

# Point-of-Care Ultrasound in the Inpatient Setting: A Case-Based Introduction

Learning POCUS isn't ascariasis seems!



Chaurasia & Boi, *NEJM* 2020

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# The New York Times

## *Ebola's Mystery: One Boy Lives, Another Dies*

Nov. 9, 2014

Over and over, doctors here have been confounded by the divergent paths of patients whose cases appeared similar at first. “No matter how long we were there, we didn’t know how to predict it,” said Dr. Steve Whiteley, a California emergency physician who volunteered.

The answers are hard to come by. In the absence of much lab testing and research, the disease seems heartbreakingly random.

## *Ebola Doctors Are Divided on IV Therapy in Africa*

Jan. 1, 2015

Some argue that more aggressive treatment with IV fluids is medically possible and a moral obligation. But others counsel caution, saying that pushing too hard would put overworked doctors and nurses in danger and that the treatment, if given carelessly, could even kill patients.

Asked Dr. Paul Farmer, “What if Ebola’s case fatality rate isn’t due to the virulence of the disease alone, but to the mediocrity of our medical care delivery?”

# Outline

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1. Goals of today's conference
2. Overview of POCUS applications in internal medicine
3. Mini-case 1 / how-to (basic abdominal ultrasound)
4. Mini-case 2 / how-to (USGPIV and basic echocardiography)
5. Mini-case 3 / how-to (Code Blue)
6. Resources and next steps

# Rationale for Using Point-of-Care Ultrasound

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- Complement the physical exam with rapid focused imaging
- Extend the reach and availability of imaging
  - Overnight, on the weekend, during a holiday, during a pandemic
  - Imaging when your patient can't move and time is short (RRT, code)
  - Imaging when other diagnostics aren't available (rural setting, in-flight)
  - Serial reassessments in a rapidly changing situation
- Engage learners (supercharge physiology/pathophysiology teaching)
- Engage patients (confer a sense of participation/ownership)
- Improve the safety and efficiency of common bedside procedures in IM

# Pitfalls of Relying on POCUS as a Trainee

- Limited training on image acquisition techniques
- Limited availability of DOM faculty qualified to review your scans
- Risk of missing important findings that **were** present
- Risk of incorrect identification of findings that were **not** present
- Risk of distracting from other essential parts of care (ie compressions)
- Risk of patients mistaking a basic bedside exam for a formal study
  - Importance of brief but clear verbal consent process
- Risk of spreading nosocomial infections
  - Only **orange-top Sani-Cloth bleach** wipes kill *C. difficile* spores!



# POCUS Devices Available to You During BWH Residency



## SonoSite X-Porte

\$20,000+

Best resolution

Least portable

Can save images to Epic

**Procedure**

OVERVIEW REPORT Overview

UNIVERSITY OF CHICAGO

Time **1**

CENTRAL CHECKLIST

Central Line Che...

BEDSIDE PROCEDURES

Procedure Notes

**Procedure Notes**

+ Create Note

All Procedure Notes

Author	Service	Author Type	Cosign
Interface Provider, Scanning		Generic Provider	

Tag Copy

Click “Procedure” tab, then “Procedure Notes”, then “Bedside Ultrasound”

**Bedside Ultrasound** Performed by: Nutt, Cameron Taylor, MD  
Authorized by: Nutt, Cameron Taylor, MD

Providers Remove

Bedside Ultrasound Procedure Documentation

Procedure name: Bedside Ultrasound

Procedure date and time: 12/19/2023 12:39 PM Now

Note: choose all exams performed first, then document.

Exam Type

Abdomen	Cardiac	Aorta
Thoracic	Pelvis	Renal
Bladder Scan	Biliary	GI
DVT	Soft Tissue	Musculoskeletal
Ocular	Testicular	Procedural Guidance
TEE		

**Procedures**

Bedside Ultrasound

Date/Time: 12/19/2023 12:39 PM

Performed by: Nutt, Cameron Taylor, MD  
Authorized by: Nutt, Cameron Taylor, MD Accession Number: E41482806

Pend a “Bedside Ultrasound” Procedure Note (can be blank)

Pend Share Sign Cancel

**3**



At the machine, click “Enter,” then “Query” or “Worklist” to find your patient and start scanning / saving clips

# POCUS Devices Available to You During BWH Residency



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\$5,000+ per probe

Great quality TTEs

DOM only has cardiac probes

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 Overview

UNIVER  
 Time

CENTRAL  
 CHECKLIST  
 Central Line Che...

BEDSIDE PROCEDURES  
 Procedure Notes

**Procedure Notes**

+ Create Note

Same initial step as SonoSite

All Procedure Notes

Author	Service	Author Type	Cosign
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Tag Copy

**Procedures**

Select Procedures

New Procedure

Performing provider: Nutt, Cameron Taylor, MD

Authorizing provider: Nutt, Cameron Taylor, MD

Procedures

Stimulated Intrauteri...	Lumbar Puncture	Embryo Transfer, Intr...
A...	Arterial Line	Aspiration/Injection J...
B...	Biopsy	Skin / nail biopsy
Blado...	Bronchoscopy	Cardiac Pacemaker ...
Central Line	Chest Tube Insertion	Epistaxis Control
Esophageal Balloon ...	Foreign Body Removal	Gastrostomy Tube C...
Incision and Drainage	Cardio	

Current Orders

+ Insert Peripheral IV c

Name

Cardiothoracic Point of Care US [US.CARDTHORAC]

Manually type “Cardiothoracic Point of Care Ultrasound” in the “More Procedures” search bar, then pend that Procedure Note (can be blank)

3



At the device, click “Create Patient,” then “Worklist” to find your patient and start scanning / saving clips



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## **Butterfly iQ**

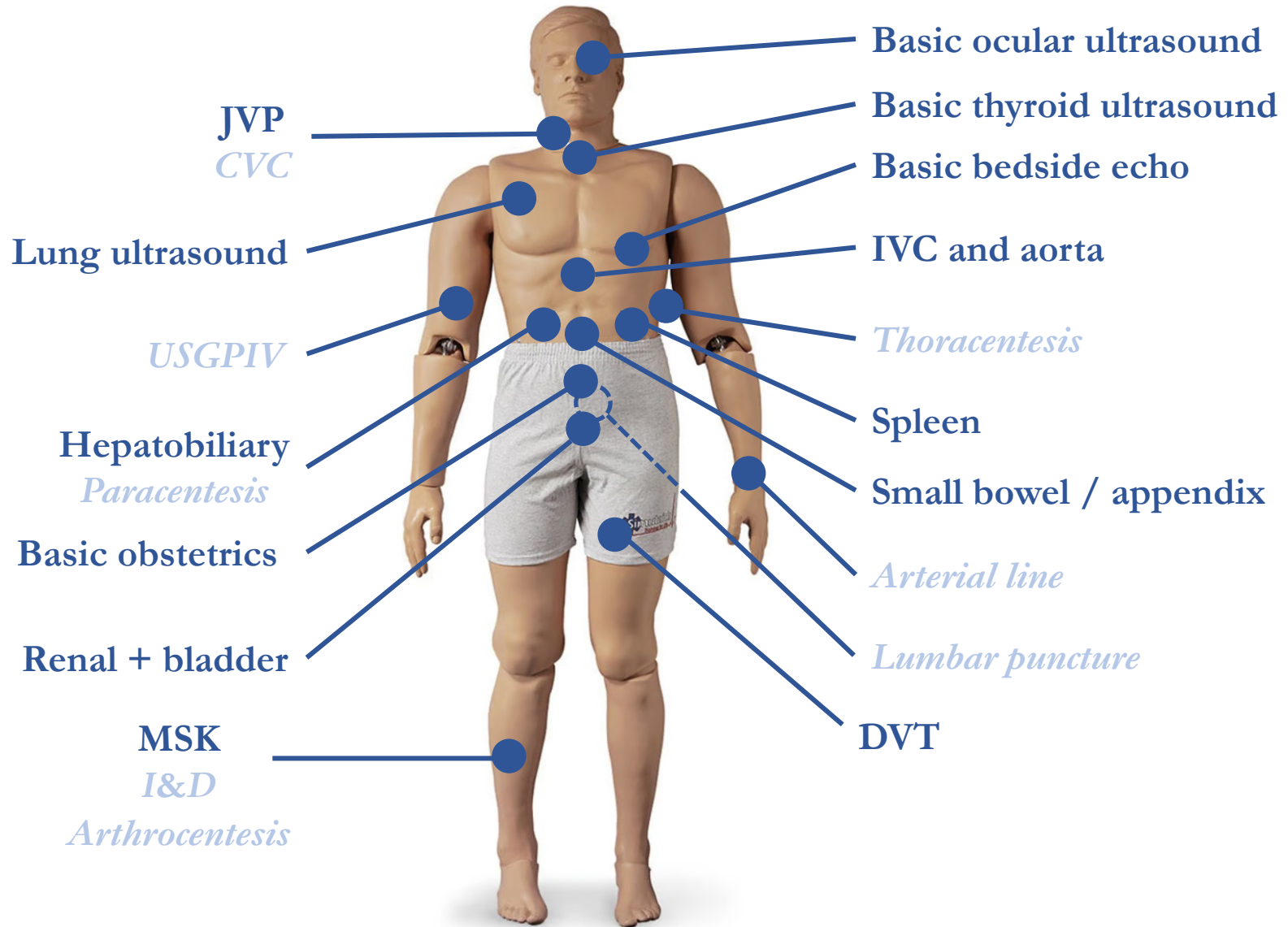
\$2,000+ for hybrid probe

Lowest resolution

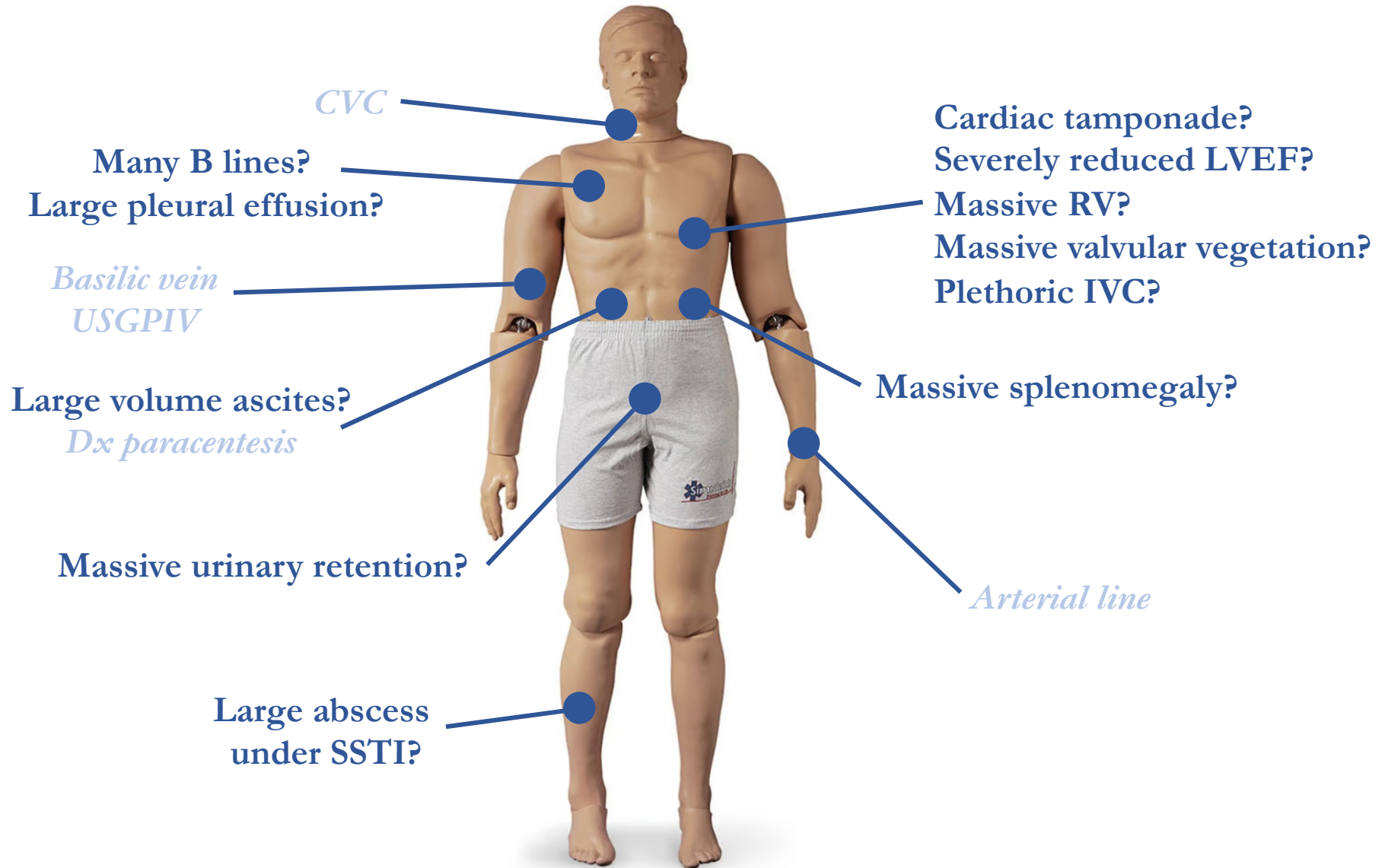
Most portable

Cannot save images to Epic

# Menu of POCUS Applications in Internal Medicine



# Realistic/Useful POCUS Applications as a Medicine Resident



**Mini-Case #1**

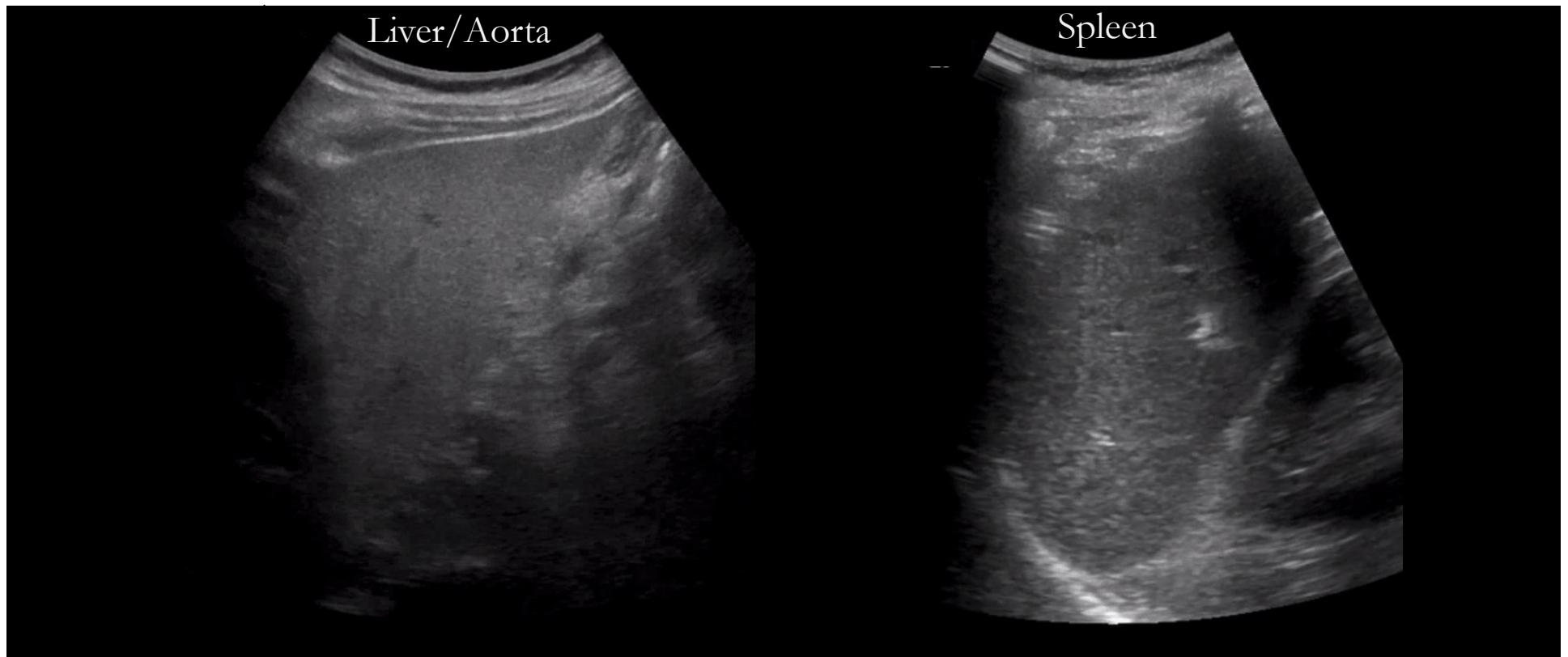


## Case #1: 63M with advanced HIV disease and subacute abdominal pain

- Clinical vignette:
  - HIV dx 10 years prior after immigration from Brazil; off ART for past 5 years
  - HIV-1 viral load 2 million copies/mL; CD4 93 cells/mm<sup>3</sup>
  - Acute onset of RLQ and epigastric pain while moving furniture 1 week ago
  - CXR unremarkable but CT A/P abnormal; plan to admit to medicine
  - You perform a basic bedside abdominal ultrasound

