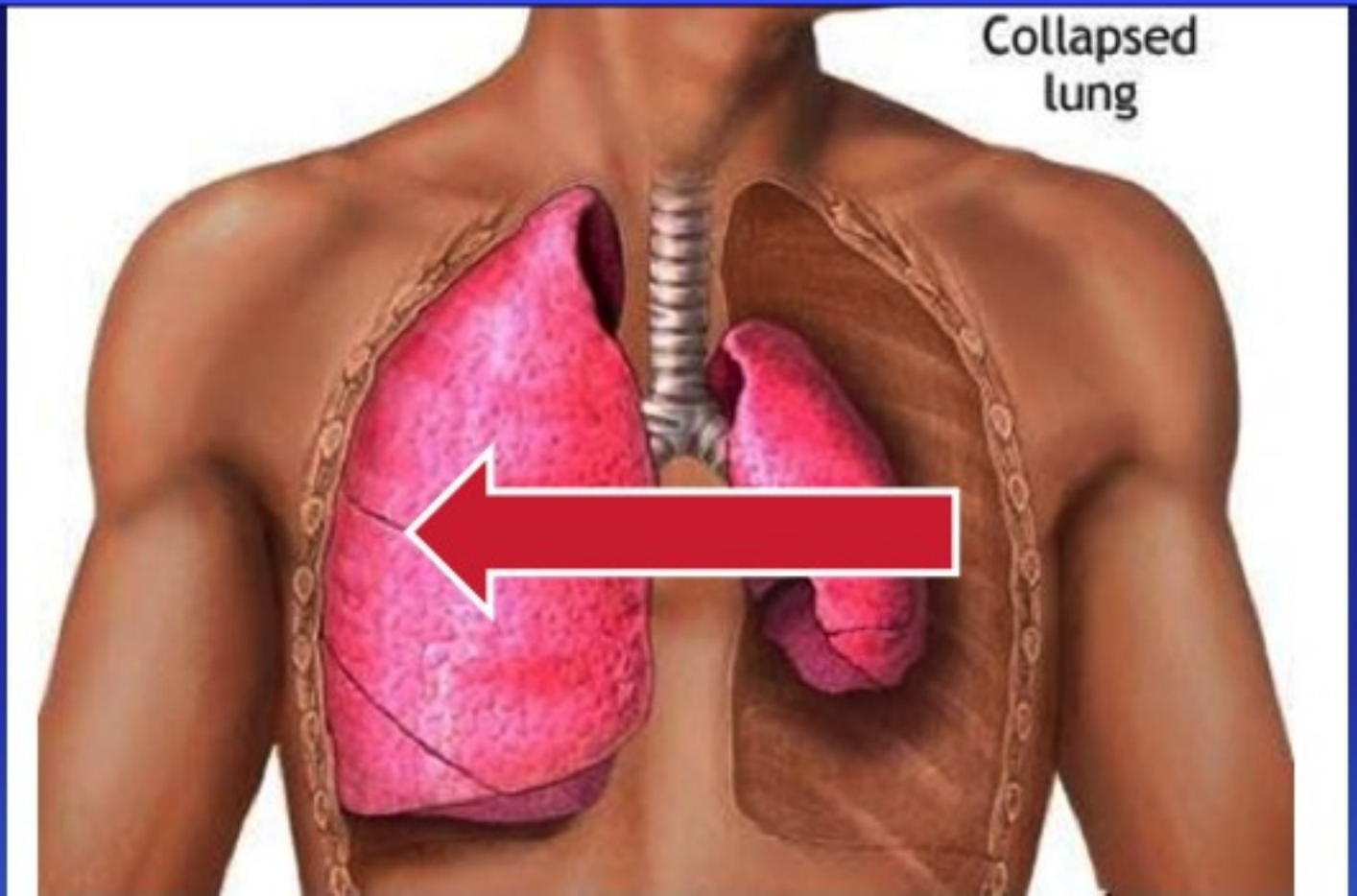
Compresses Lung Even More

↓

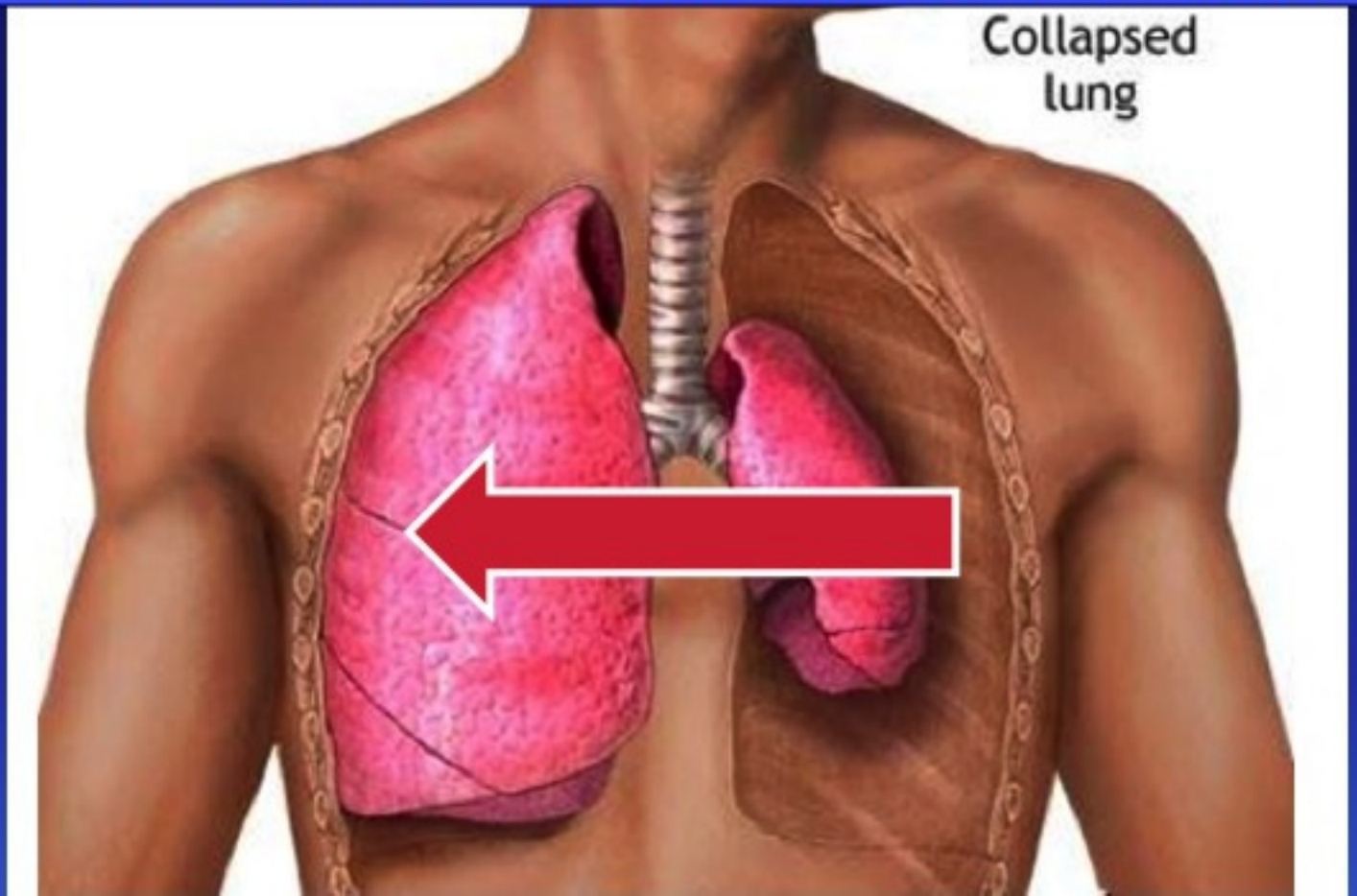
Shifts Mediastinum

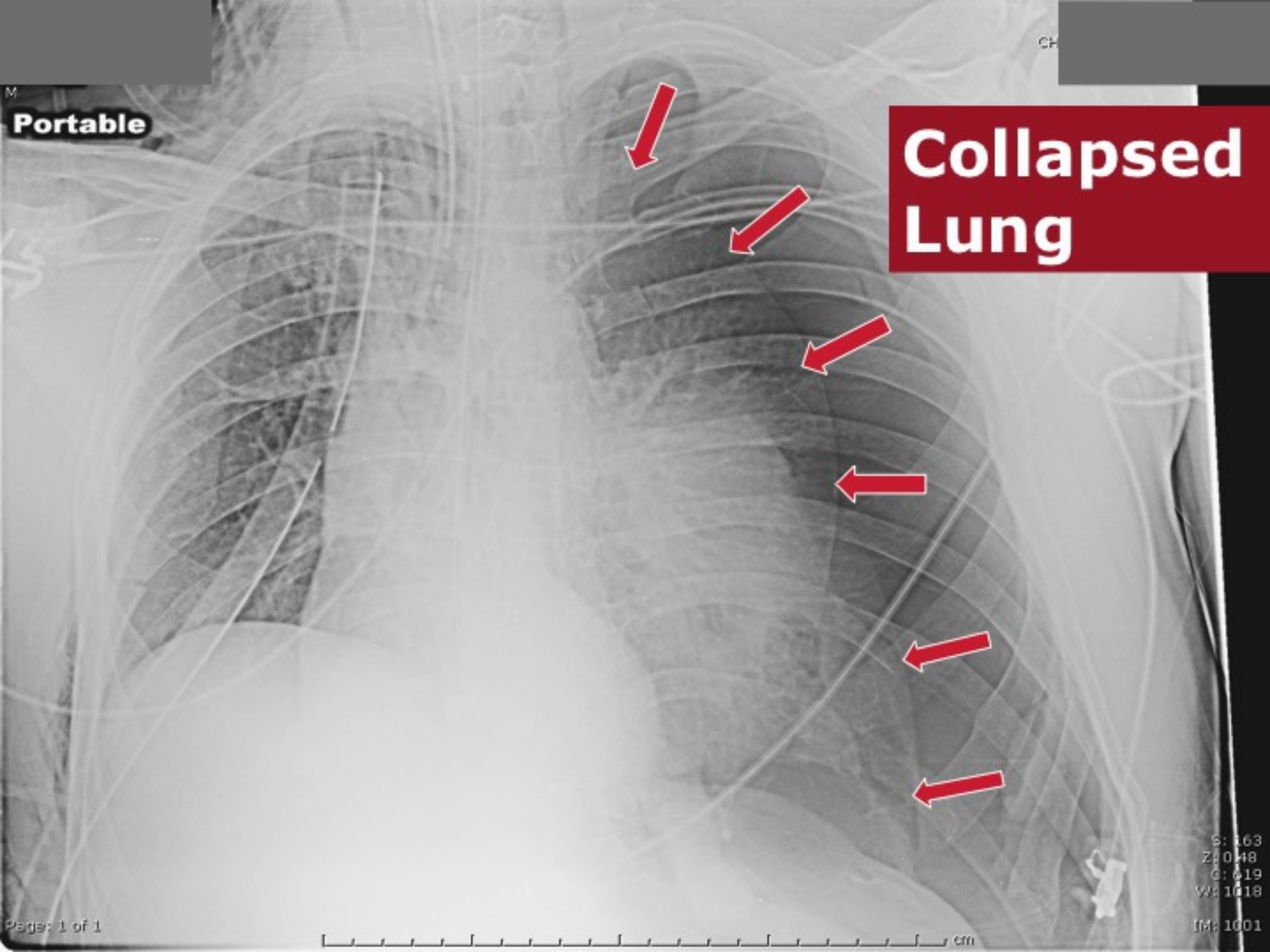


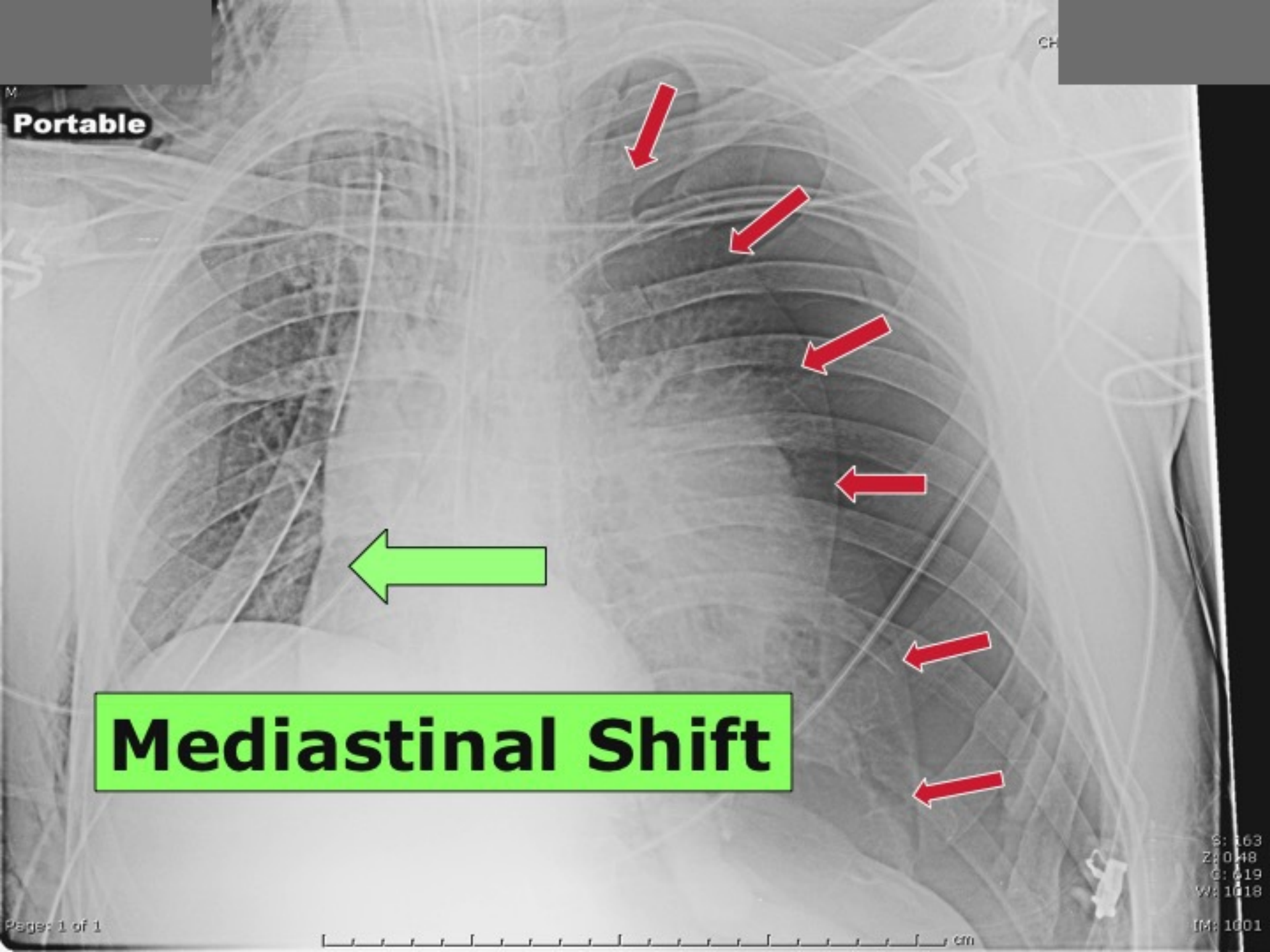
Functional Deformation
+
Impaired Venous Return
↓
Decreased CO



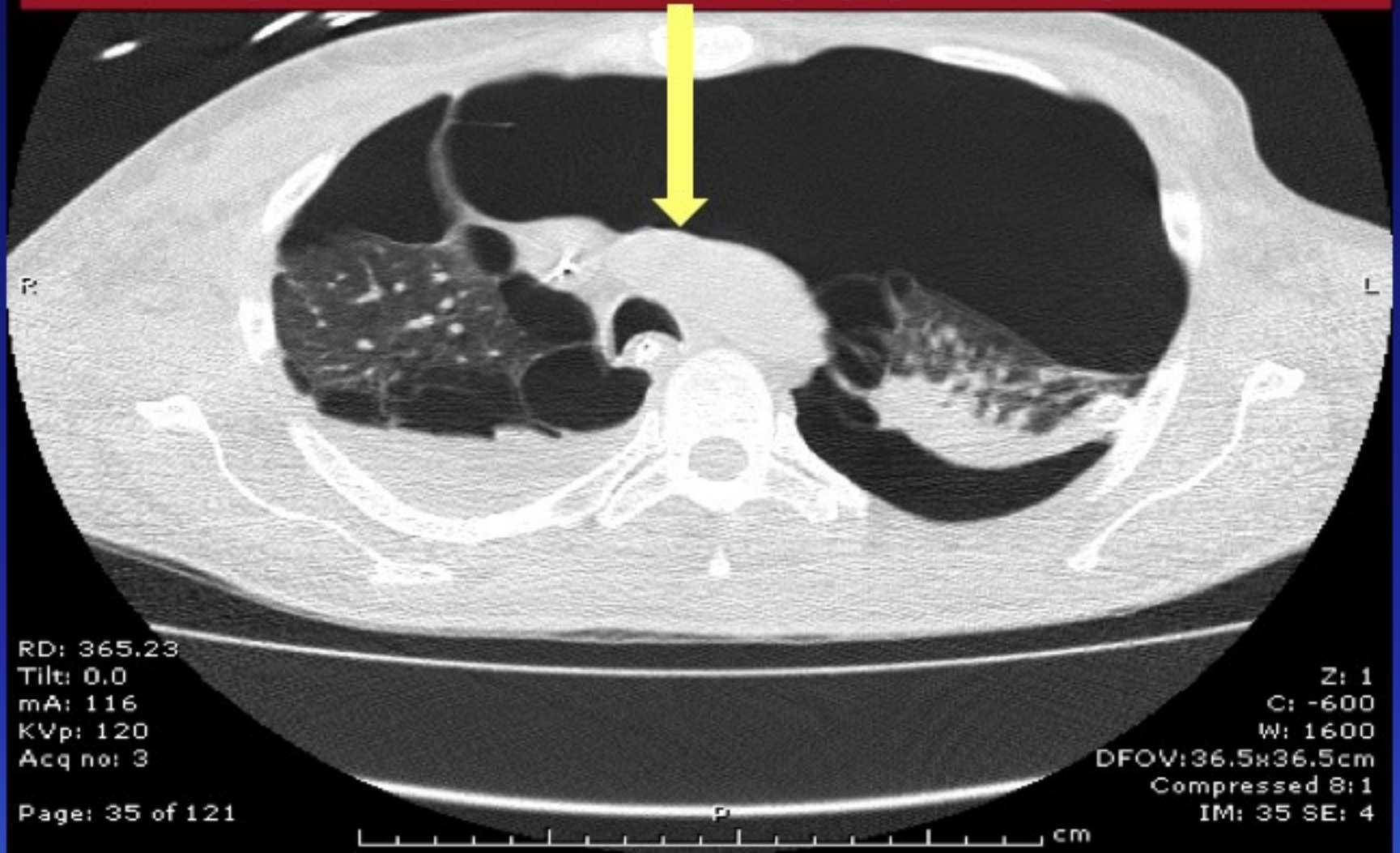
Functional Deformation
+