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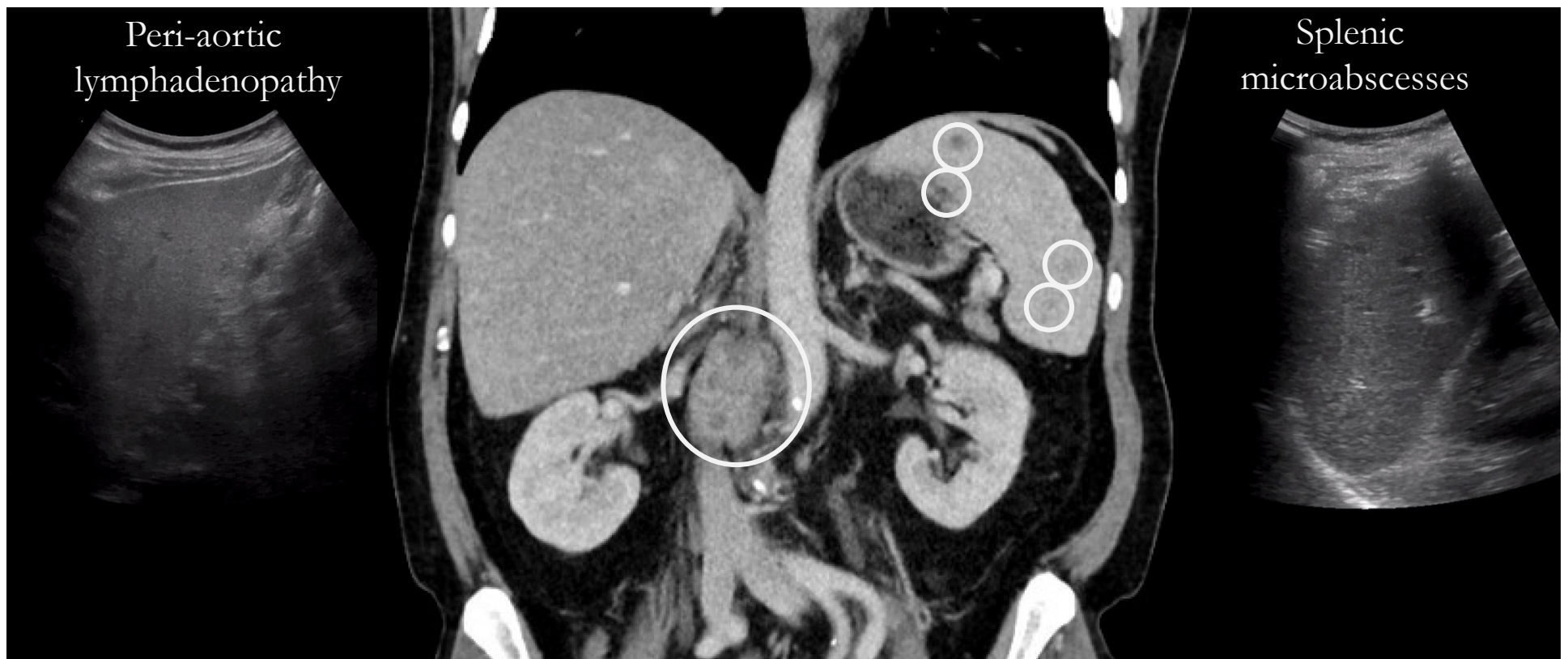
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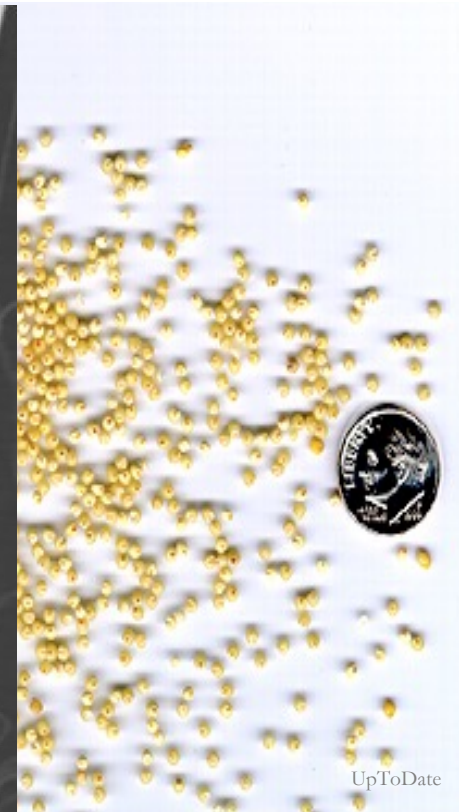
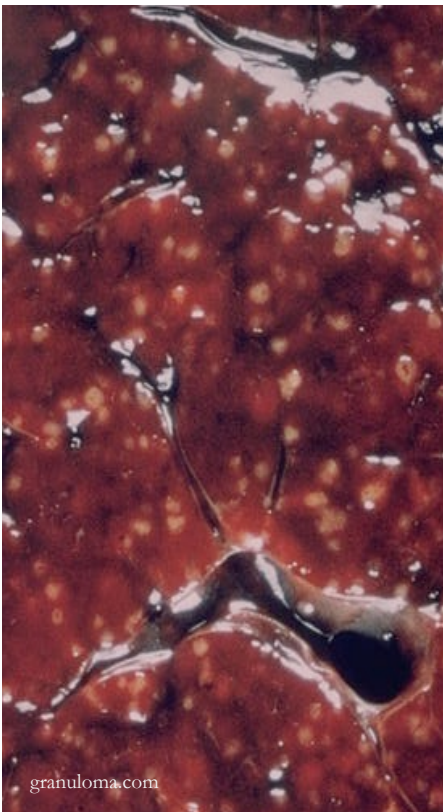
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  - You perform a basic bedside abdominal ultrasound and see signs of disseminated TB



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  - CXR unremarkable but CT A/P abnormal; plan to admit to medicine
  - You perform a basic bedside abdominal ultrasound and see signs of disseminated TB
  - Empiric RIPE started on arrival to medicine floor (no known exposure to MDR-TB)
  - Five days later, an abdominal lymph node biopsy is performed by IR
  - Two days after that, AFB stain is positive
  - Three weeks after that, mycobacterial cultures grow *M. tuberculosis*

Specimen Source/ Description	FLUID
Special Requests	LYMPH NODE Comment: BIOPSY IR ASPIRATE
SMEAR	ACID FAST BACILLI OBSERVED !
SMEAR	(NOTE) Method: Fluorochrome (250x): Acid-fast bacilli found, 1-10 per field.
Culture/Test	Performed at STATE LAB, MA Dept of Public Health, 305 South Street, Jamaica Plain, MA 02130 MYCOBACTERIUM TUBERCULOSIS COMPLEX !

# The Focused Assessment with Sonography in HIV/TB (FASH)

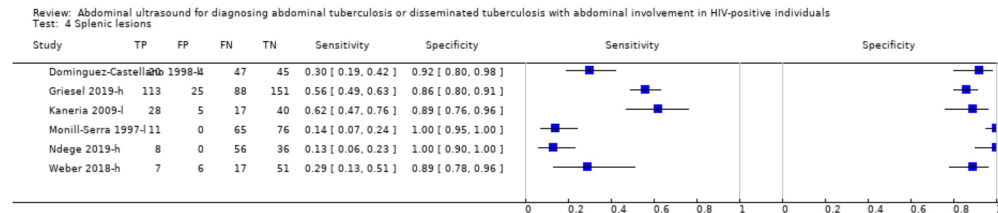
[Diagnostic Test Accuracy Review]

## Abdominal ultrasound for diagnosing abdominal tuberculosis or disseminated tuberculosis with abdominal involvement in HIV-positive individuals

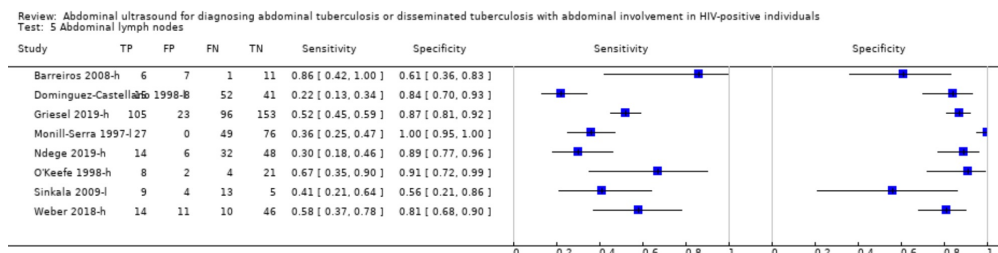
Daniel J Van Hoving<sup>1</sup>, Rulan Griesel<sup>2</sup>, Graeme Meintjes<sup>3</sup>, Yemisi Takwoingi<sup>4</sup>, Gary Maartens<sup>2</sup>, Eleanor A Ochodo<sup>5</sup>

“In HIV-positive individuals thought to have abdominal TB or disseminated TB with abdominal involvement, abdominal ultrasound appears to have **63% sensitivity** and **68% specificity** when TB was bacteriologically confirmed.”

### Test 4. Splenic lesions.



### Test 5. Abdominal lymph nodes.



The presence of **BOTH** splenic micro-abscesses and para-aortic lymphadenopathy is highly specific for disseminated TB in AIDS patients across studies (if insensitive).

# How-To: Basic Bedside Abdominal Ultrasound

- Best online resource: **POCUS 101** [abdominal ultrasound guide](#) and videos:
  - [Basic liver ultrasound video](#)
  - [Basic spleen ultrasound video](#)

## Liver

+R pleural space

+R kidney



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## Liver

+Gallbladder

+Aorta / IVC



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### **Spleen**

- +L pleural space
- +L kidney

**Mini-Case #2**



Photo by Sean McGrath



## Case #2: 36M with IVDU (on methadone) and high-grade MRSA bacteremia

- Clinical vignette:
  - Presented 4 days earlier with fevers; patient-directed discharge occurred in <24 hours
  - Blood cultures later grew multiple isolates of MRSA (6/4 bottles!?), and he agreed to re-present for care but only via direct admission, bypassing ED
  - On arrival to floor overnight, has persistent high fevers with tenuous HR and BPs
  - Initial nursing attempts at IV placement unsuccessful

Blood culture, routine [1119447725] (Abnormal) Blood RIGHT~ARM~SET1	Final result	Component Special Requests BLOOD CULTURE	Value No Special Requests Aerobic and Anaerobic bottles: STAPHYLOCOCCUS AUREUS SEE LATER CULTURE FOR SENSITIVITIES ! RESULT CALLED TO CARE UNIT AND/OR MD ON 1/4/23 ! Aerobic bottle: STAPHYLOCOCCUS AUREUS of a second type SEE LATER CULTURE FOR SENSITIVITIES ! NOTE: Staphylococcus aureus bacteremia is a serious infection and should not be regarded as a contaminant. Standard therapy for adult patients is 4-6 weeks of an effective IV antibiotic, along with a thorough search for the source and complications of bacteremia. ID consultation should be strongly considered. !
Blood culture, routine [1119447727] 🗑️ (Abnormal) Blood RA SET2	Edited Result - FINAL	Component Special Requests BLOOD CULTURE	Value No Special Requests Aerobic and Anaerobic bottles: STAPHYLOCOCCUS AUREUS ! Aerobic and Anaerobic bottles: STAPHYLOCOCCUS AUREUS of a second type ! Anaerobic bottle: STAPHYLOCOCCUS AUREUS of a third type ! NOTE: Staphylococcus aureus bacteremia is a serious infection and should not be regarded as a contaminant. Standard therapy for adult patients is 4-6 weeks of an effective IV antibiotic, along with a thorough search for the source and complications of bacteremia. ID consultation should be strongly considered. ! RESULT CALLED TO CARE UNIT AND/OR MD ON 1/4/23 !

### Susceptibility

.Comment	Staphylococcus aureus (1)		Staphylococcus aureus (2)		Staphylococcus aureus (3)	
	SEE NOTES	Note 1	SEE NOTES	Note 1	SEE NOTES	Note 1
Clindamycin	0.25	Susceptible	0.25	Susceptible	0.25	Susceptible
Daptomycin	1	Susceptible	1	Susceptible	1	Susceptible
Doxycycline	<=0.5	Susceptible	<=0.5	Susceptible	<=0.5	Susceptible
Erythromycin	0.5	Susceptible	0.5	Susceptible	<=0.25	Susceptible
Gentamicin	<=0.5	Susceptible	<=0.5	Susceptible	<=0.5	Susceptible
Oxacillin(methicillin)	>=4	Resistant	>=4	Resistant	>=4	Resistant

## Case #2: 36M with IVDU (on methadone) and high-grade MRSA bacteremia

- Clinical vignette:
  - Overnight IV nursing team recommends CVC, which patient declines
  - Medicine resident pages ID to ask about oral antibiotic options, as the patient is planning to leave the hospital
  - You review his medications and see that his methadone dose is 115mg PO Q24H and that he is also prescribed an SSRI (relative contra-indication to linezolid)

Registered Nurse  
IV Therapy

Addendum

IV team consulted for ultrasound guided PIV placement. Forearms have no visible, palpable veins of quality at this time. Left arm is being saved for fistula. To avoid thrombotic complications left forearm is not assessed at this time with ultrasound. Right forearm is assessed, with the only compressable vessel being an accessory cephalic. One attempt was made, vessel difficult to cannulate despite compressability. Patient stating several times I hate this, take it out. Procedure aborted. Bedside RN present and aware as was renal fellow. At this time, patient does not appear to have vasculature that will tolerate antibiotic therapy. A left IJ would be the recommended line for this patient to insure safe, reliable access.



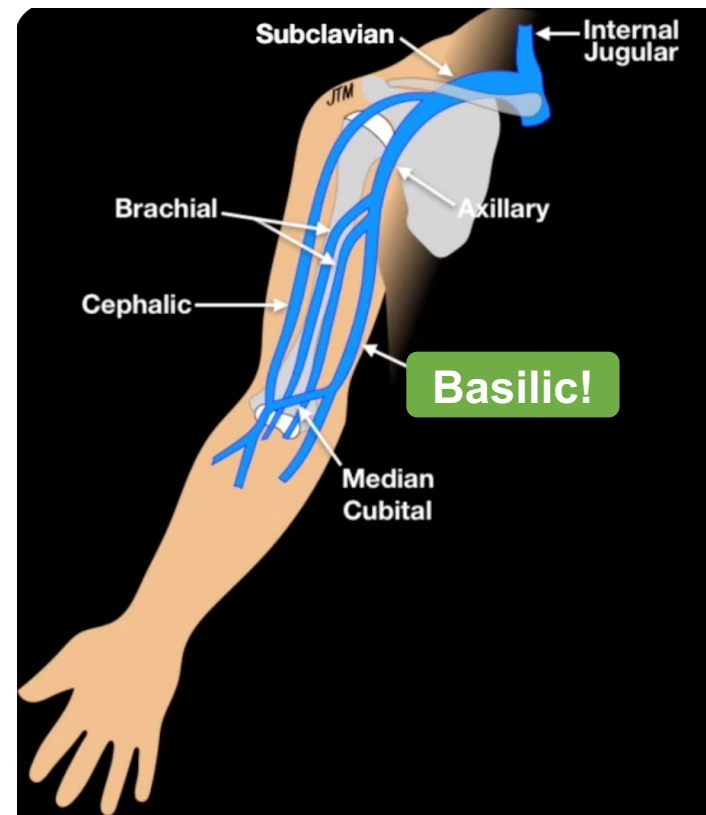
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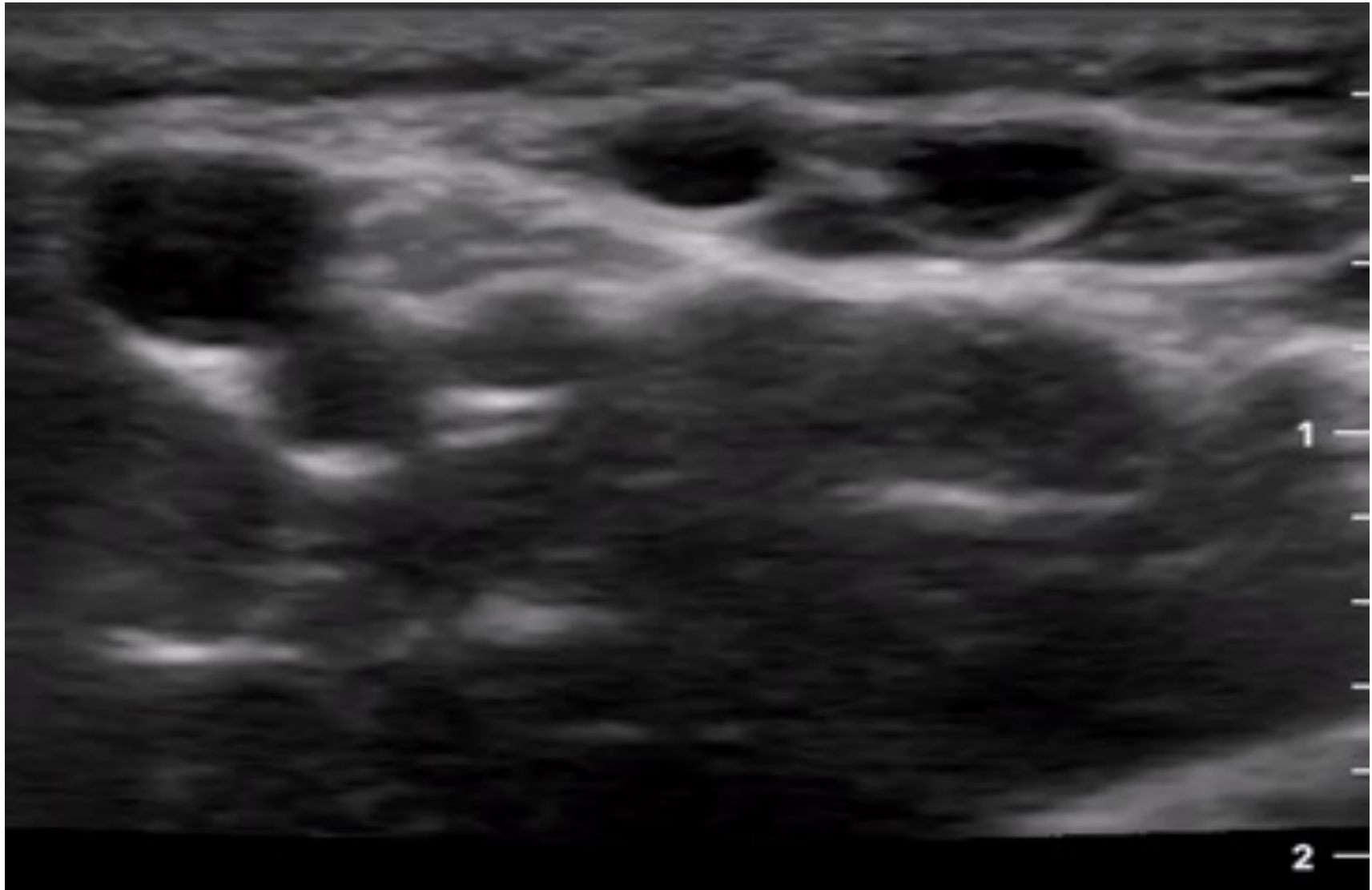


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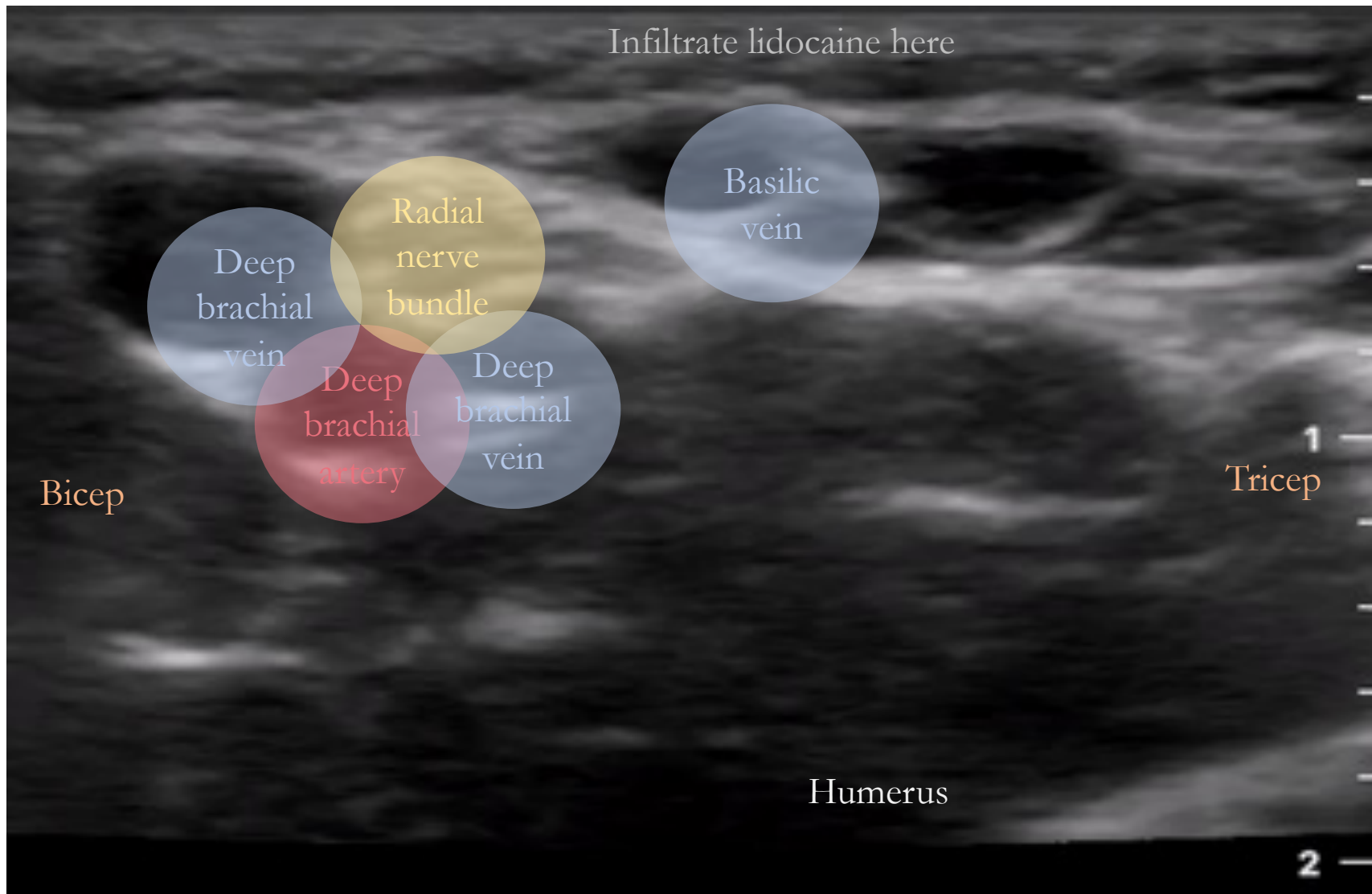
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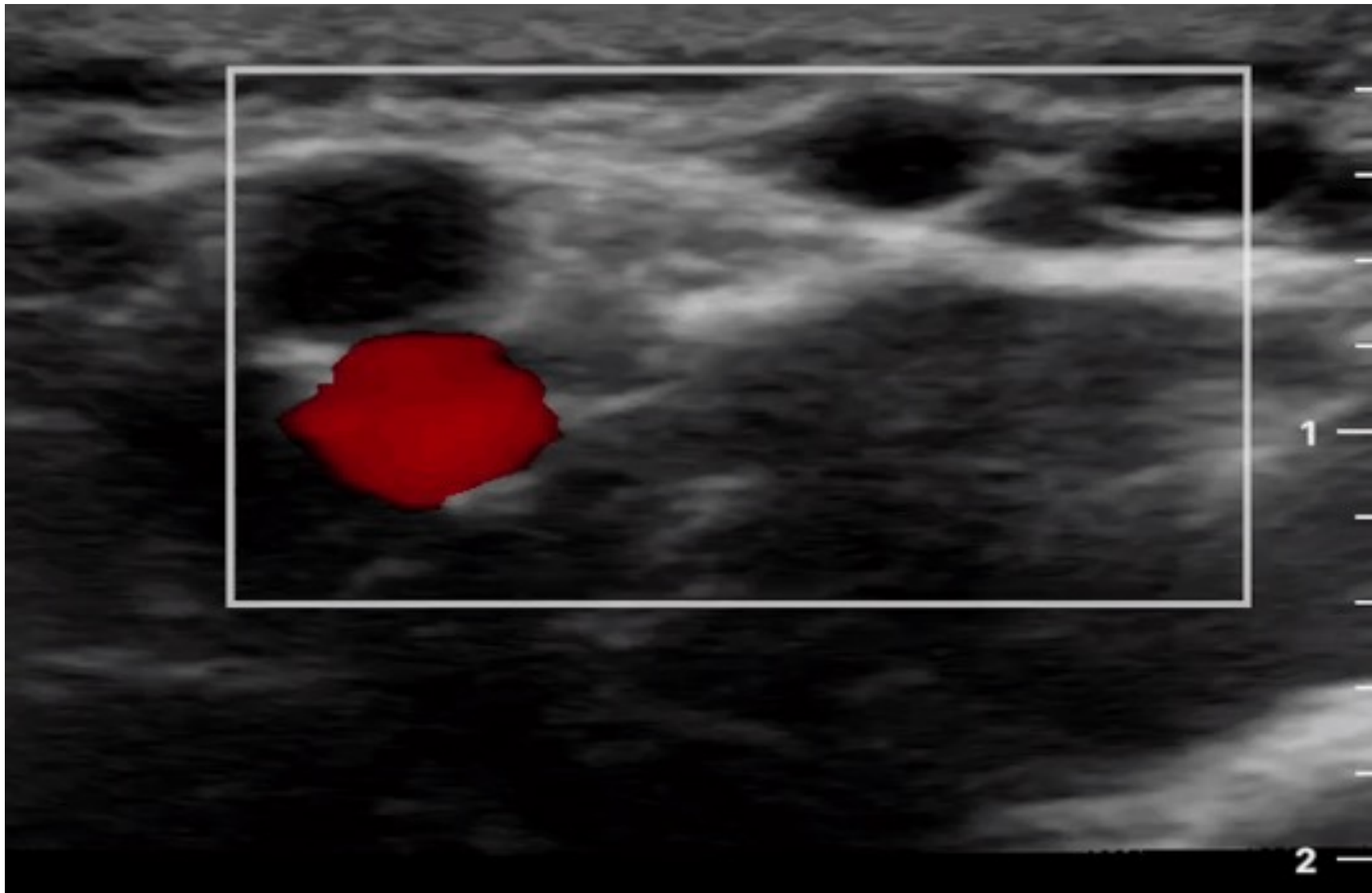
## Case #2 How-To: Basilic Vein USGPIV



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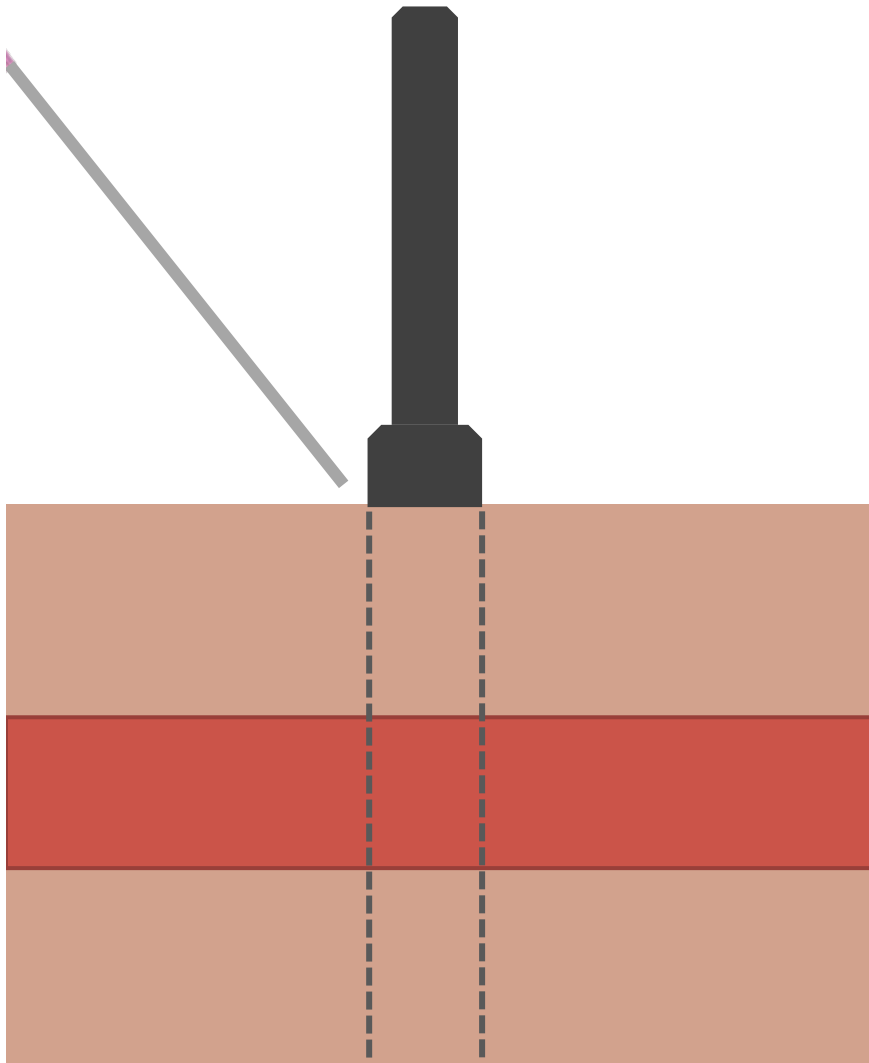