Impaired Venous Return
↓
TENSION PNEUMOTHORAX




Portable
Collapsed Lung


Portable
Mediastinal Shift

- ✓ EXTRINSIC COMPRESSION
- ✓ CARDIAC DEFORMATION
- ✓ DECREASED VENOUS RETURN

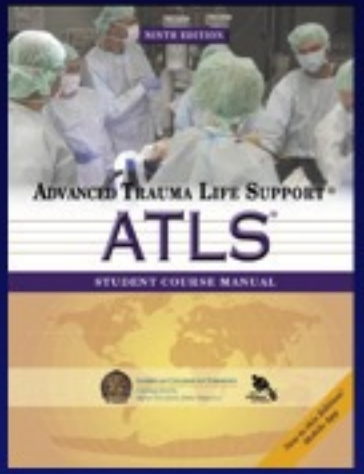


OBJECTIVES

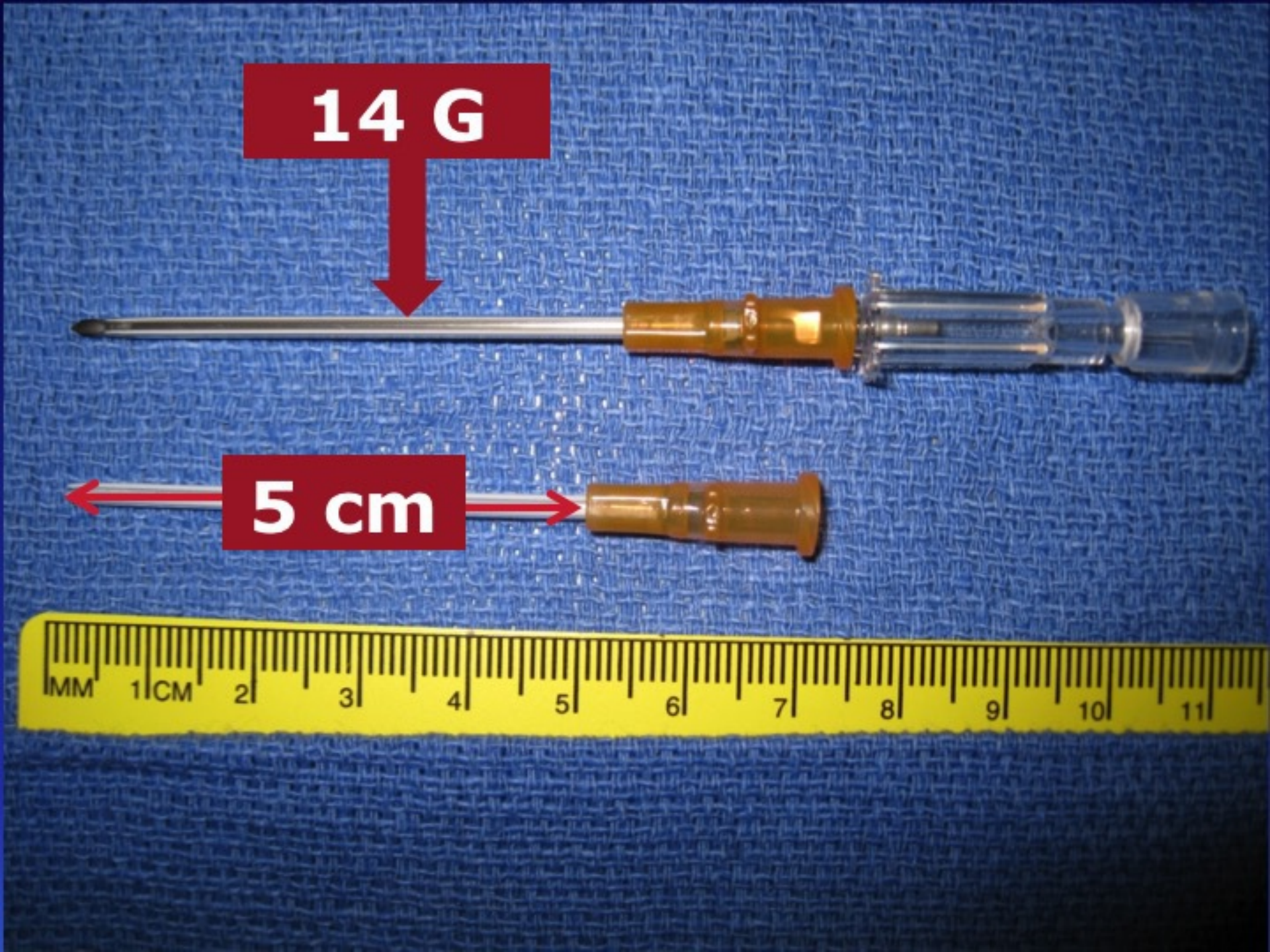
- ✓ What is Tension Pneumothorax
- ✓ Treatment and Pitfalls
- ✓ New directions