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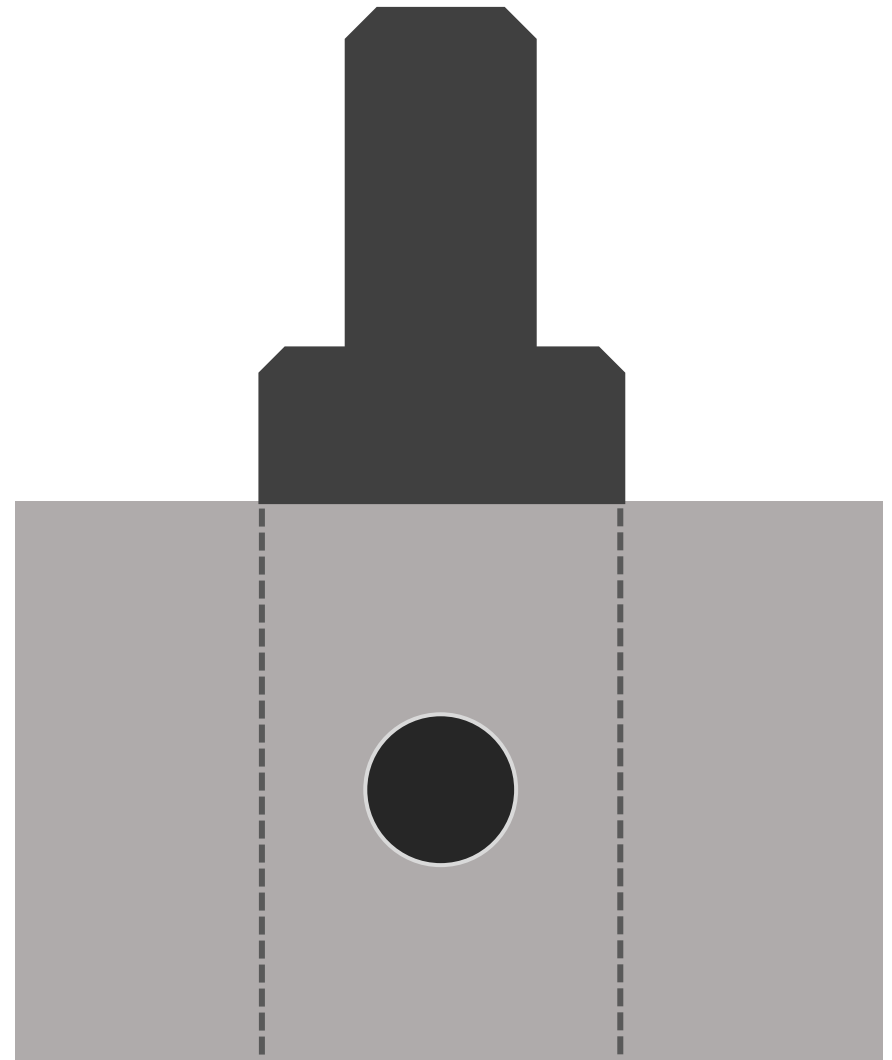


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What's happening



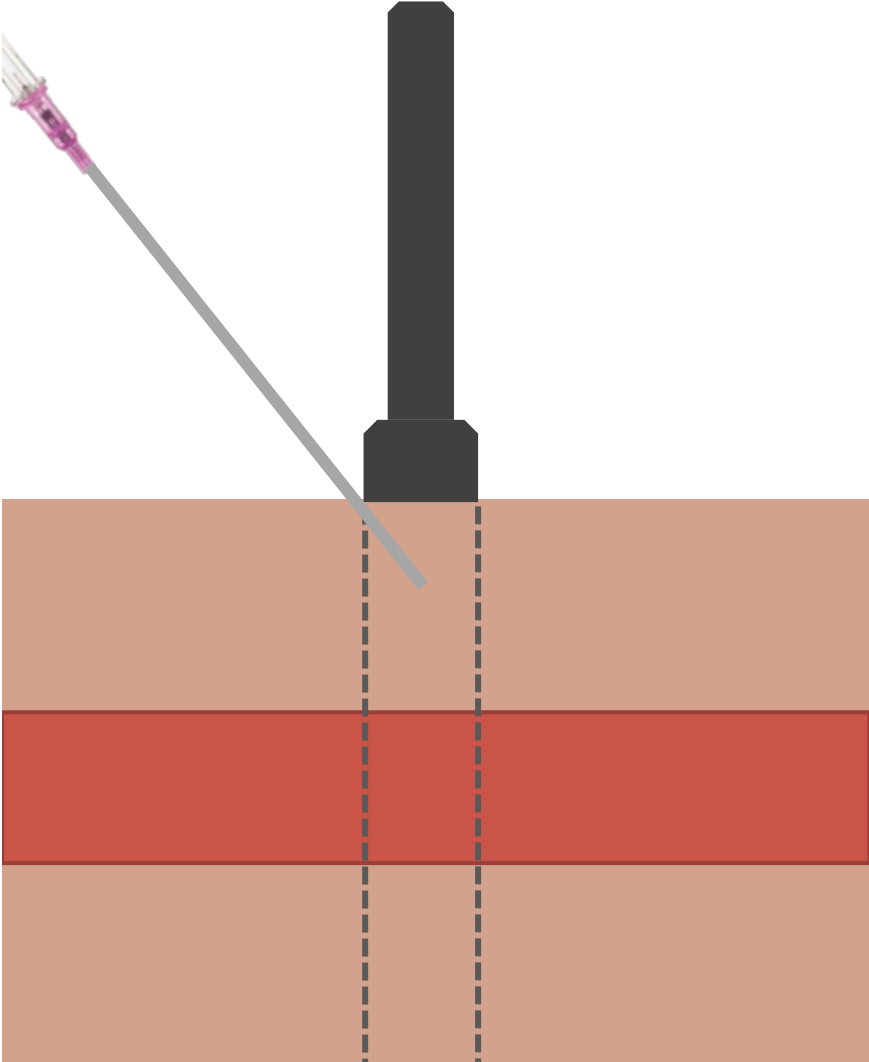
What you see  
(transverse view)



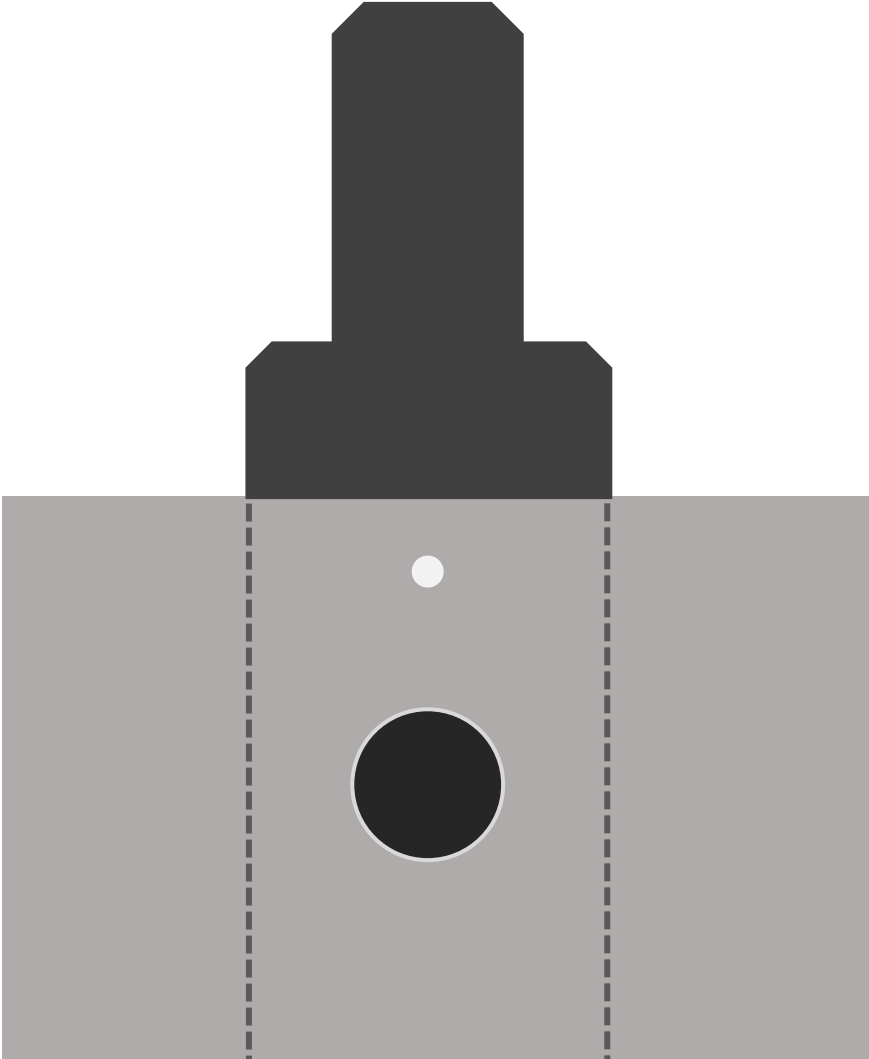


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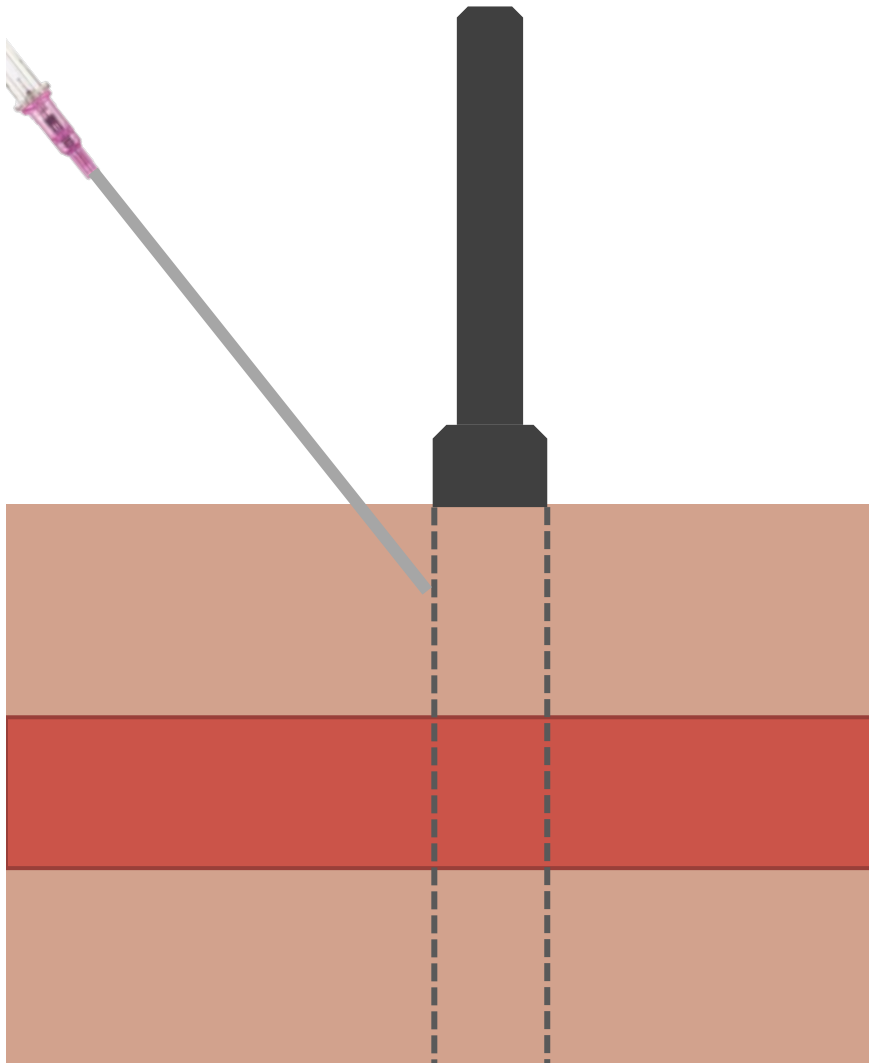


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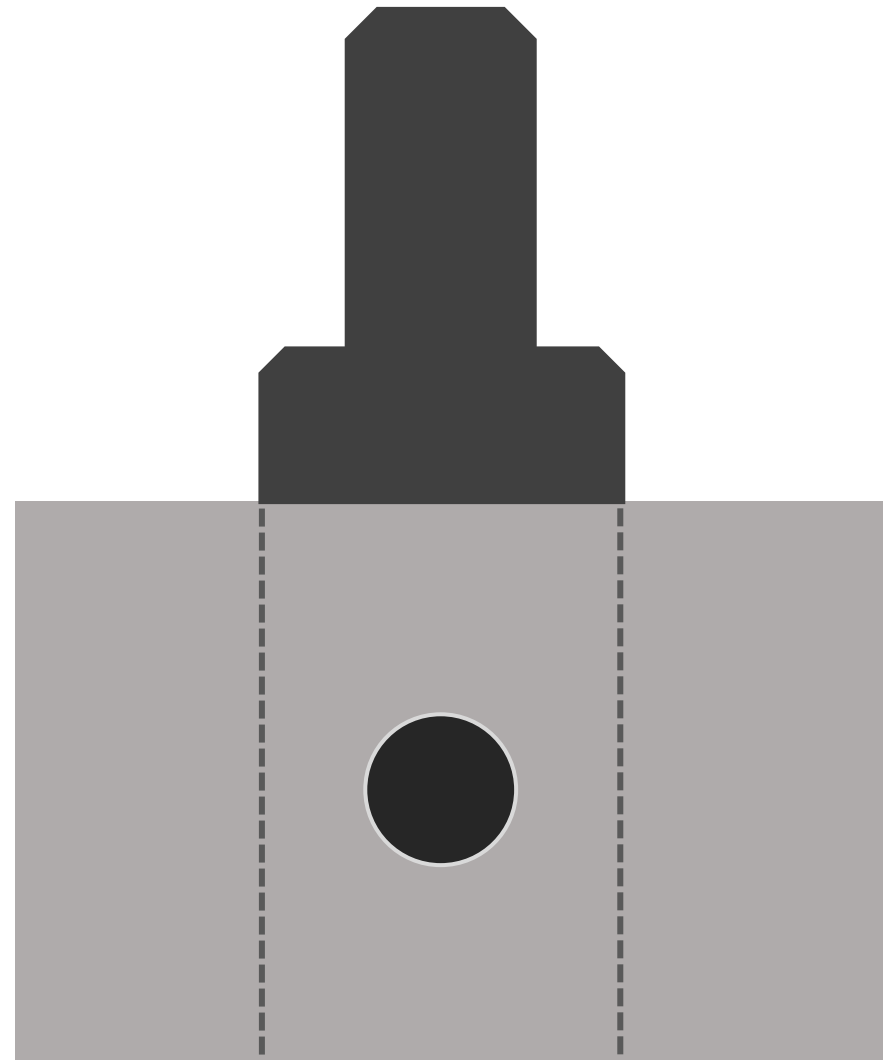


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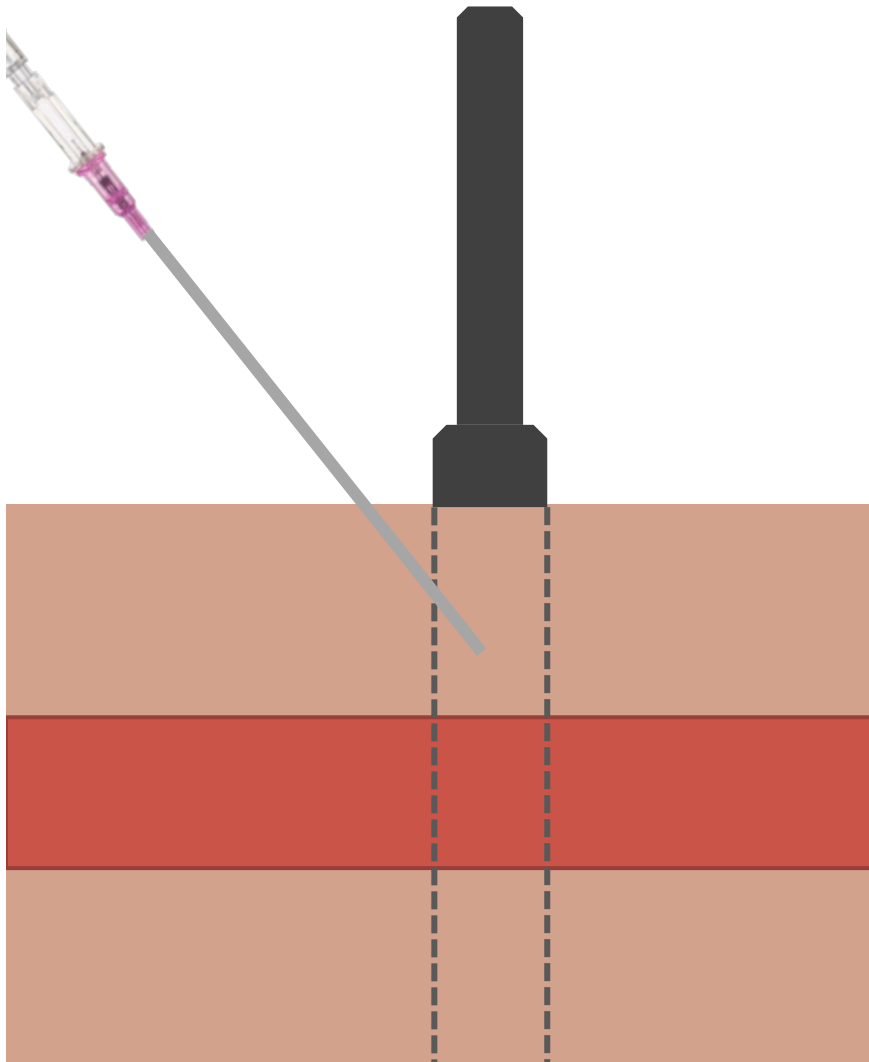