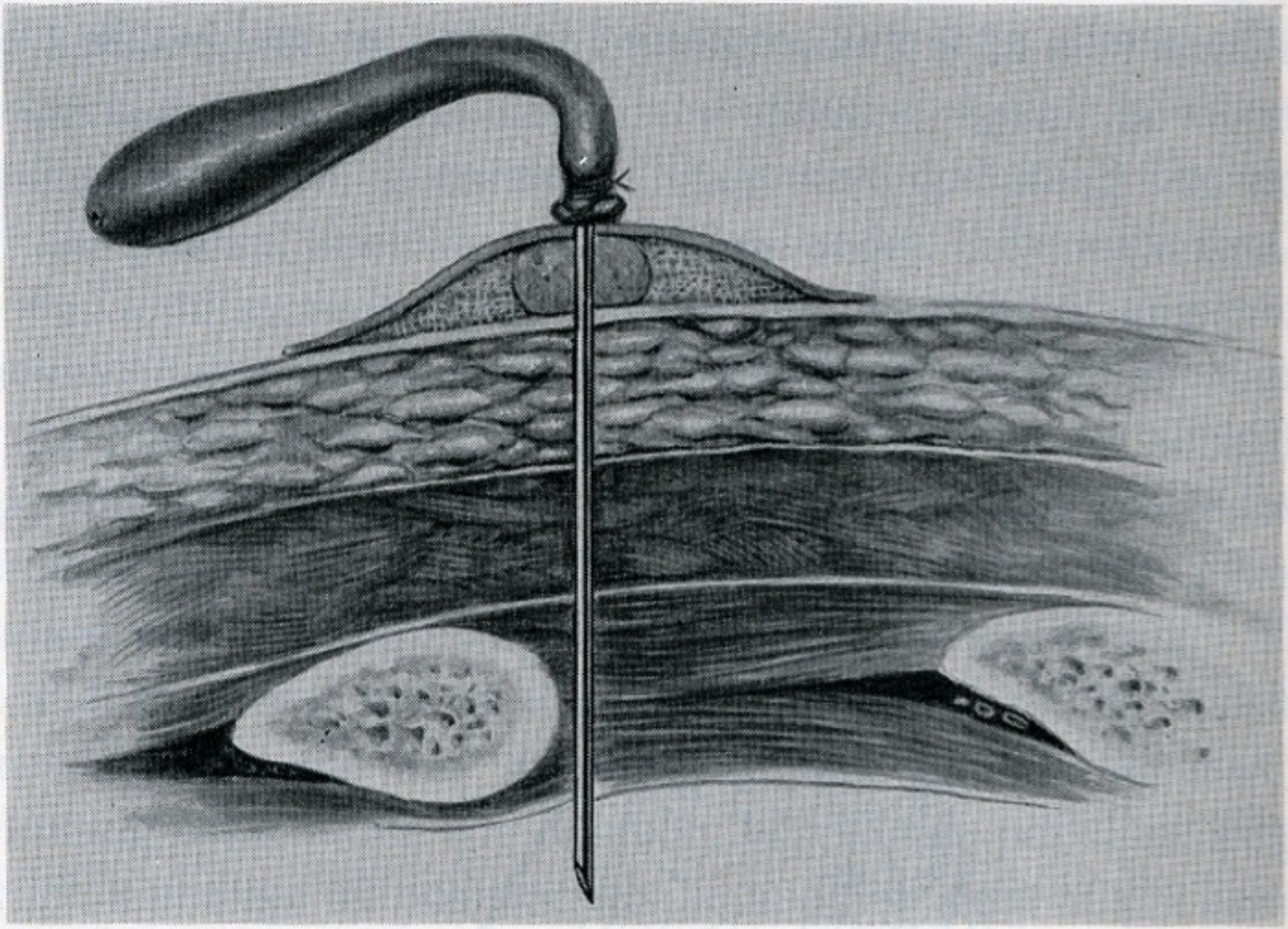
NEEDLE DECOMPRESSION

NEEDLE DECOMPRESSION



- ✓Emergent procedure for decompression
- ✓ATLS - 2nd Intercostal space, Mid-clavicular line
- ✓5 cm catheter


14 G
5 cm
MM
1
CM
2
3
4
5
6
7
8
9
10
11

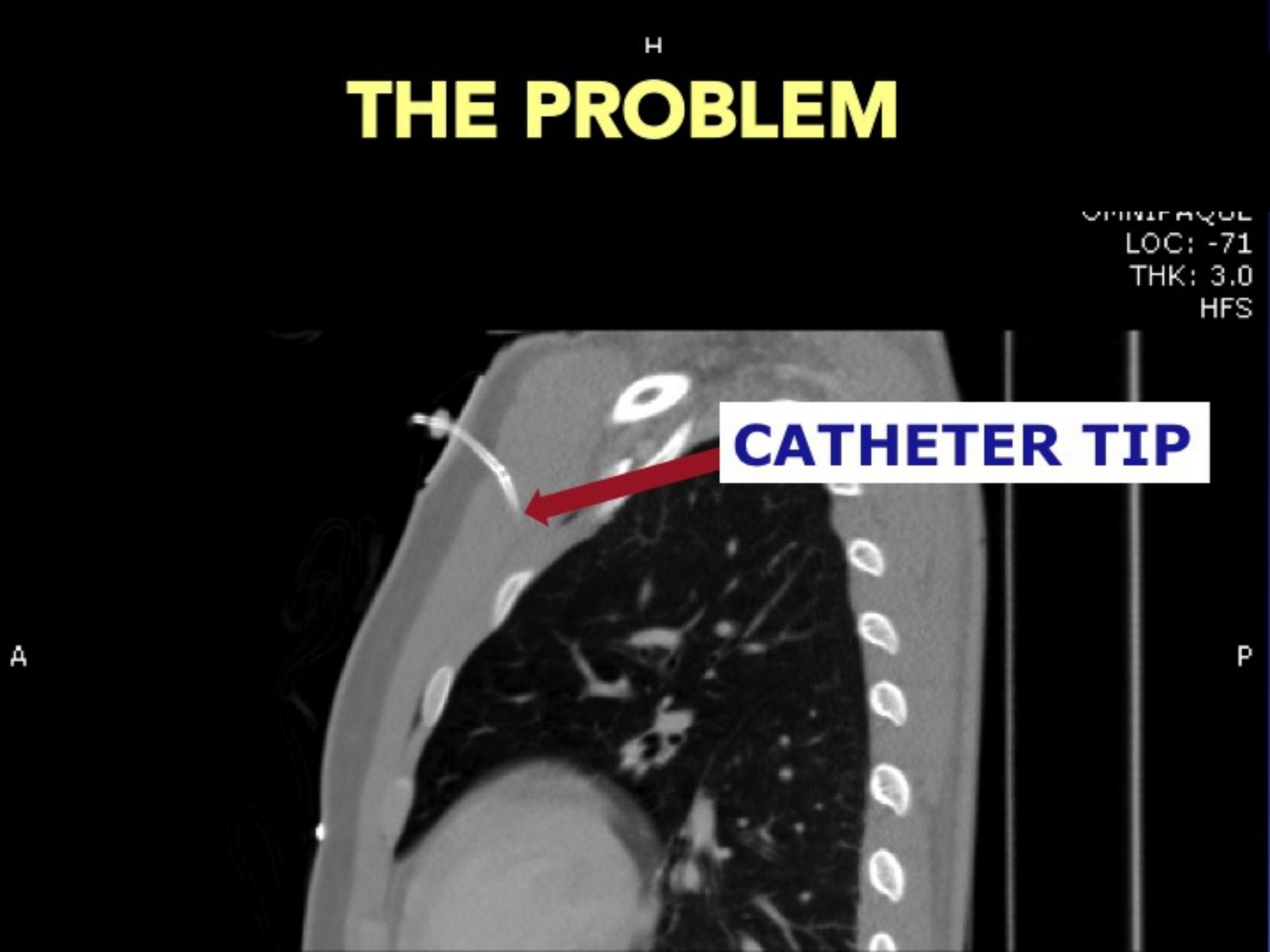


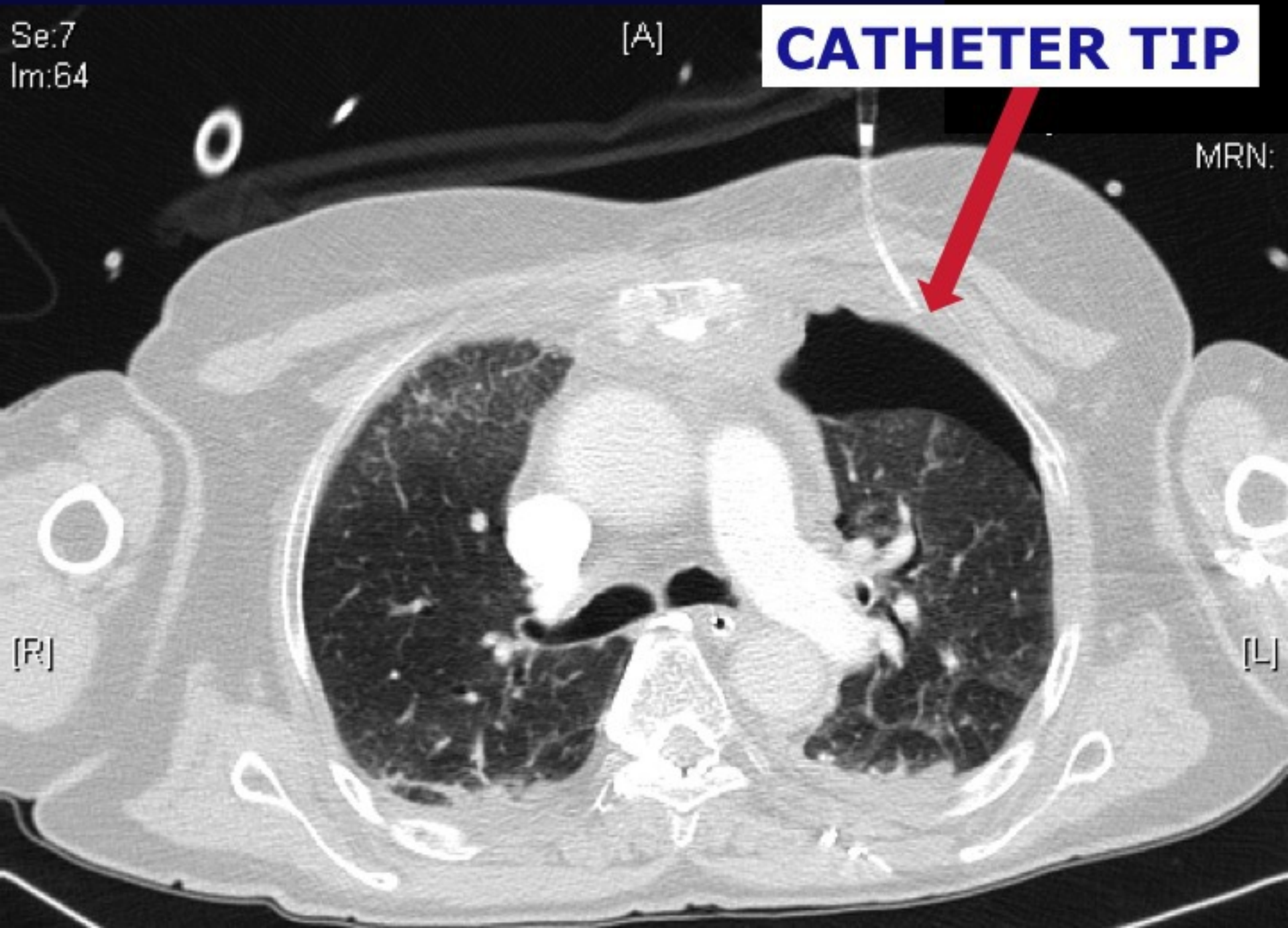
Thoracic needle decompression for tension pneumothorax: clinical correlation with catheter length