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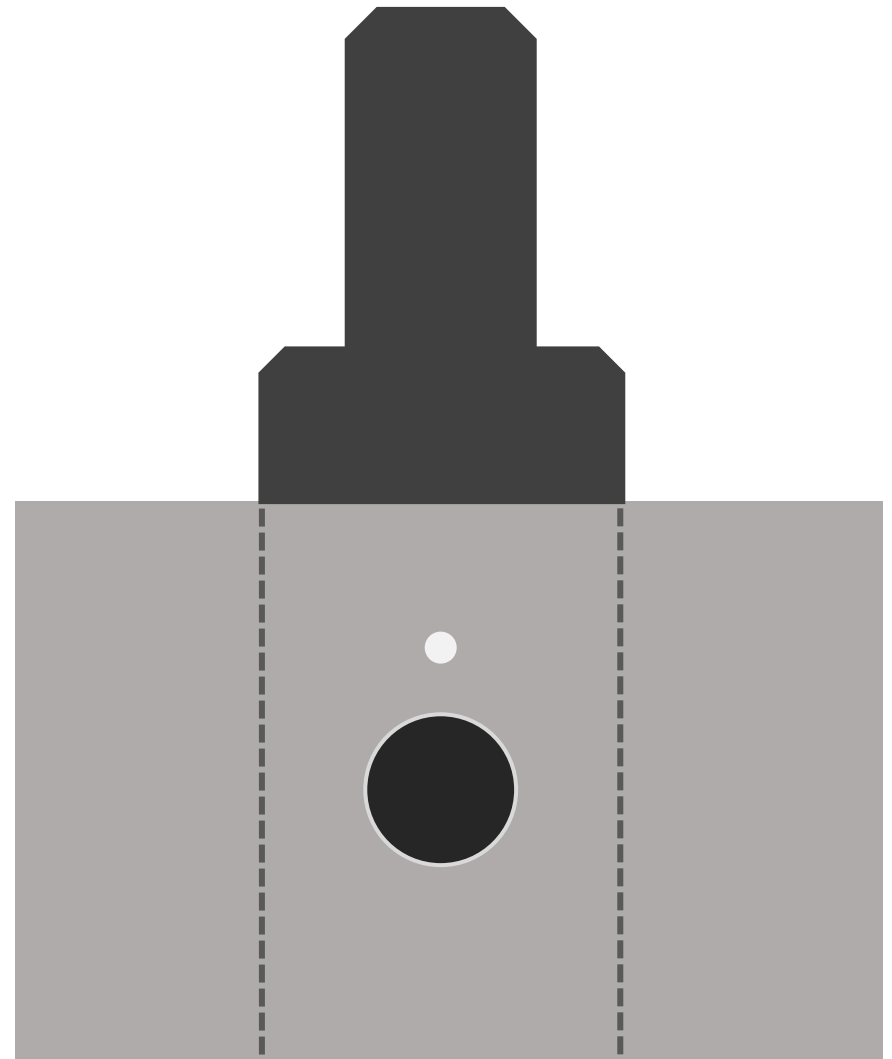


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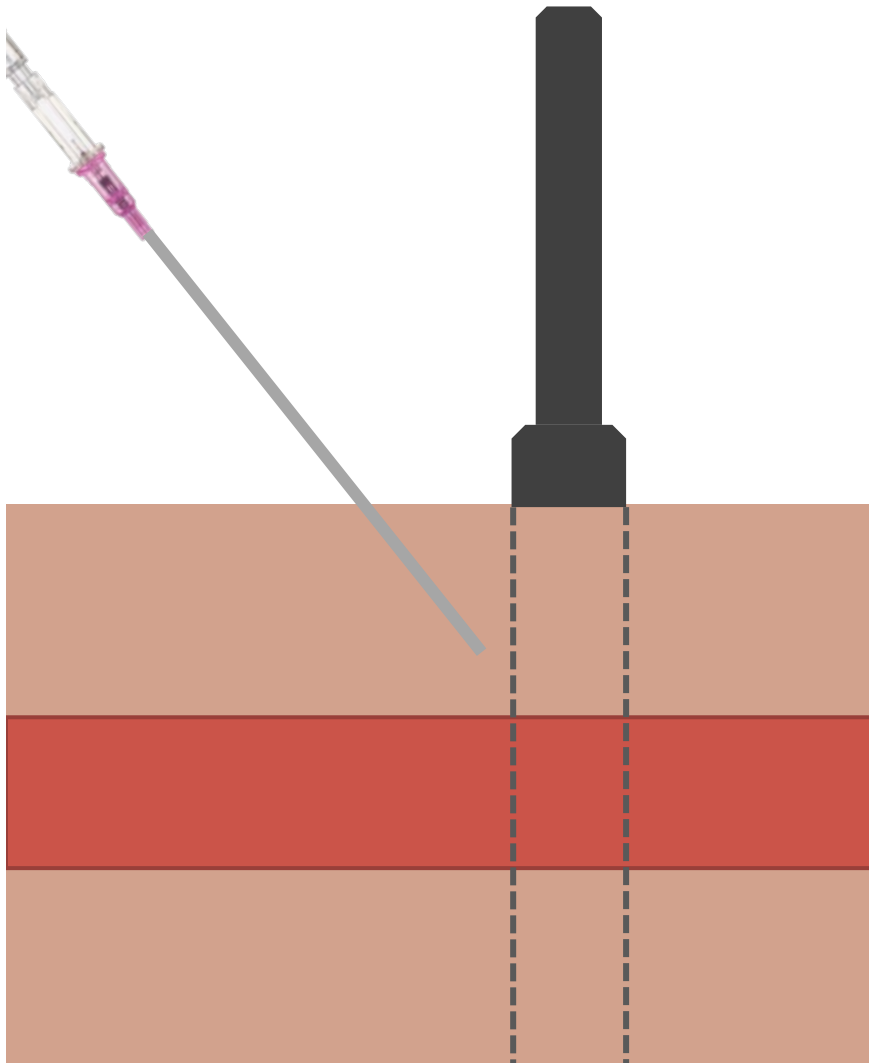


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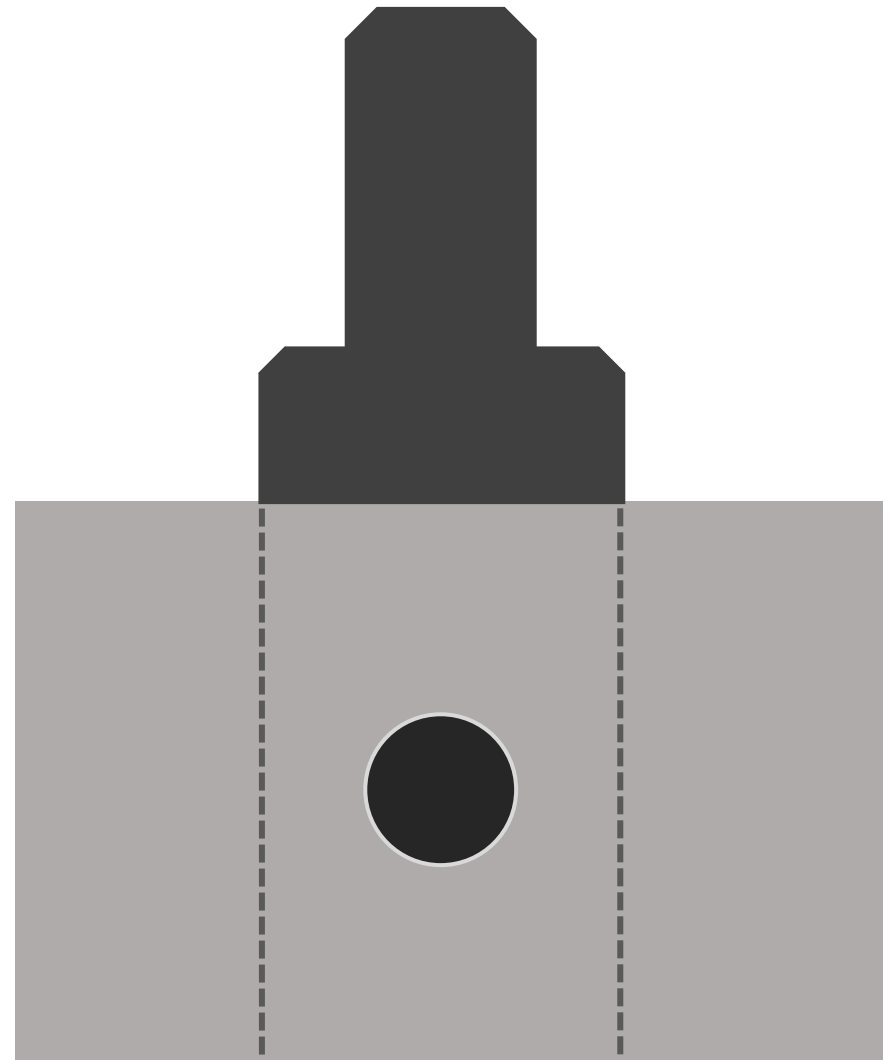


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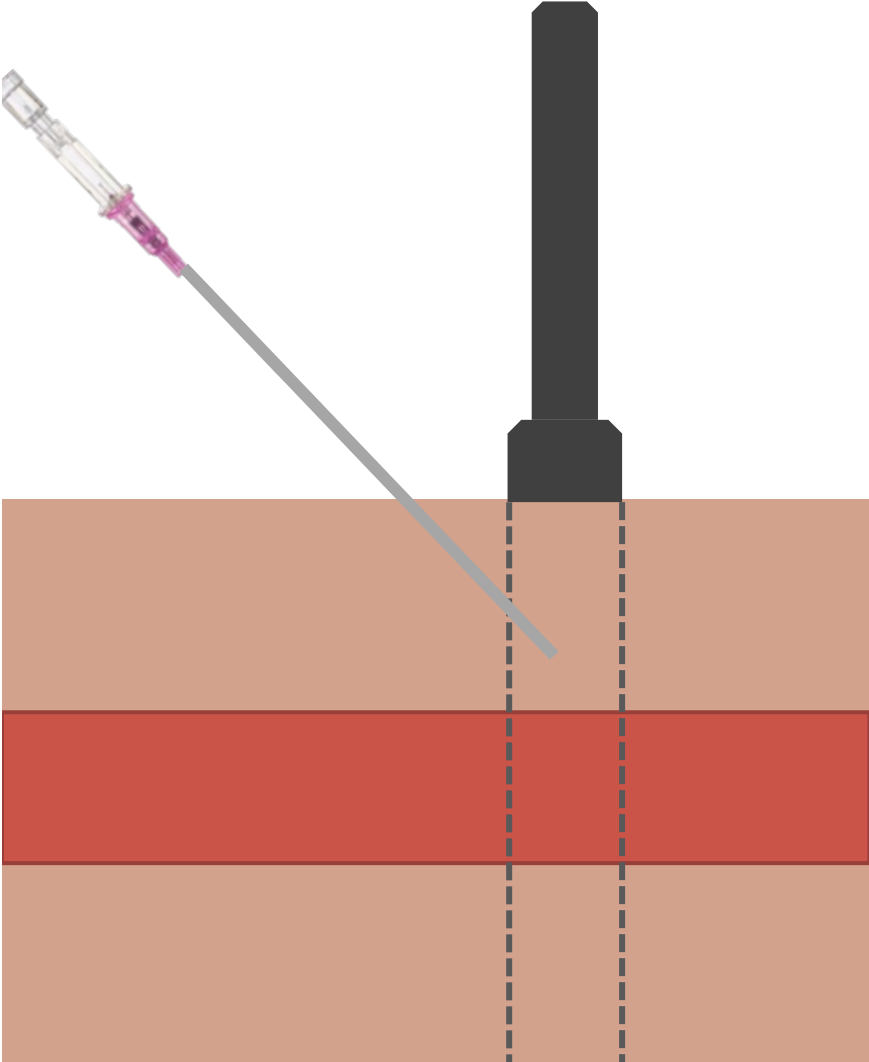


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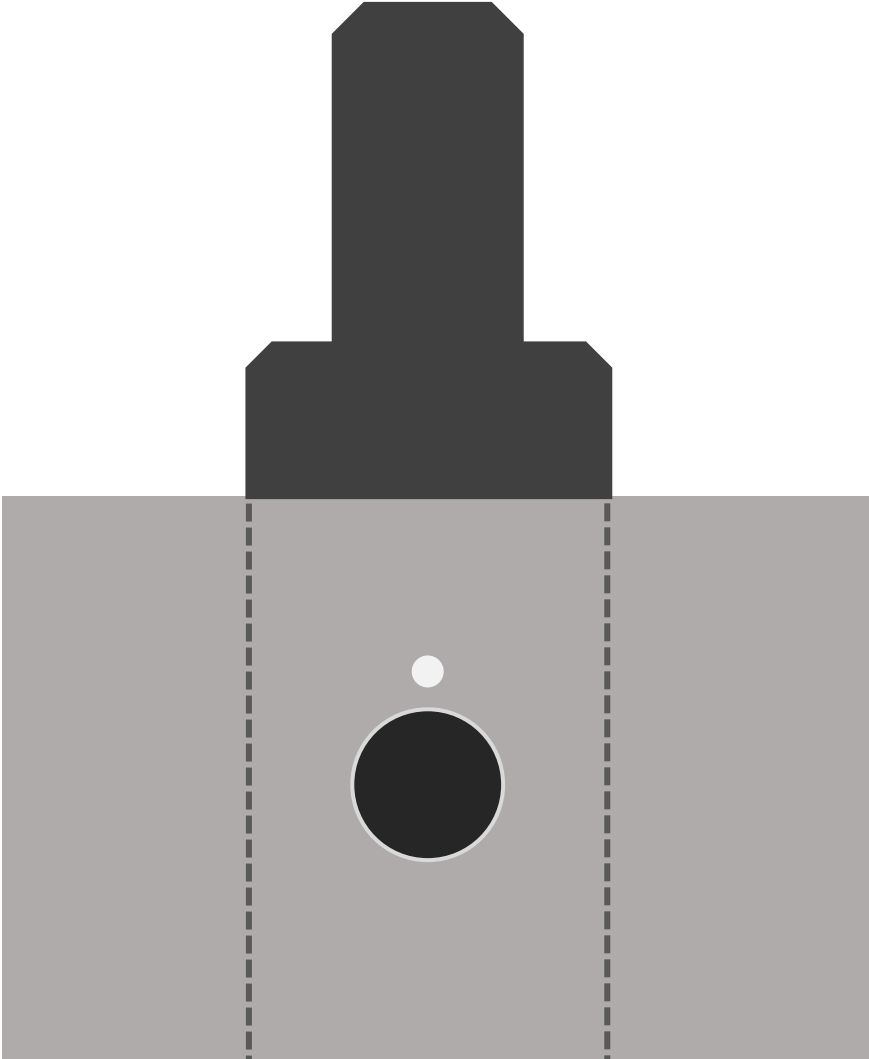