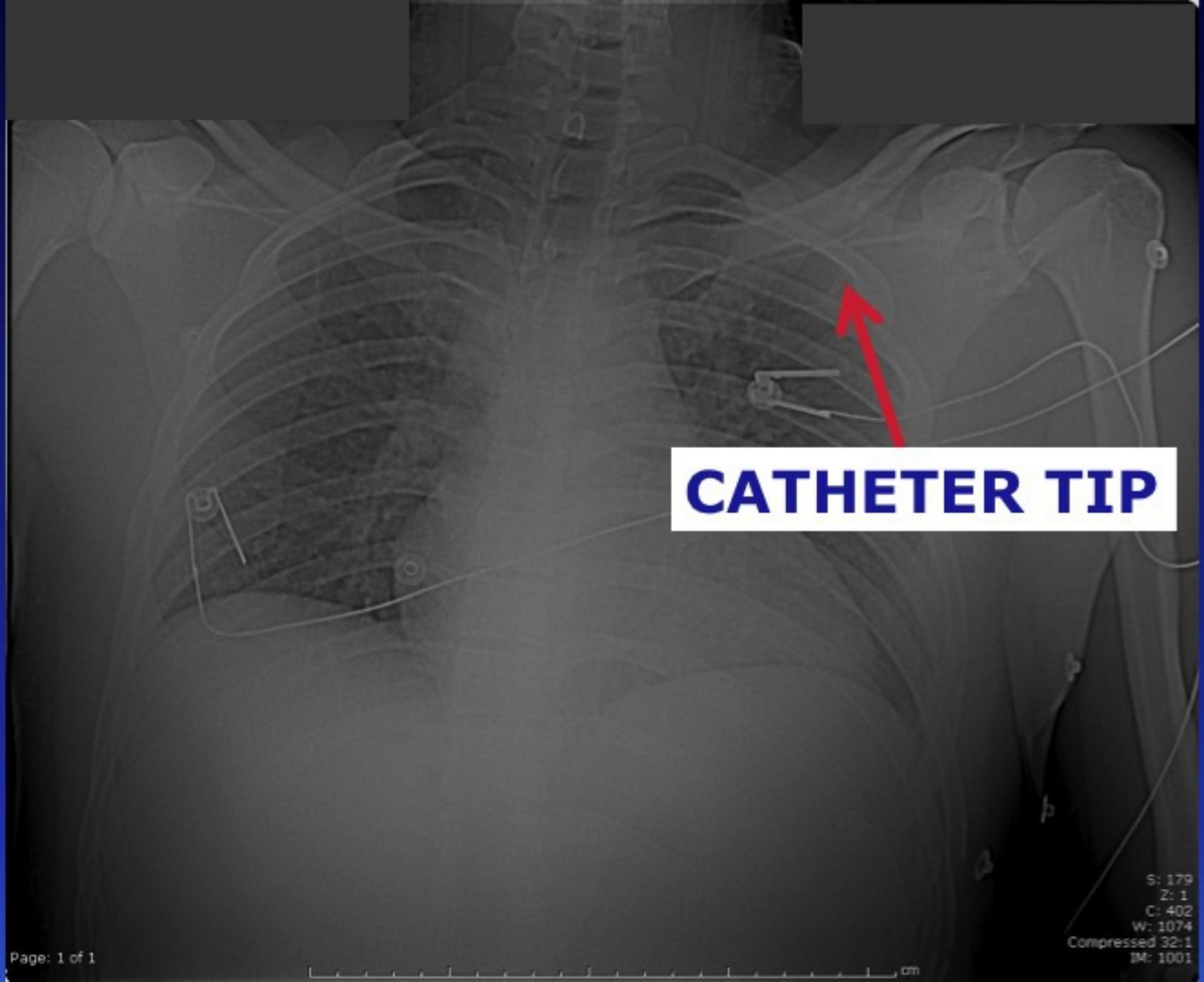
2010

Chad G. Ball, MD*
Amy D. Wyrzykowski, MD*
Andrew W. Kirkpatrick, MD†
Christopher J. Dente, MD*
Jeffrey M. Nicholas, MD*
Jeffrey P. Salomone, MD*
Grace S. Rozycki, MD*
John B. Kortbeek, MD†
David V. Feliciano, MD*

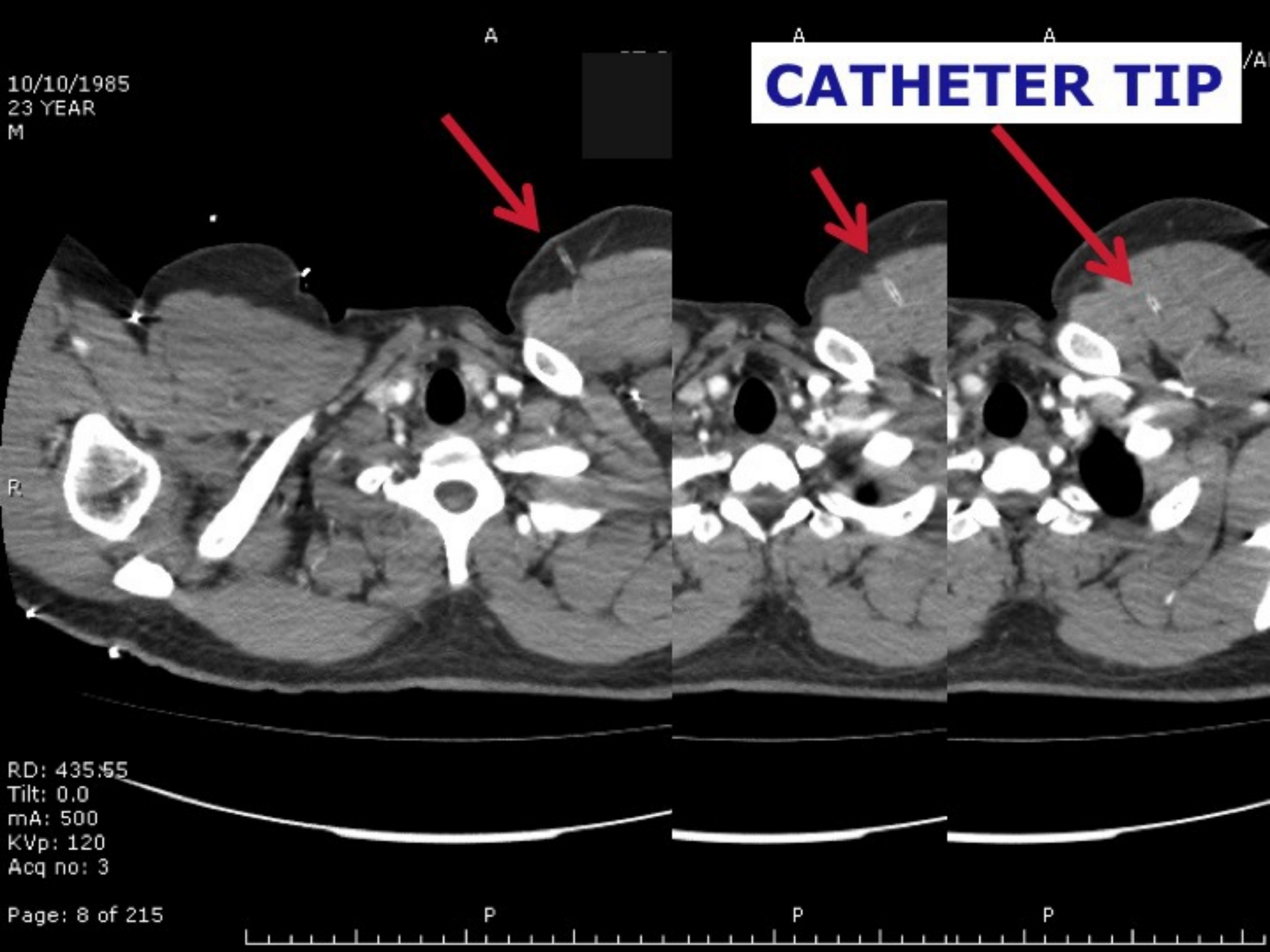
- ✓Retrospective, n=101
- ✓1.4% blunt patients needled
- ✓3.2-4.5 cm catheters
- ✓Assuming all had a Ptx
- ✓4-65% residual large Ptx

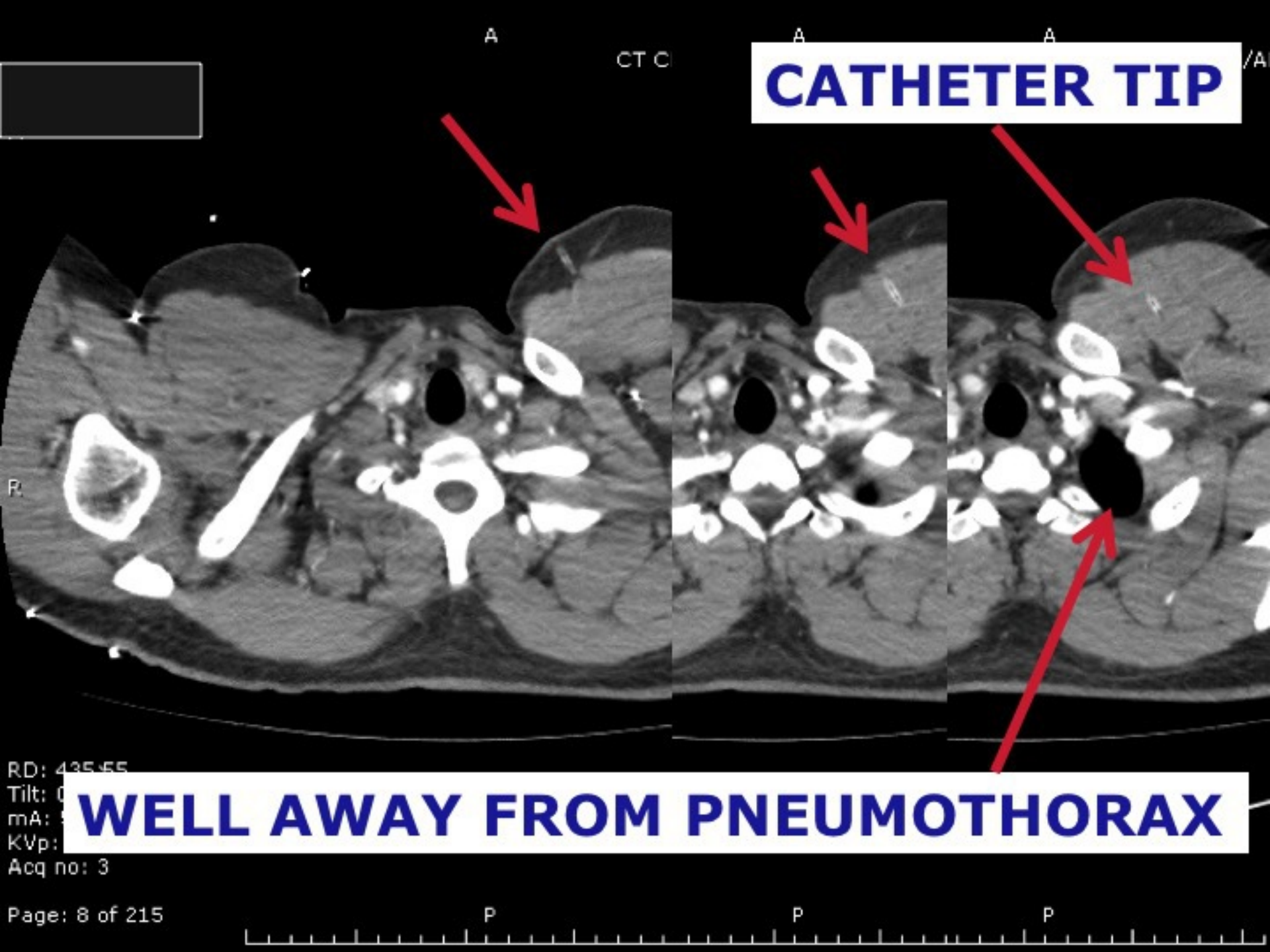

H
THE PROBLEM
LOC: -71
THK: 3.0
HFS
CATHETER TIP
A
P


Se:7
Im:64
[A]
CATHETER TIP
MRN:
[R]
[L]


CATHETER TIP
Page: 1 of 1
cm
S: 179
Z: 1
C: 402
W: 1074
Compressed 32:1
IM: 1001

CATHETER TIP
Page: 1 of 1


CATHETER TIP
10/10/1985
23 YEAR
M
R
RD: 435:55
Tilt: 0.0
mA: 500
KVp: 120
Acq no: 3
Page: 8 of 215

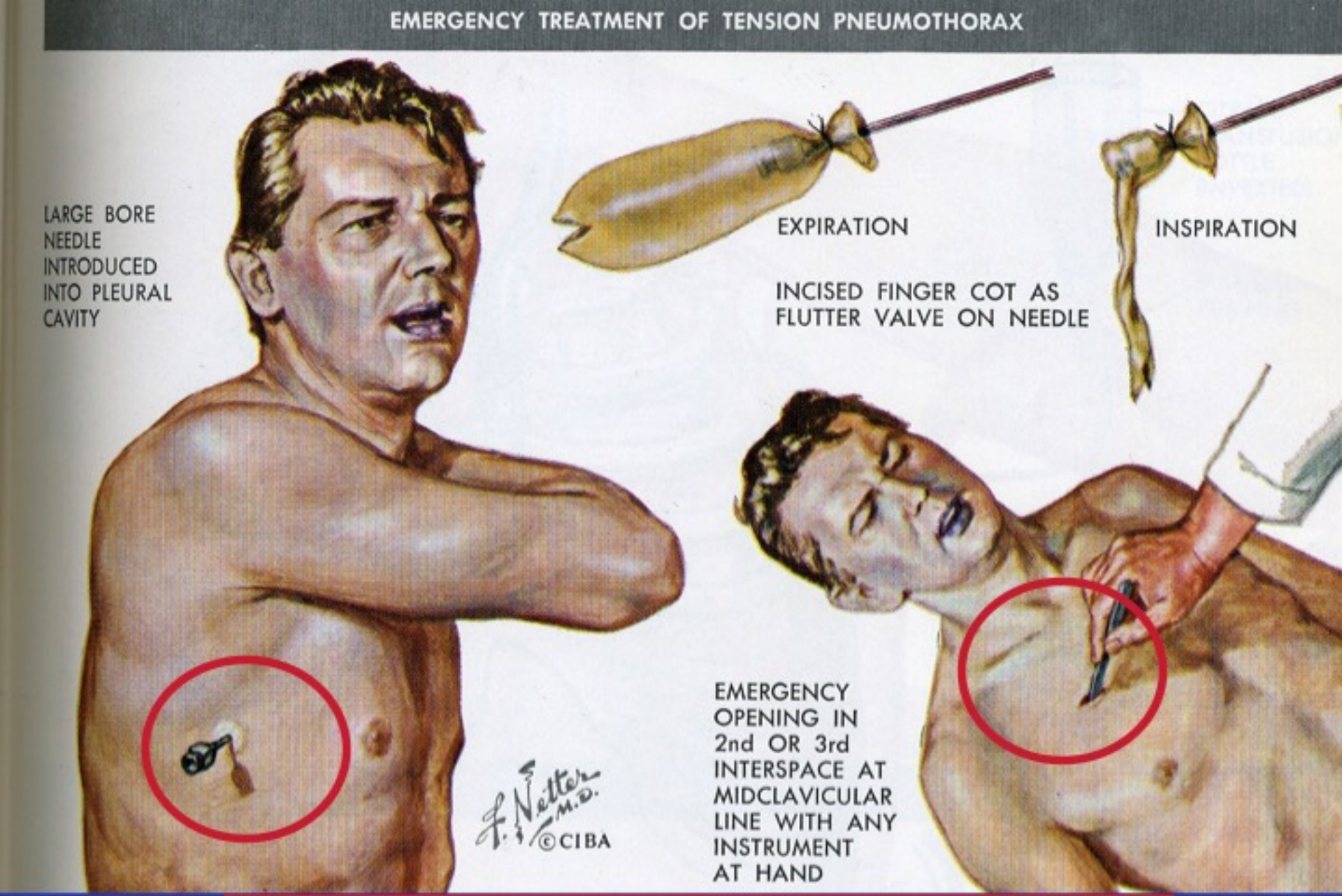

CATHETER TIP
WELL AWAY FROM PNEUMOTHORAX

OBJECTIVES

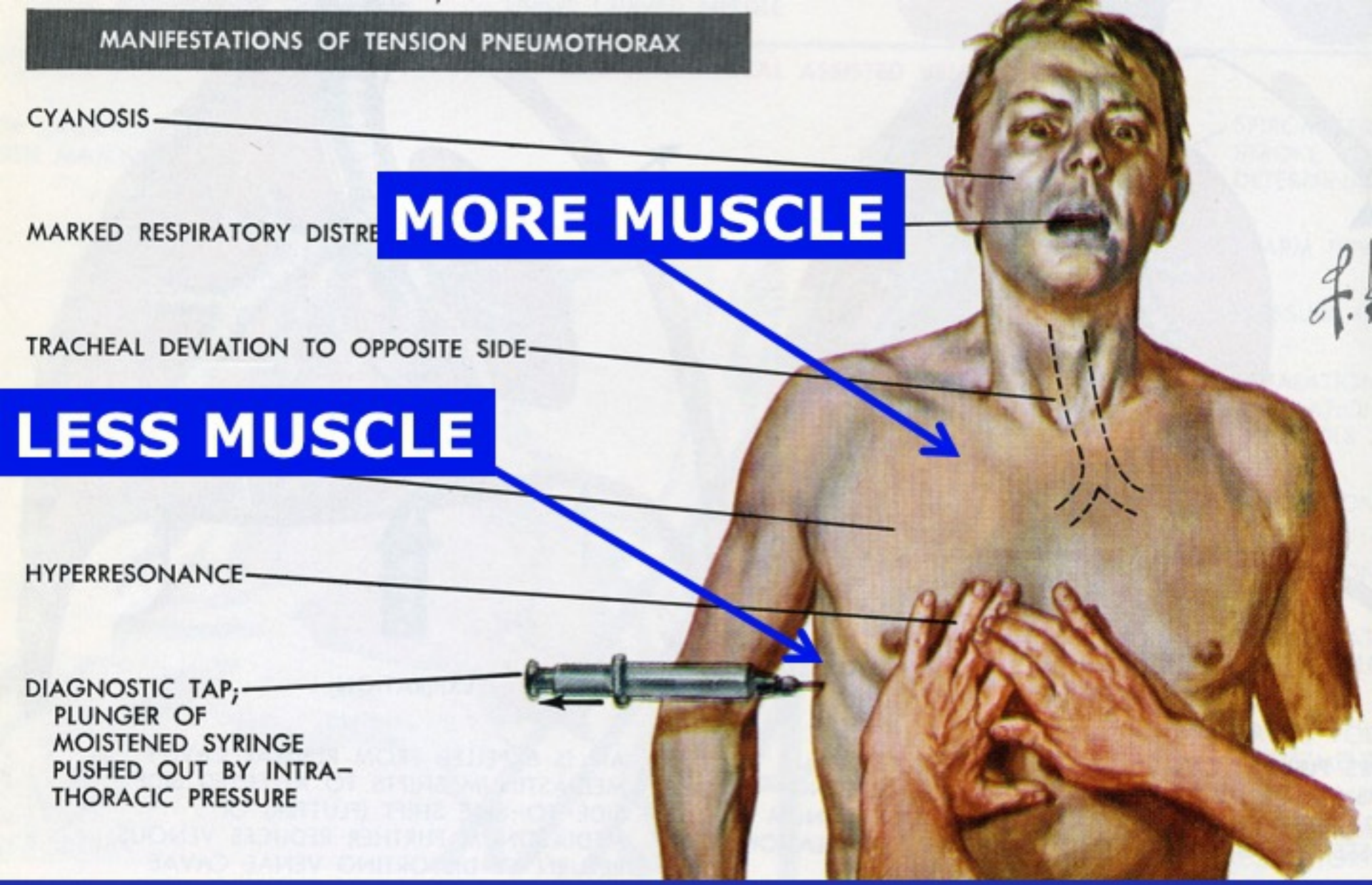
- ✓ What is Tension Pneumothorax
- ✓ Treatment and Pitfalls
- ✓ New directions

DIFFERENT INSERTION SITE?

- 5th Intercostal space, anterior axillary line
- Potential benefits
  - ✓Easily accessible supine
  - ✓Does not impact transport
  - ✓Experience with CT insertion



NOT A NEW CONCEPT


MANIFESTATIONS OF TENSION PNEUMOTHORAX
CYANOSIS
MARKED RESPIRATORY DISTRE
TRACHEAL DEVIATION TO OPPOSITE SIDE
HYPERRESONANCE
DIAGNOSTIC TAP; PLUNGER OF MOISTENED SYRINGE PUSHED OUT BY INTRA-THORACIC PRESSURE
MORE MUSCLE
LESS MUSCLE