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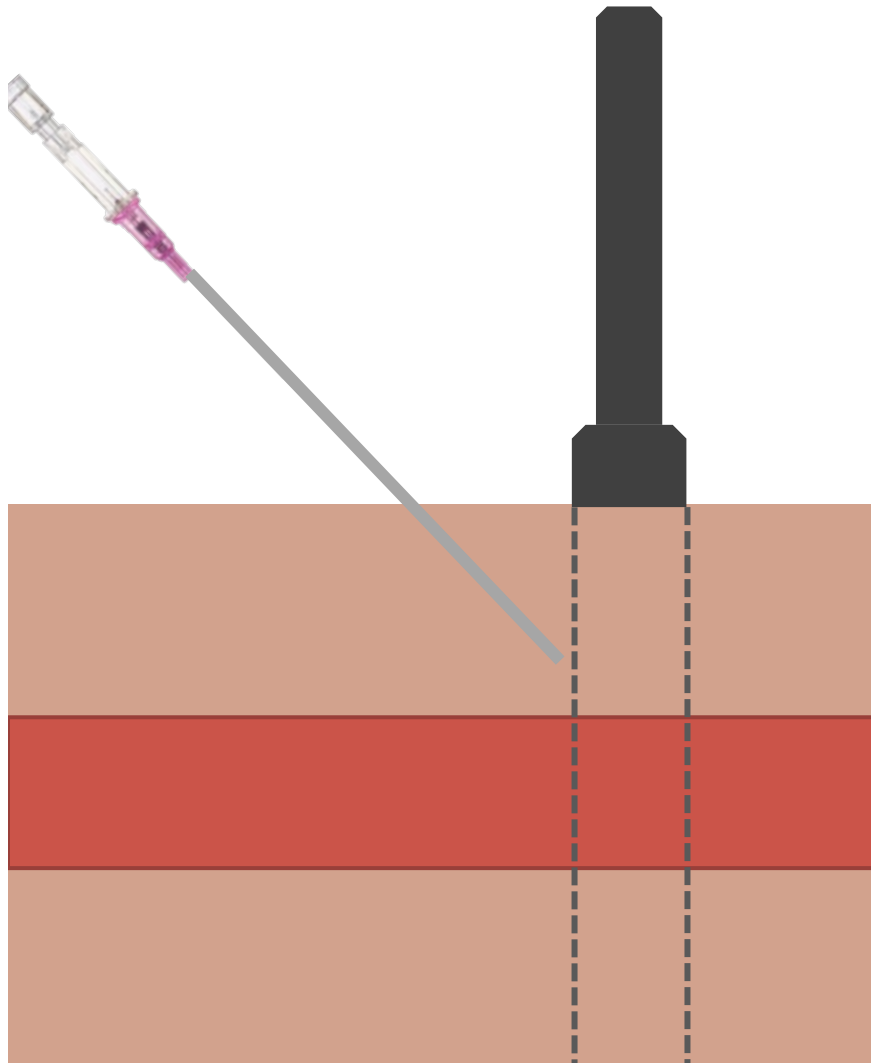


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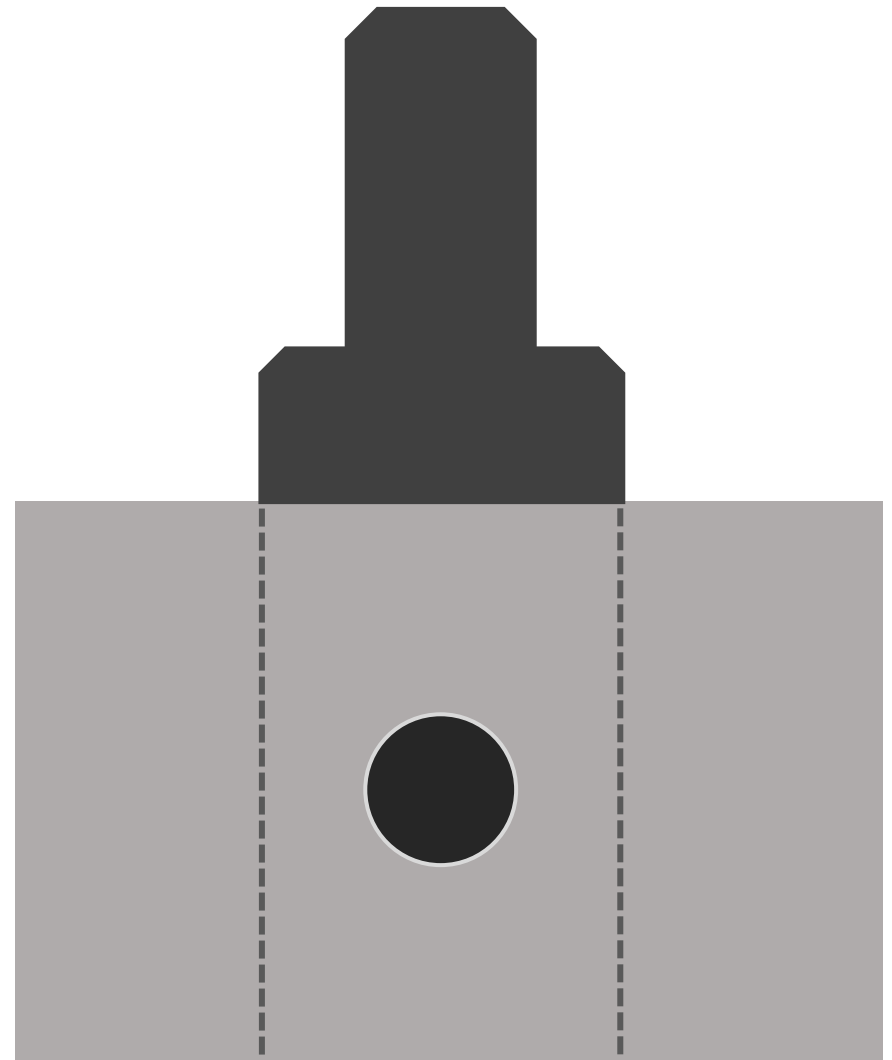


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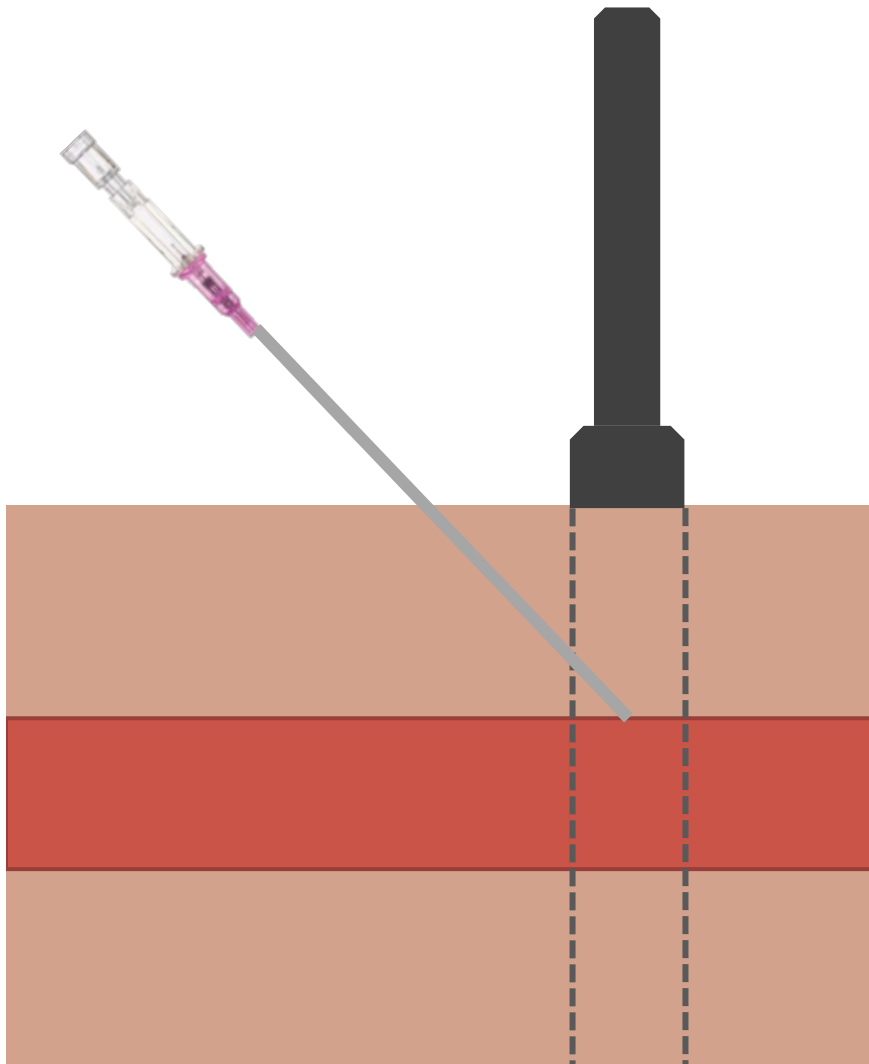


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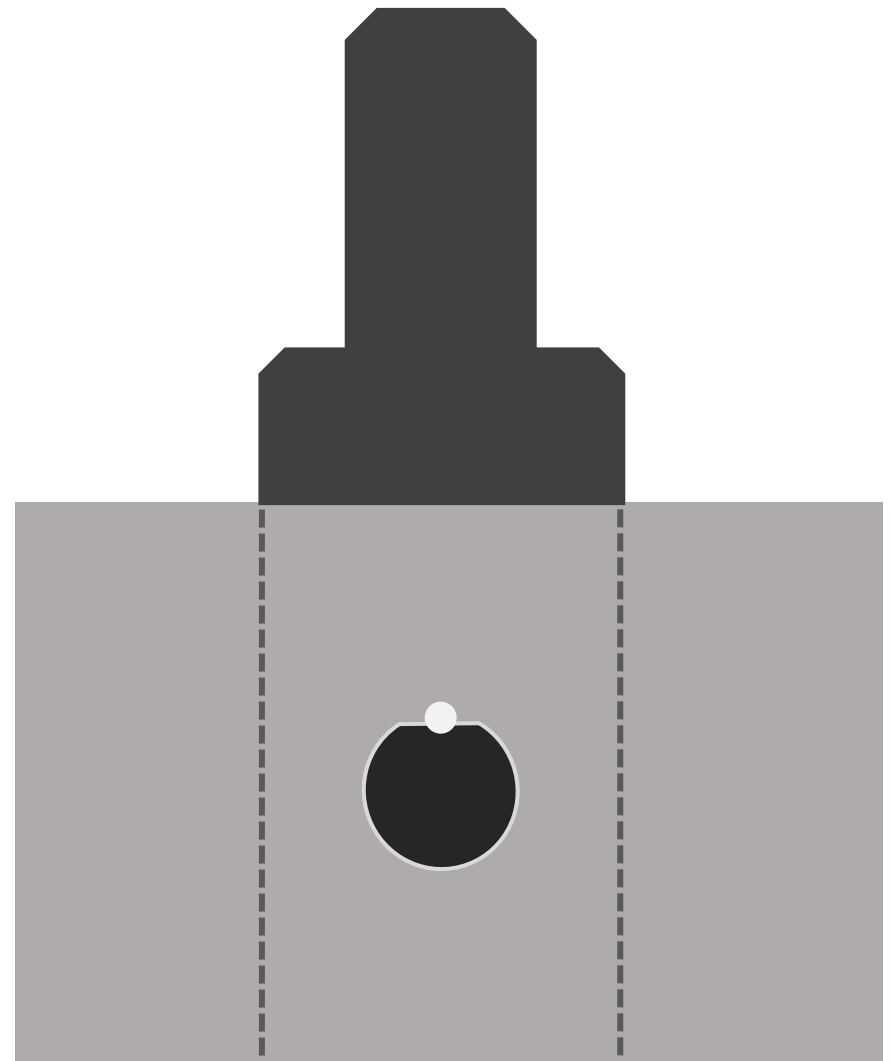


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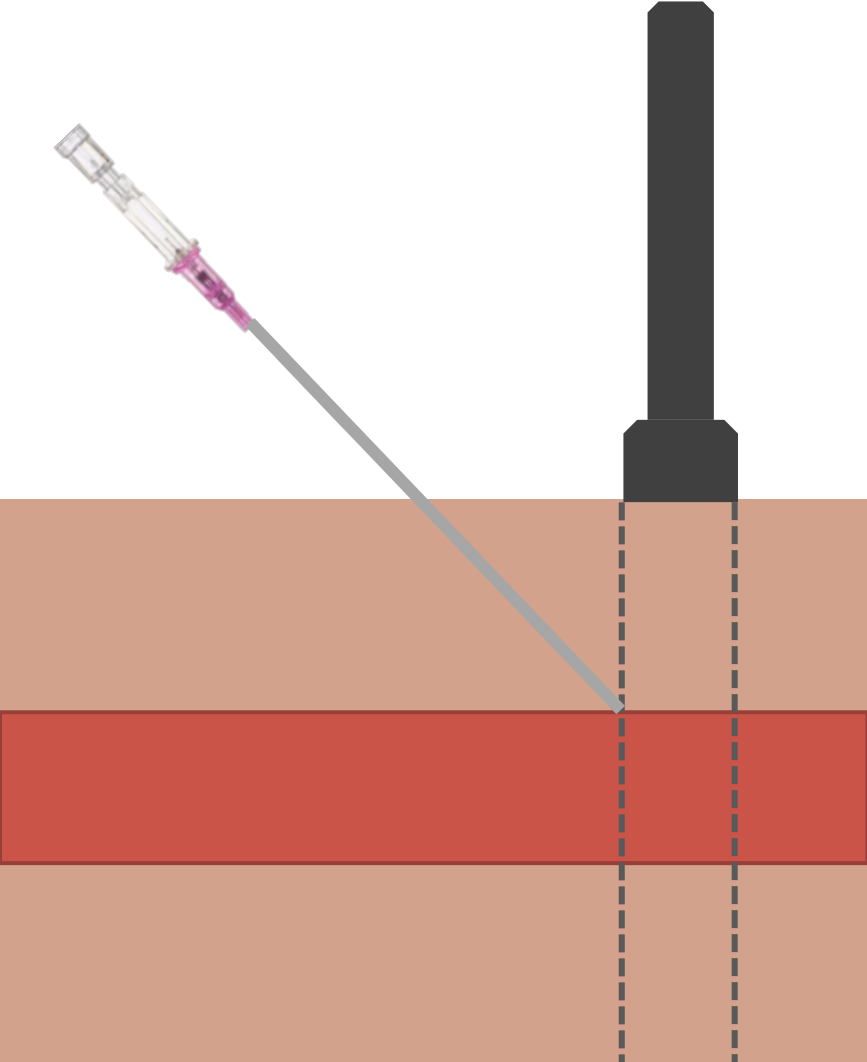