Studies

1. CADAVERIC MODEL
2. CT BASED HUMAN EVALUATION
3. EMS EVALUATION

Studies

1. CADAVERIC MODEL
2. CT BASED HUMAN EVALUATION
3. EMS EVALUATION

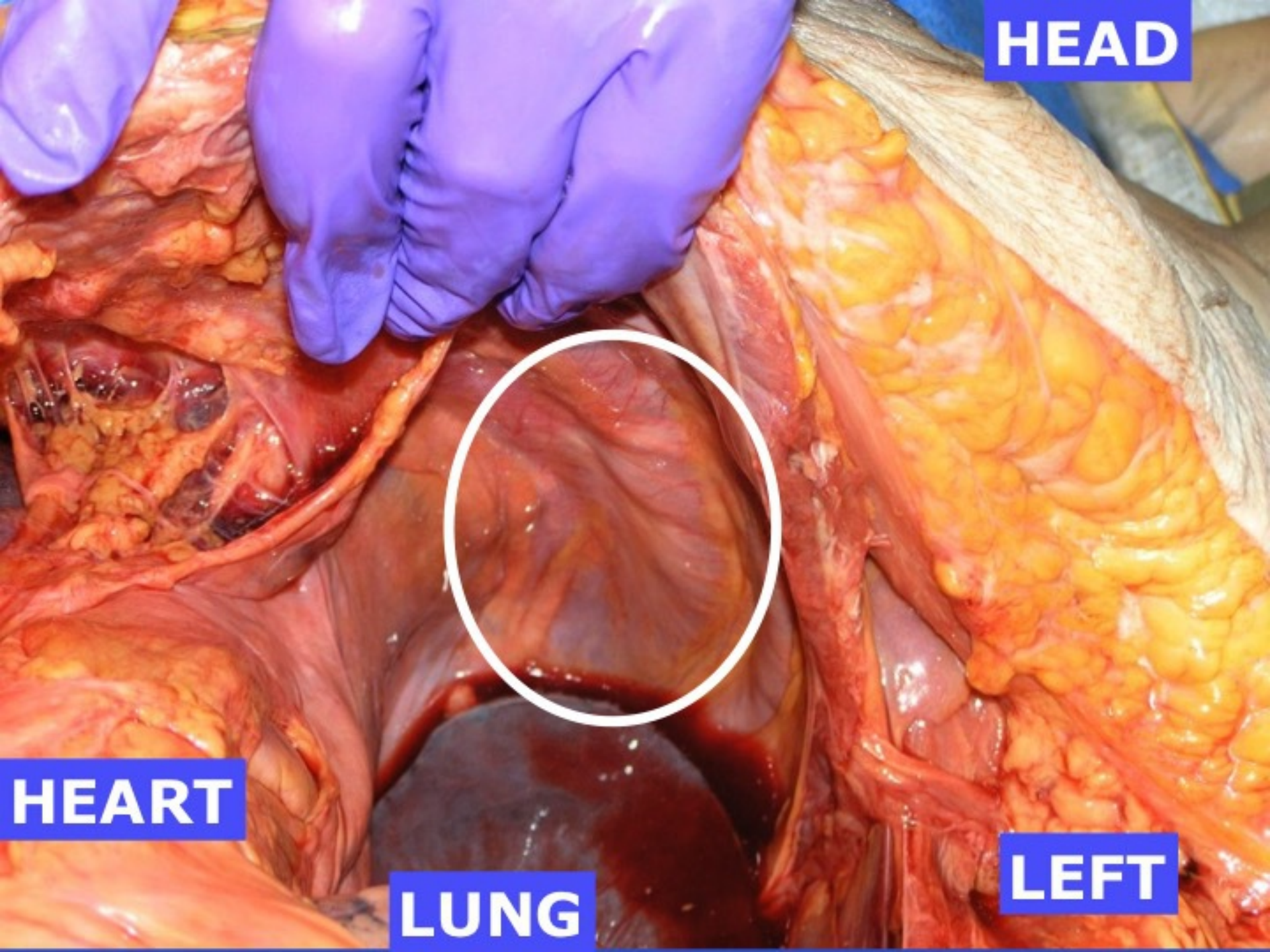
Optimal Positioning for Emergent Needle Thoracostomy: A Cadaver-Based Study

Kenji Inaba, MD, FRCSC, FACS, Bernardino C. Branco, MD, Marc Eckstein, MD, David V. Shatz, MD, Matthew J. Martin, MD, Donald J. Green, MD, Thomas T. Noguchi, MD, and Demetrios Demetriades, MD, PhD

2011

- ✓Human cadavers
- ✓Traditional 2nd v. 5th ICS
- ✓5cm standard catheter
- ✓80 needles into 20 cadavers
- ✓Clamshell to assess penetration
- ✓Chest wall thickness measured

2ND MID-CLAVICULAR
5TH ANTERIOR-AXILLARY


HEAD
HEART
LUNG
LEFT

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2011

- ✓**CWT 3.5 v. 4.5cm ($p<0.001$)**

Optimal Positioning for Emergent Needle Thoracostomy: A Cadaver-Based Study

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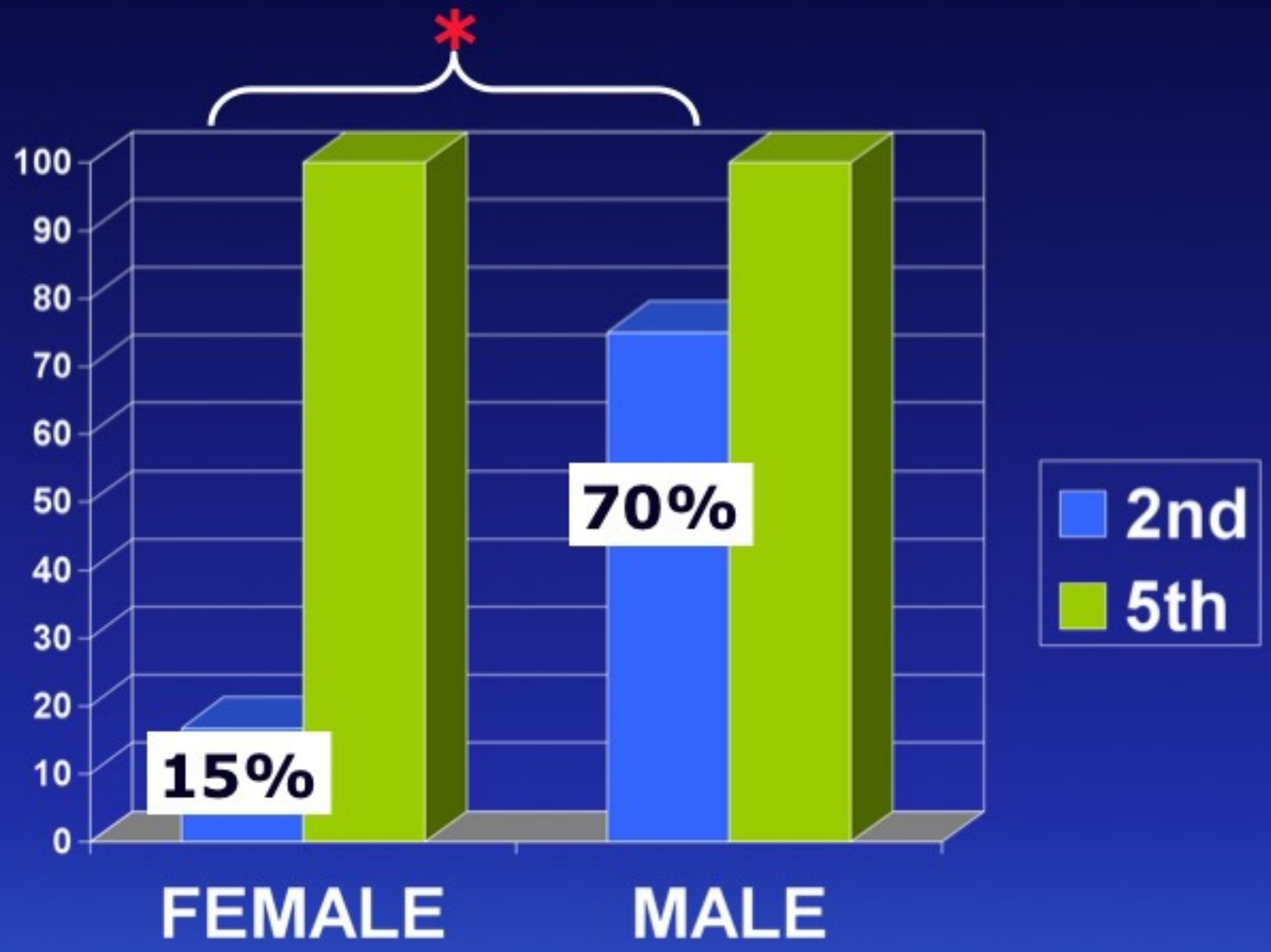
2011

- ✓CWT 3.5 v. 4.5cm ($p<0.001$)
- ✓2nd ICS – 58%
- ✓5th ICS – 100%

SUCCESSFUL PENETRATION

SUCCESSFUL PENETRATION



Cadaver Summary

- ✓ Chest thicker at 2nd v. 5th ICS
- ✓ Especially females
- ✓ 42% of 2nd ICS did not penetrate chest
- ✓ 100% at 5th ICS successful

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- ✓ Especially females
- ✓ 42% of 2nd ICS did not penetrate chest
- ✓ 100% at 5th ICS successful

NO cardiac, lung, hilum, aorta, spleen or liver injury…

Studies

1. CADAVERIC MODEL
2. CT BASED LIVING HUMAN EVALUATION
3. EMS EVALUATION

ONLINE FIRST

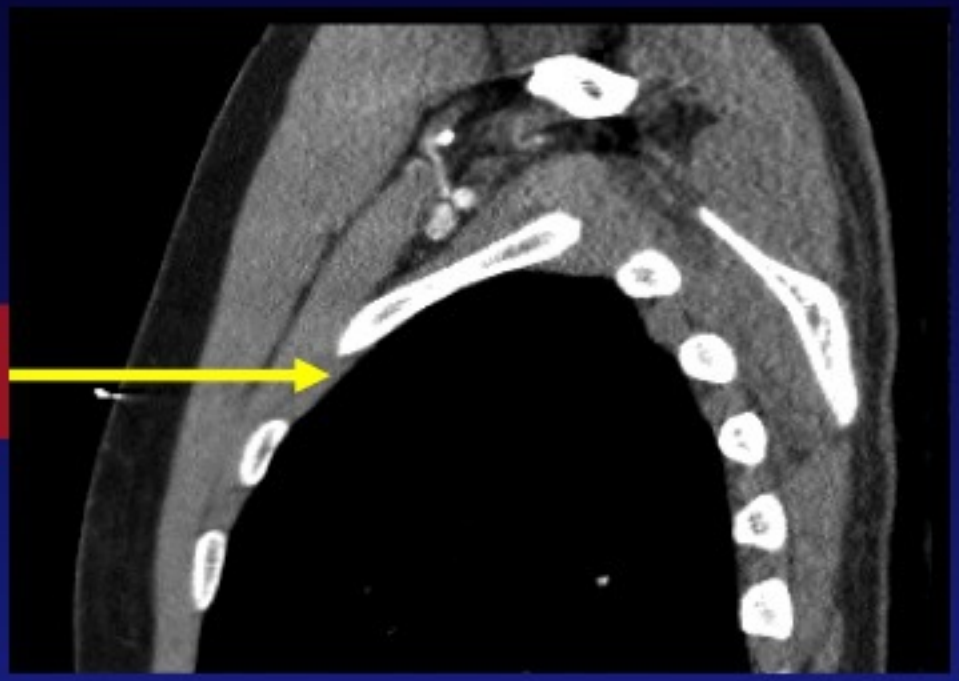
Radiologic Evaluation of Alternative Sites for Needle Decompression of Tension Pneumothorax

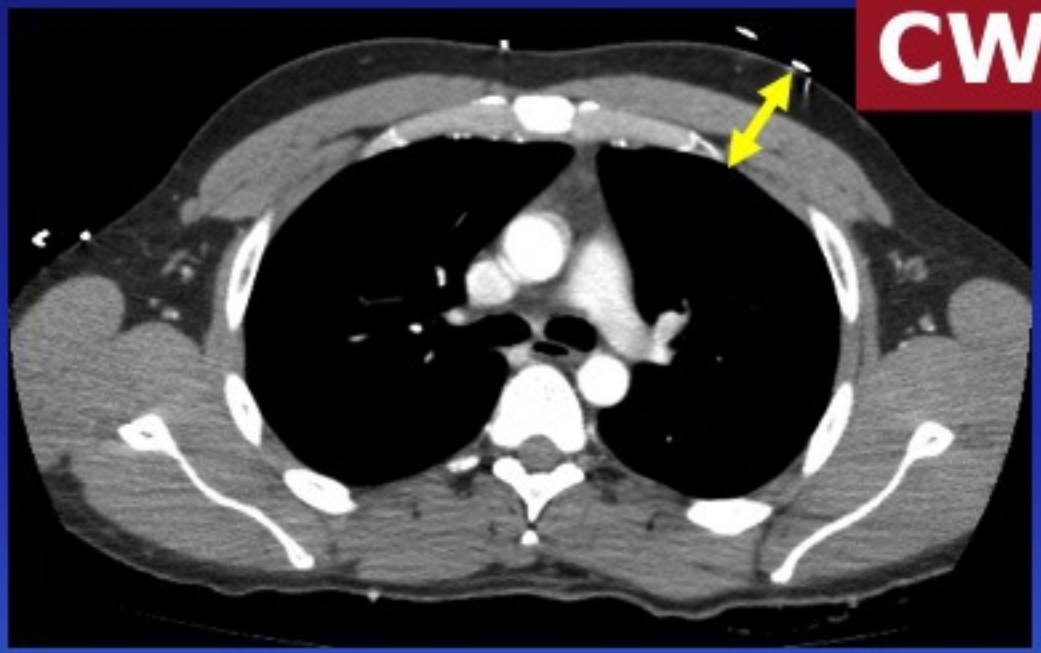
Kenji Inaba, MD; Crystal Ives, BSc; Kelsey McClure, BA; Bernardino C. Branco, MD; Marc Eckstein, MD, MPH; David Shatz, MD; Matthew J. Martin, MD; Sravanthi Reddy, MD; Demetrios Demetriades, MD, PhD

2012

- ✓Evaluate 2nd v 5th using Chest CTs of real patients
- ✓Trauma >16yo undergoing Chest CT for trauma
- ✓30 random from each of 4 BMI quartiles

2nd ICS

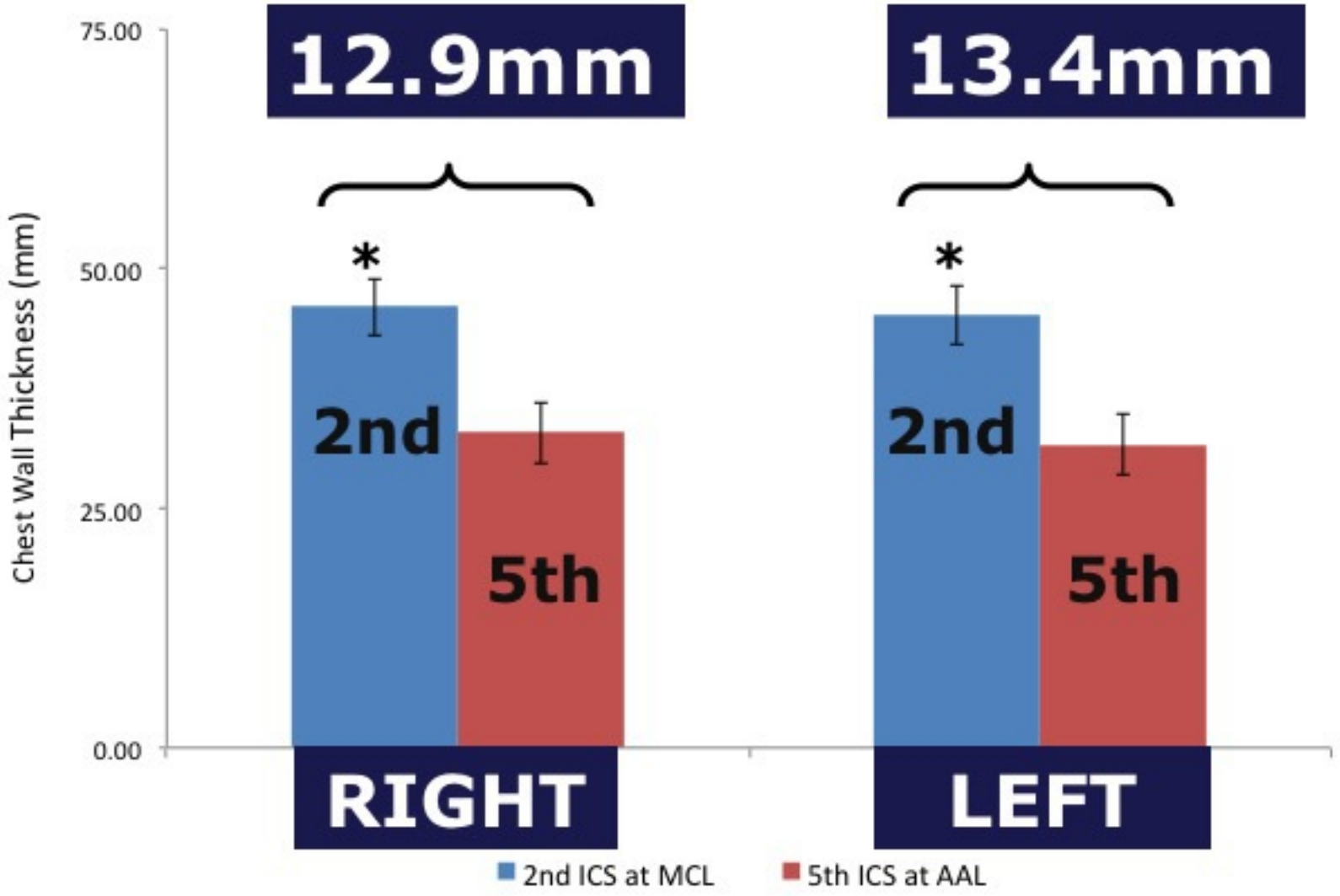




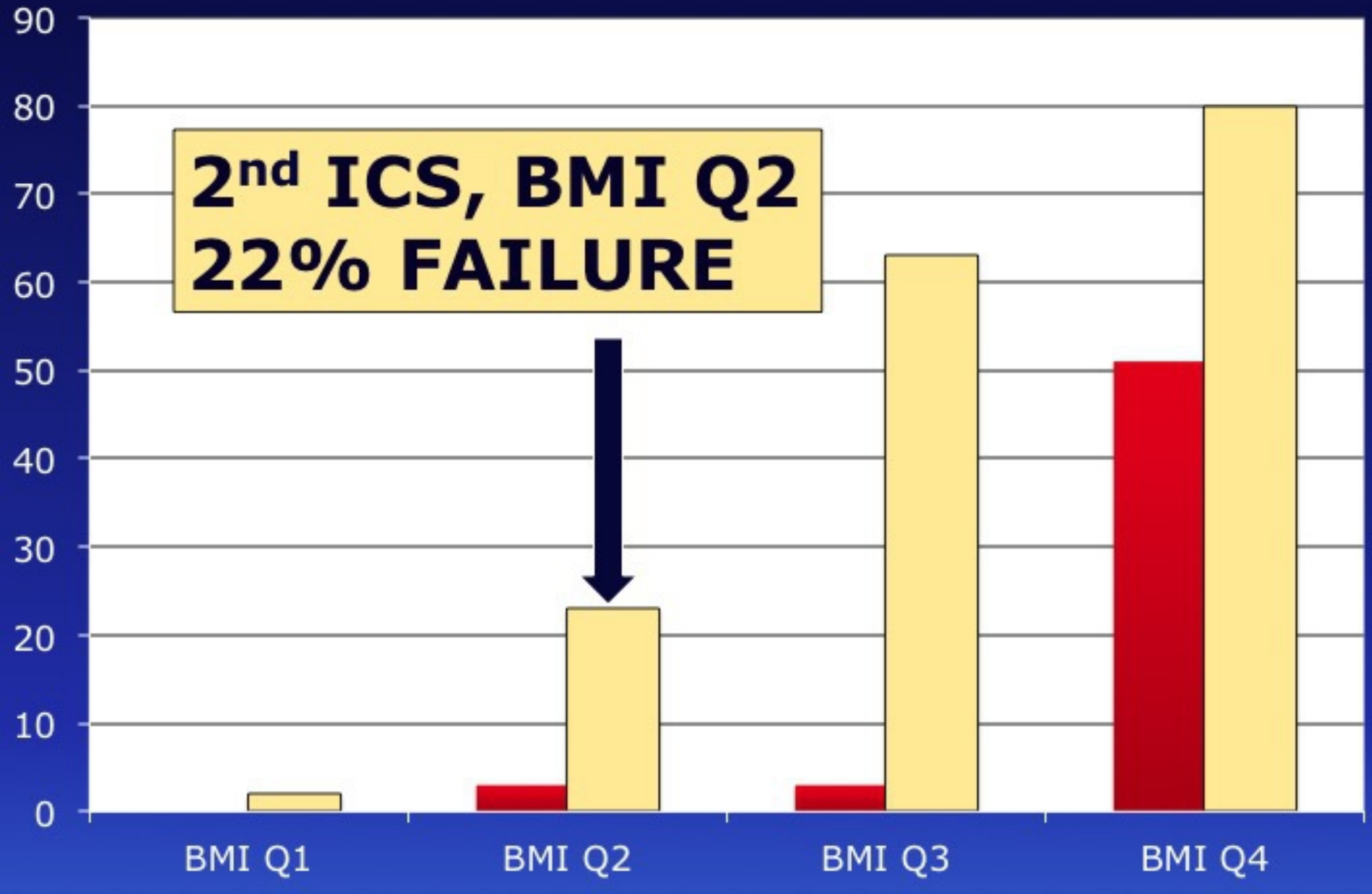
Aims

- ✓ Chest Wall thickness at each position?
- ✓ Could a standard 5cm needle penetrate the chest?