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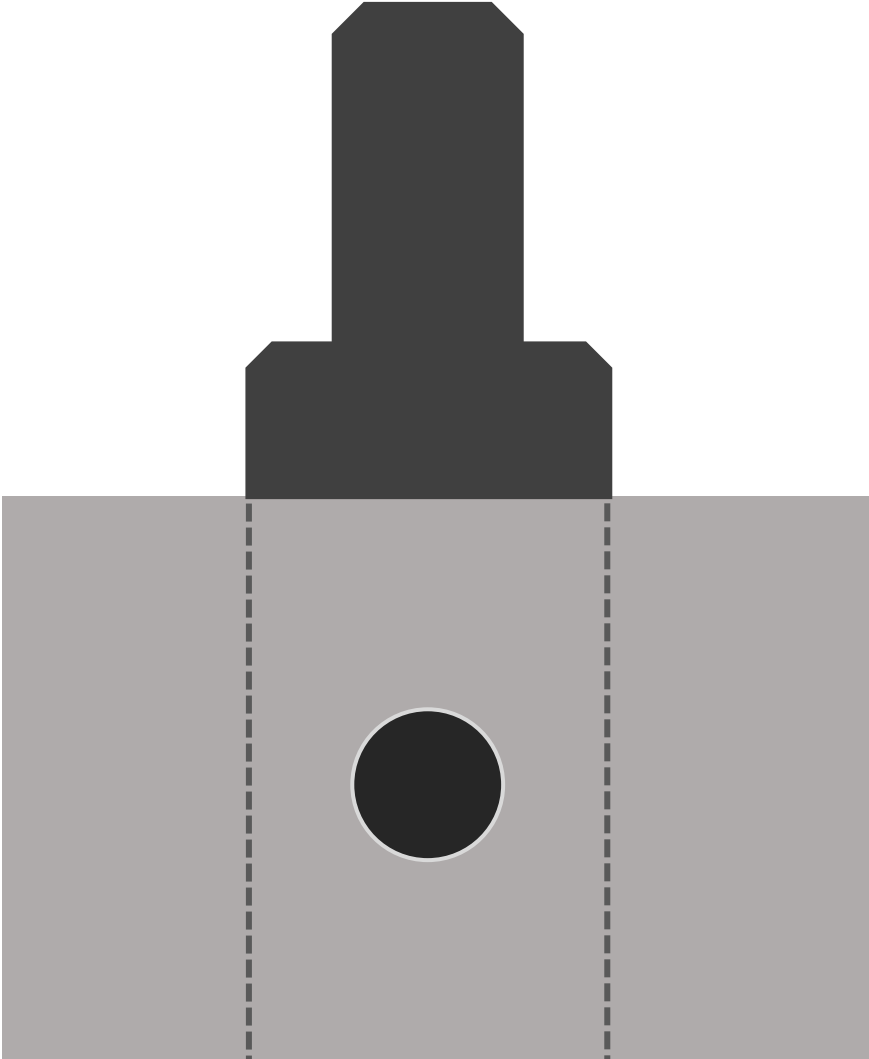


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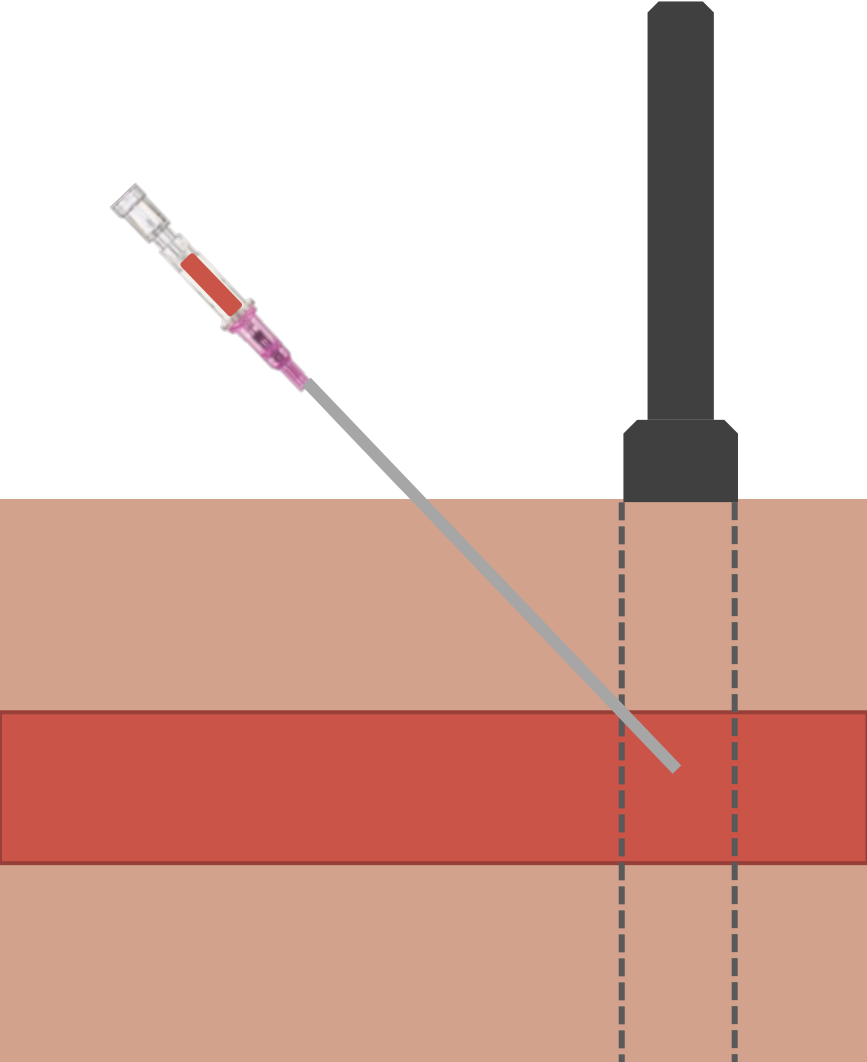
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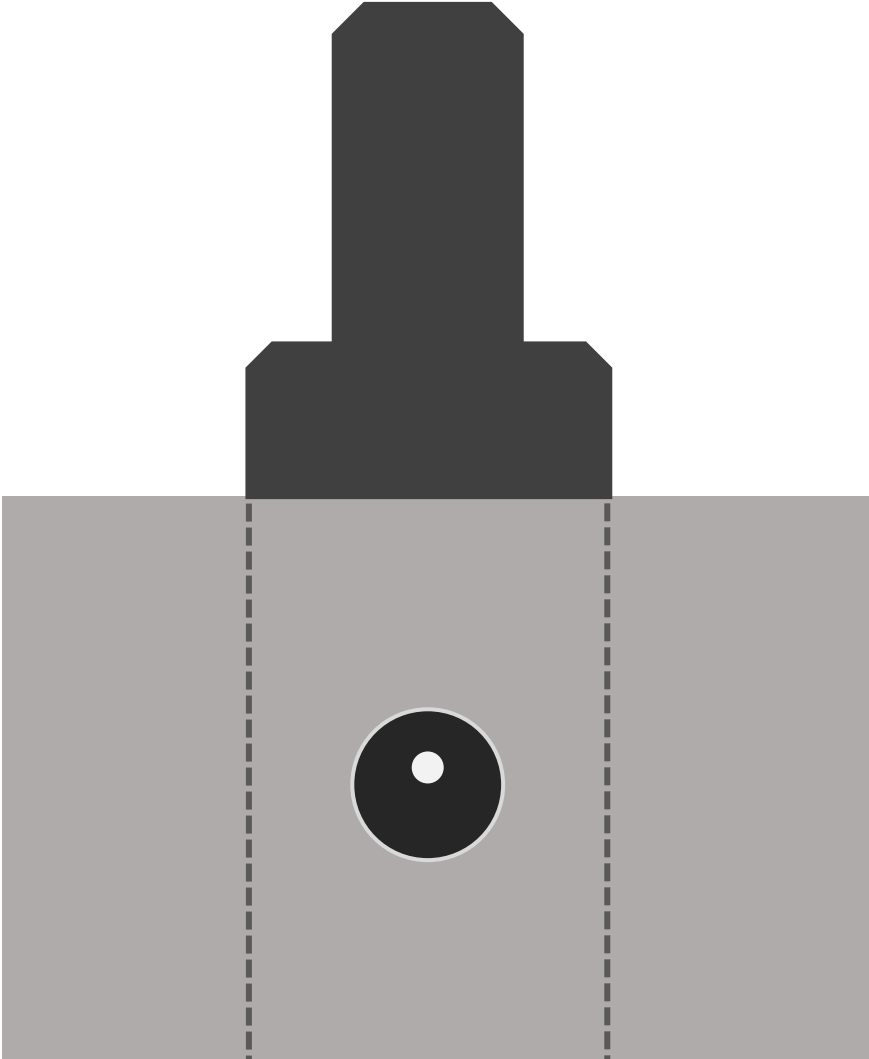


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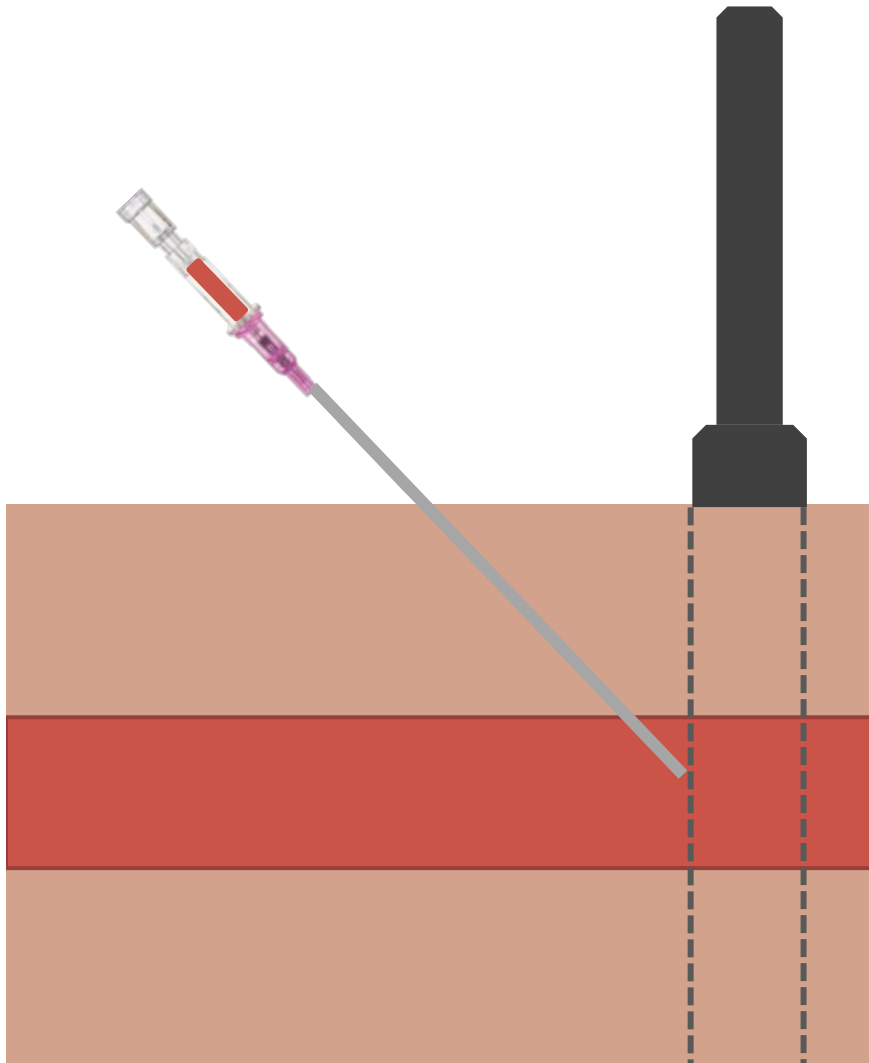


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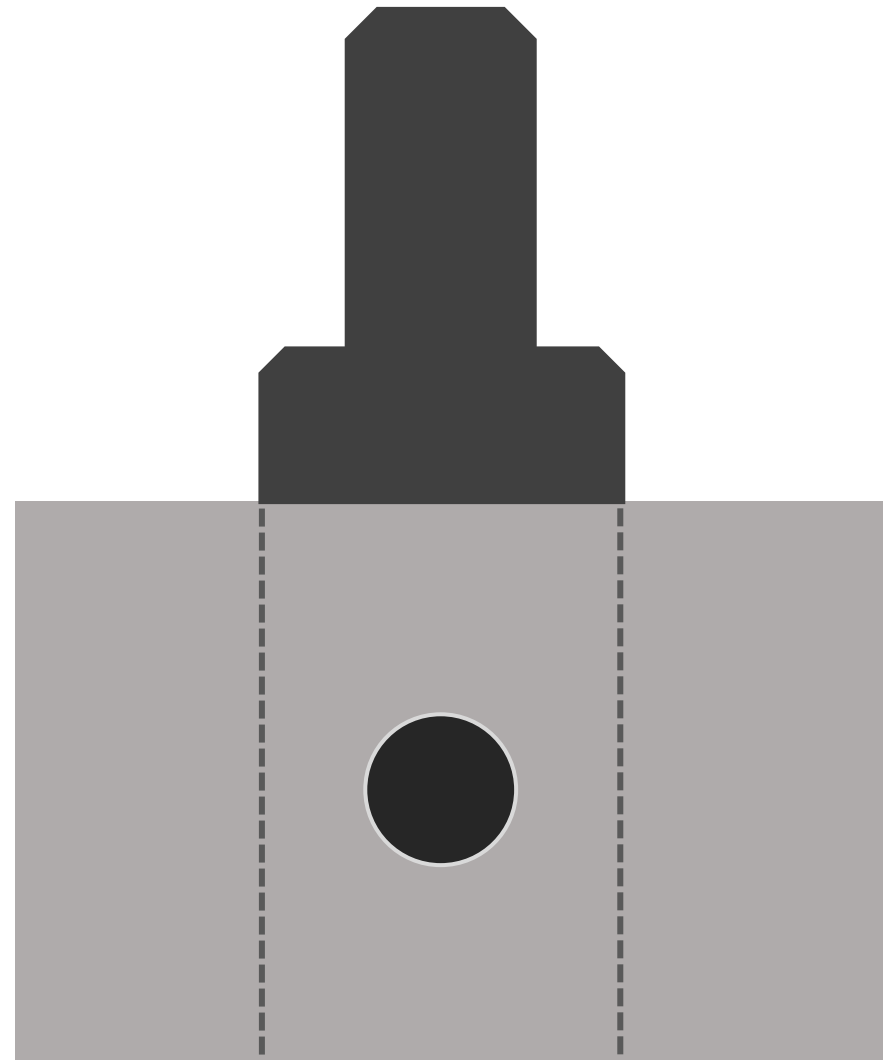


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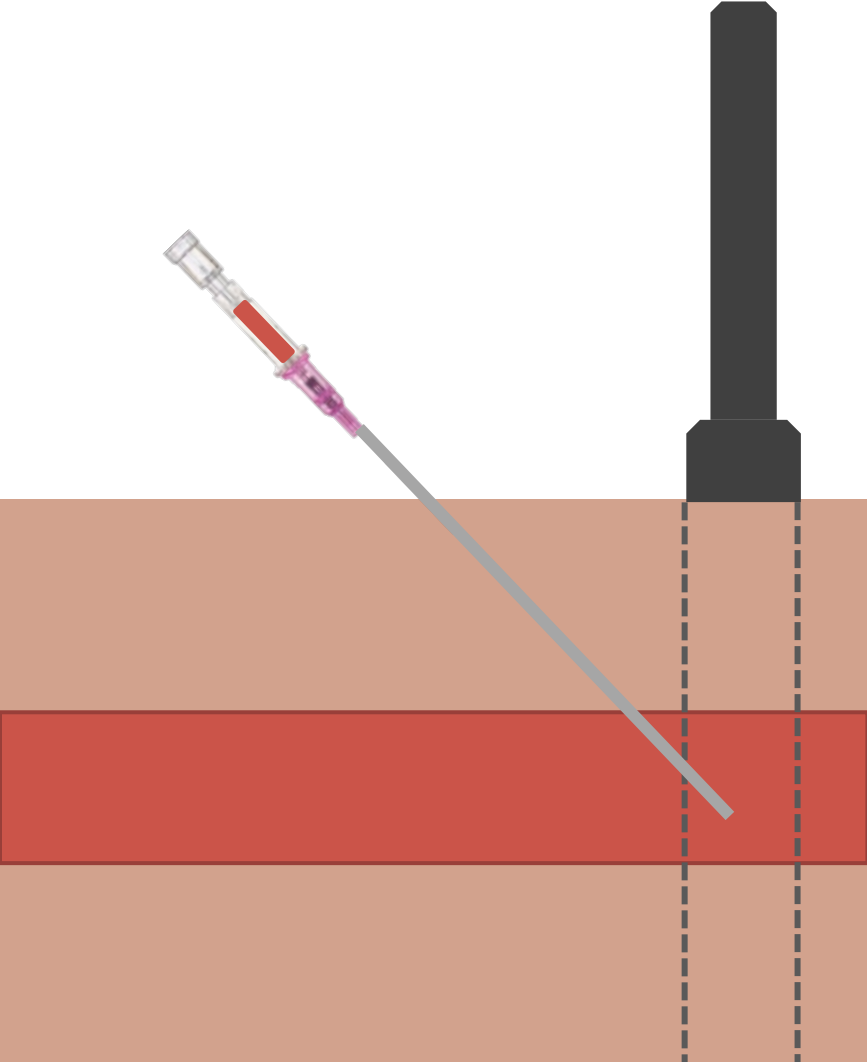