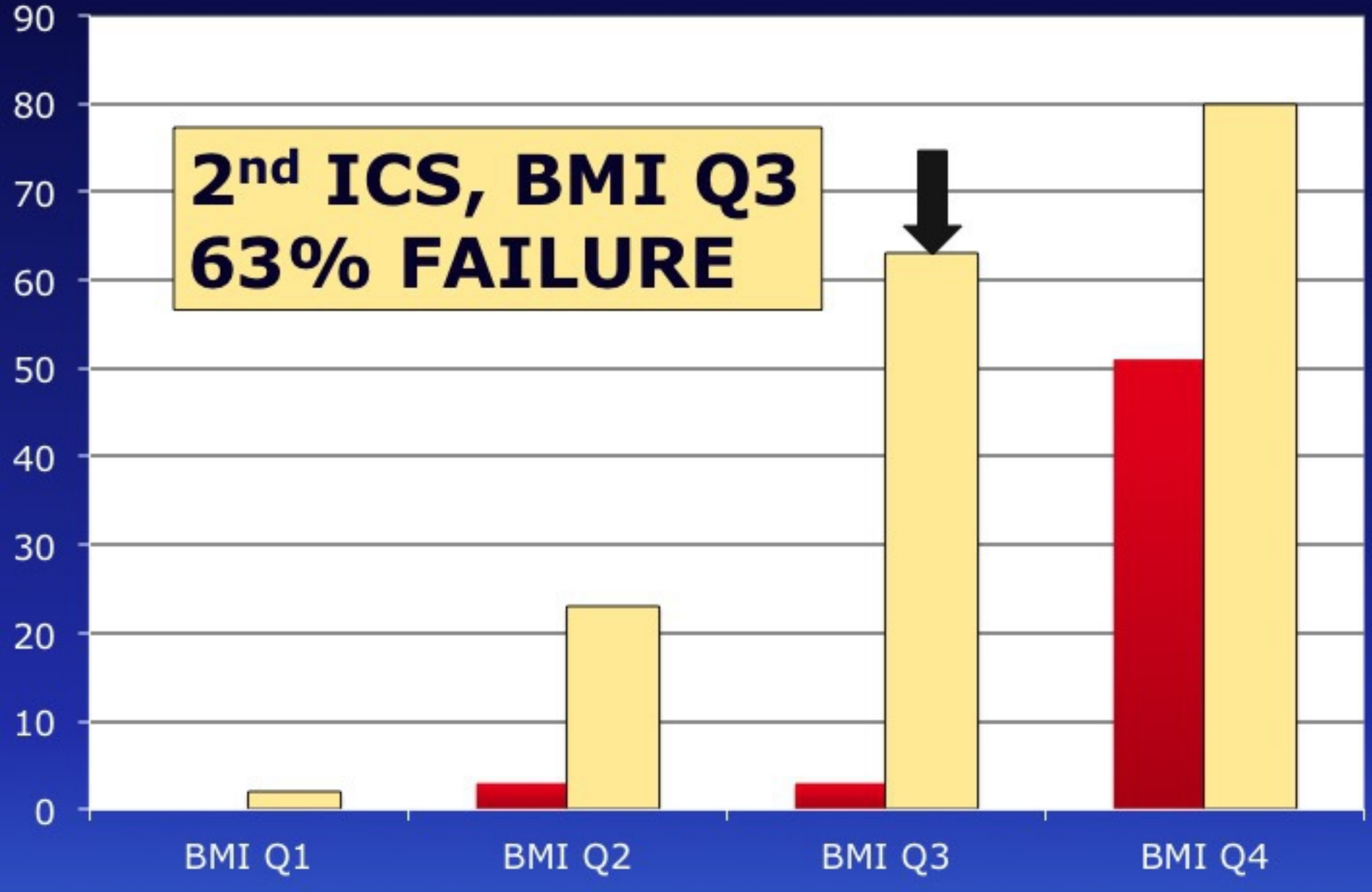
CHEST WALL THICKNESS



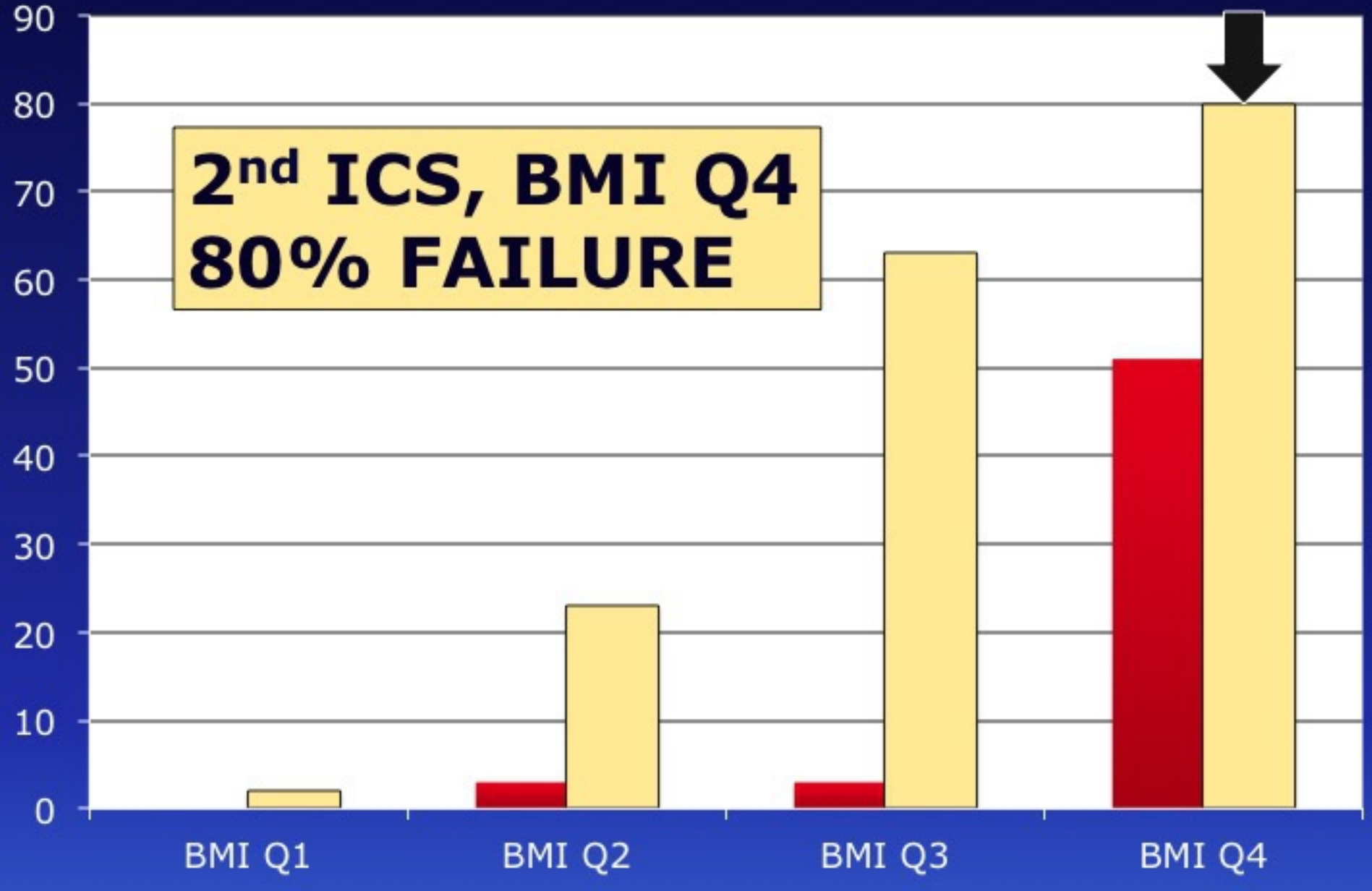
FAILED CHEST ENTRY BY BMI



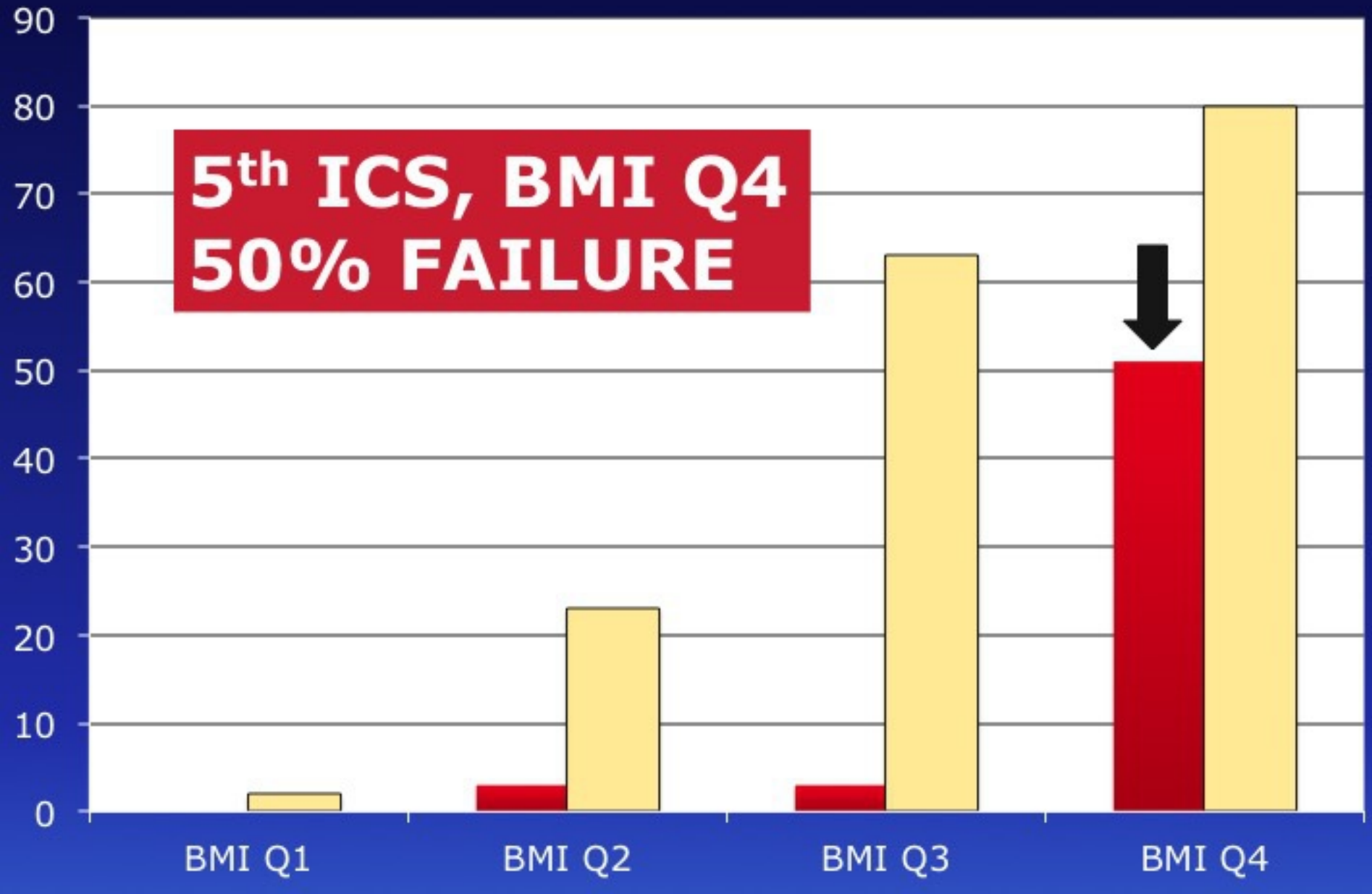
FAILED CHEST ENTRY BY BMI



FAILED CHEST ENTRY BY BMI



FAILED CHEST ENTRY BY BMI



SUMMARY

- Thickness of $2^{nd} > 5^{th}$
- Both R and L
- Worse as BMI increases
- At 2^{nd}, with eccentric placement, all but first quartile would fail
- At 5^{th}, decompression possible in all but last quartile

Studies

1. CADAVERIC MODEL
2. CT BASED HUMAN EVALUATION
3. EMS EVALUATION

The right place in the right space? Awareness of site for needle thoracocentesis

E P Ferrie, N Collum, S McGovern

2005

- ✓**25 EM physicians in Ireland**
- ✓**84% ATLS certified**
- ✓**Do they know where to Needle?**
- ✓**Can they find it on a live model?**

The right place in the right space? Awareness of site for needle thoracocentesis

E P Ferrie, N Collum, S McGovern

2005

- ✓88% named 2nd ICS MCL
- ✓Only 60% able to point out where this was on patient
- ✓4% pointed out 5th ICS AAL
- ✓8% wanted to needle abdomen below & lateral to xiphoid

EMS

- ✓ Ability of Navy corpsmen to place 2nd versus 5th needles
  - Accuracy
  - Time to decompression
  - Collateral damage

EMS

- ✓20 Corpsmen, 80 needles
- ✓25.5+/-3.9 years, 75% male
- ✓4.4+/-3.3 years experience
- ✓Half previous deployment

RESULTS

- ✓Time to insertion
- ✓Ease of localizing and inserting needle
- ✓Accuracy

RESULTS

- ✓ Time to needle placement
  - 15.3s v 16.1s, p=0.438
- ✓ Ease of finding position
  - 75% rated 5th easier, 15% the same, 10% as harder

ACCURACY

- ✓ Accuracy within a 10cm circle
  - 95.0% v 27.5%, $p<0.001$
- ✓ Aggregate distance from correct position
  - 1.5+/-1.6 v 3.5+/-1.6cm, $p<0.001$

Take Home Points

- ✓Indications for needle decompression not well delineated
- ✓If going to needle, know the following…

Take Home Points

- ✓Standard Angiocath <5cm
- ✓Chest wall 2nd ICS >5cm in 40-50%
- ✓Most in upper ¾ of BMIs cannot be decompressed with standard needle

Take Home Points

- ✓In controlled experiments, 60% will fail entry
- ✓R and L
- ✓Females > Males
- ✓Worse as BMI increases

Take Home Points

- ✓May not be in chest
- ✓If not responding, try again with a different angle
- ✓Especially for females or obese
- ✓May consider alternate positions