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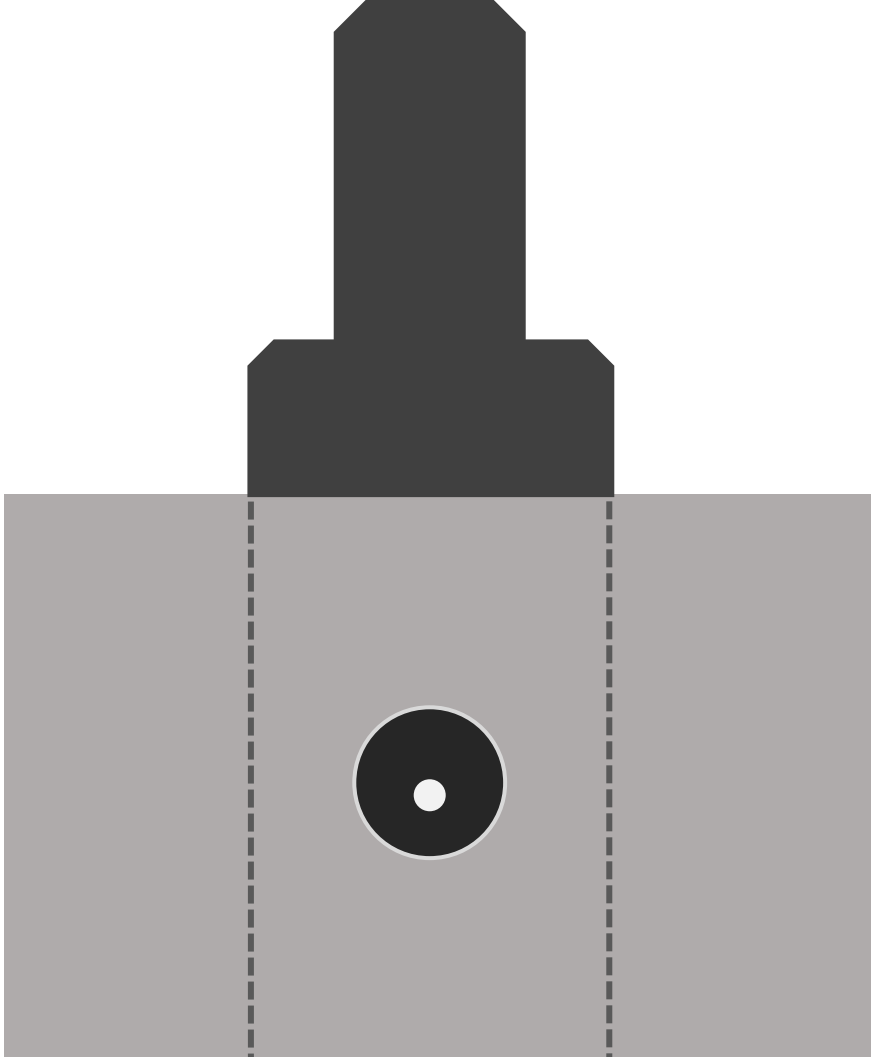


# Case #2 How-To: Basilic Vein USGPIV

What's happening



What you see  
(transverse view)



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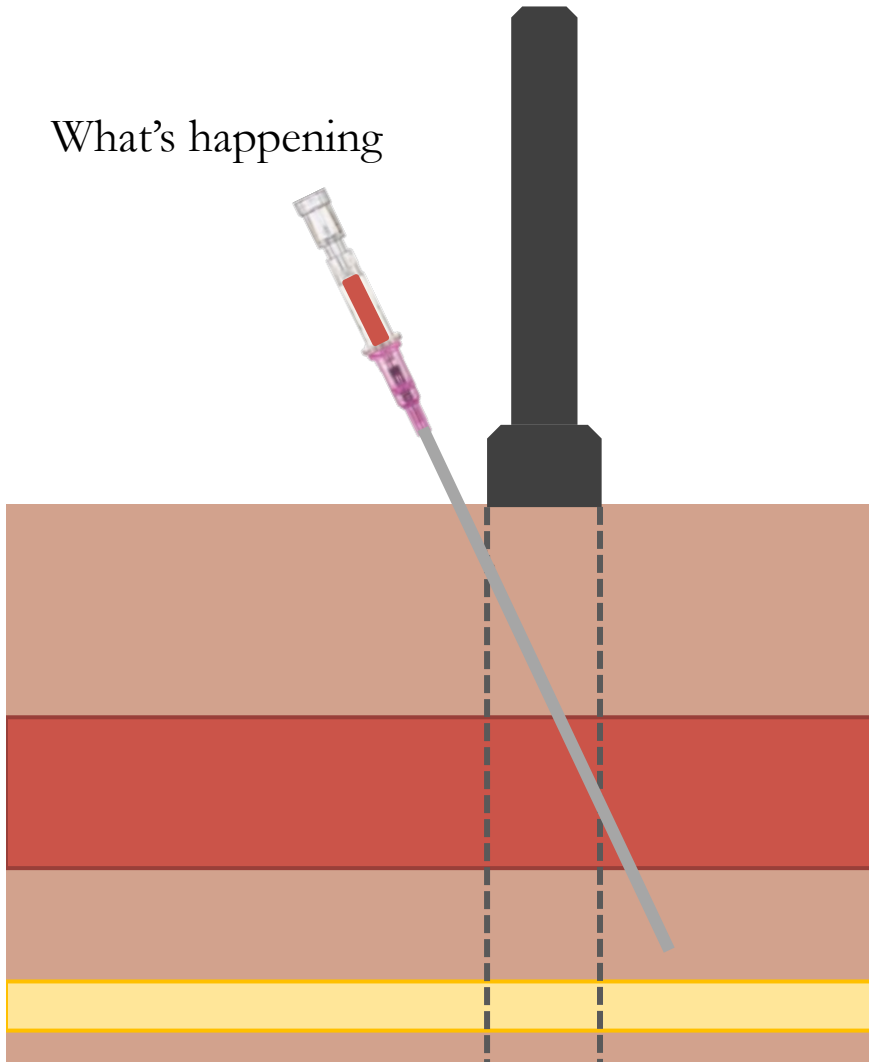
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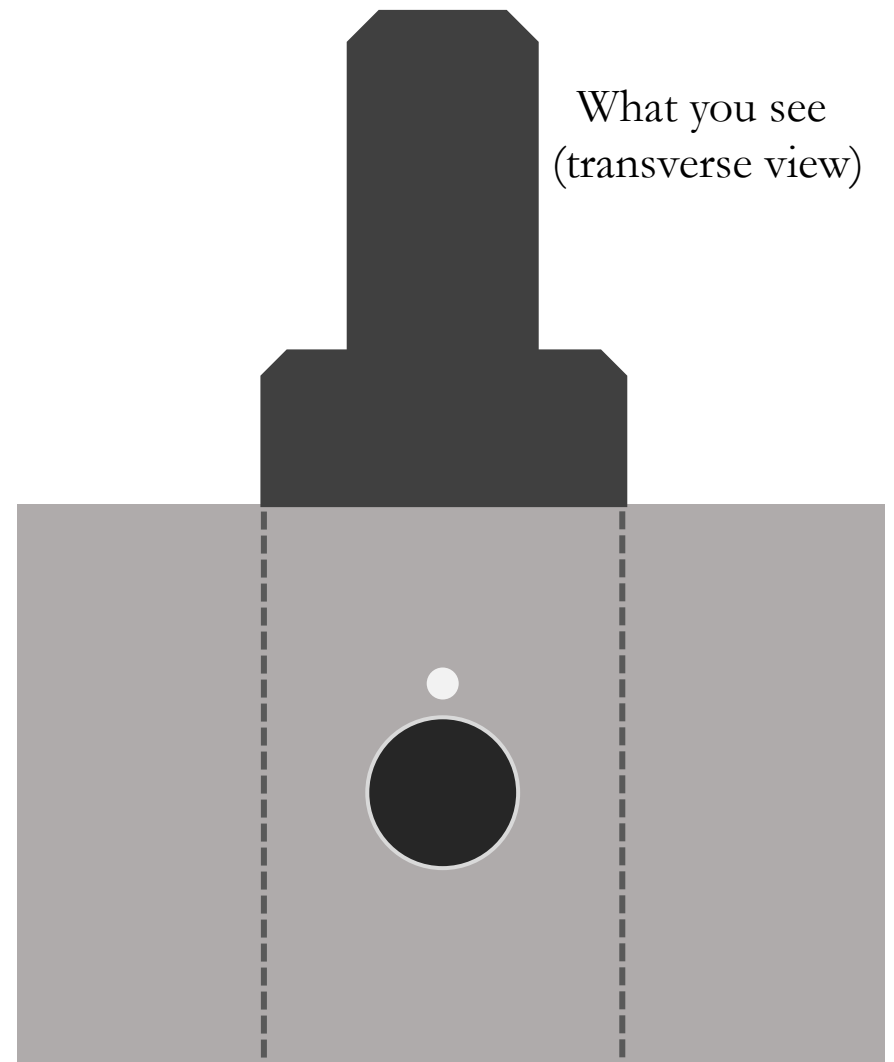
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Why it's essential to continually prove to yourself you are seeing the TIP of the needle!

What's happening



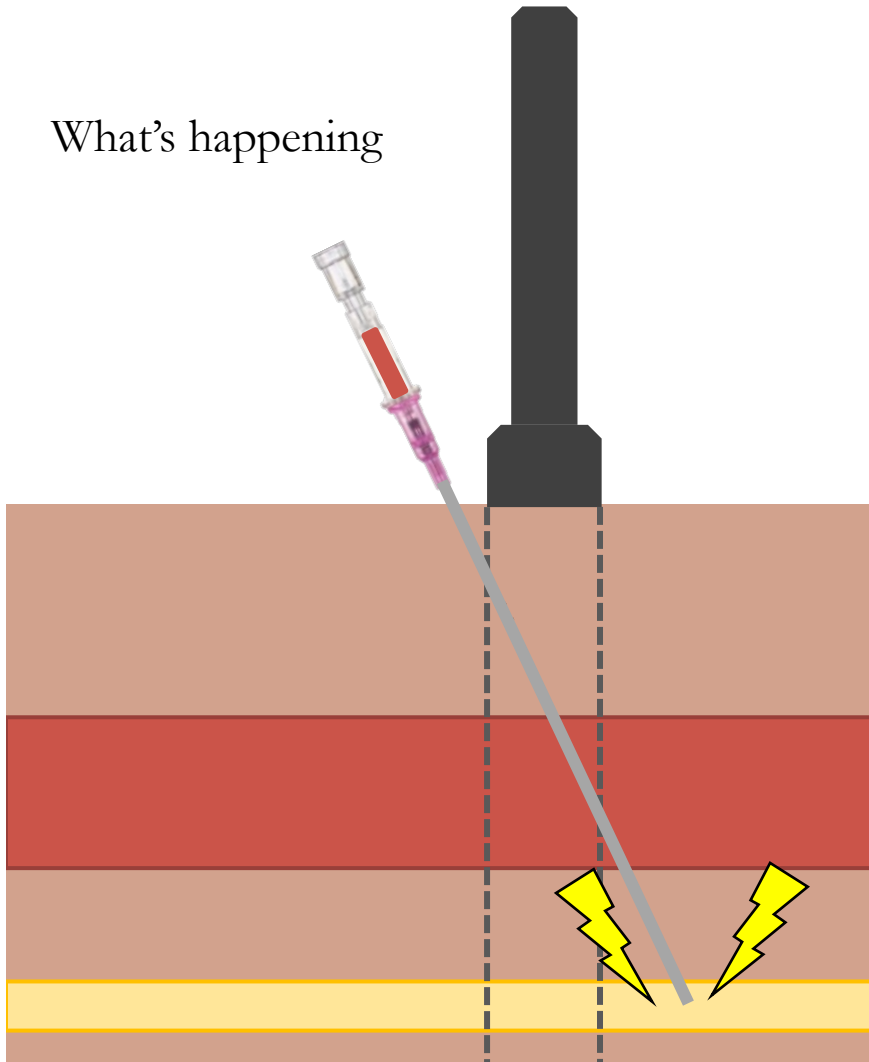
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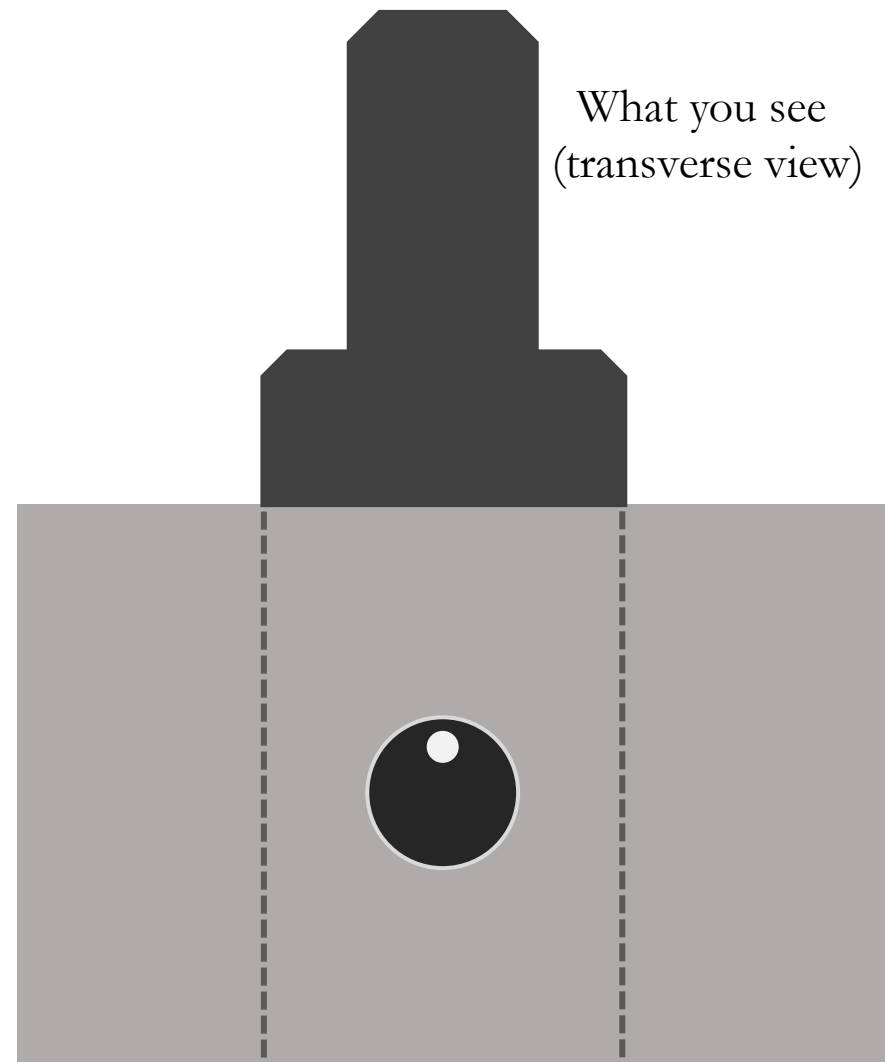
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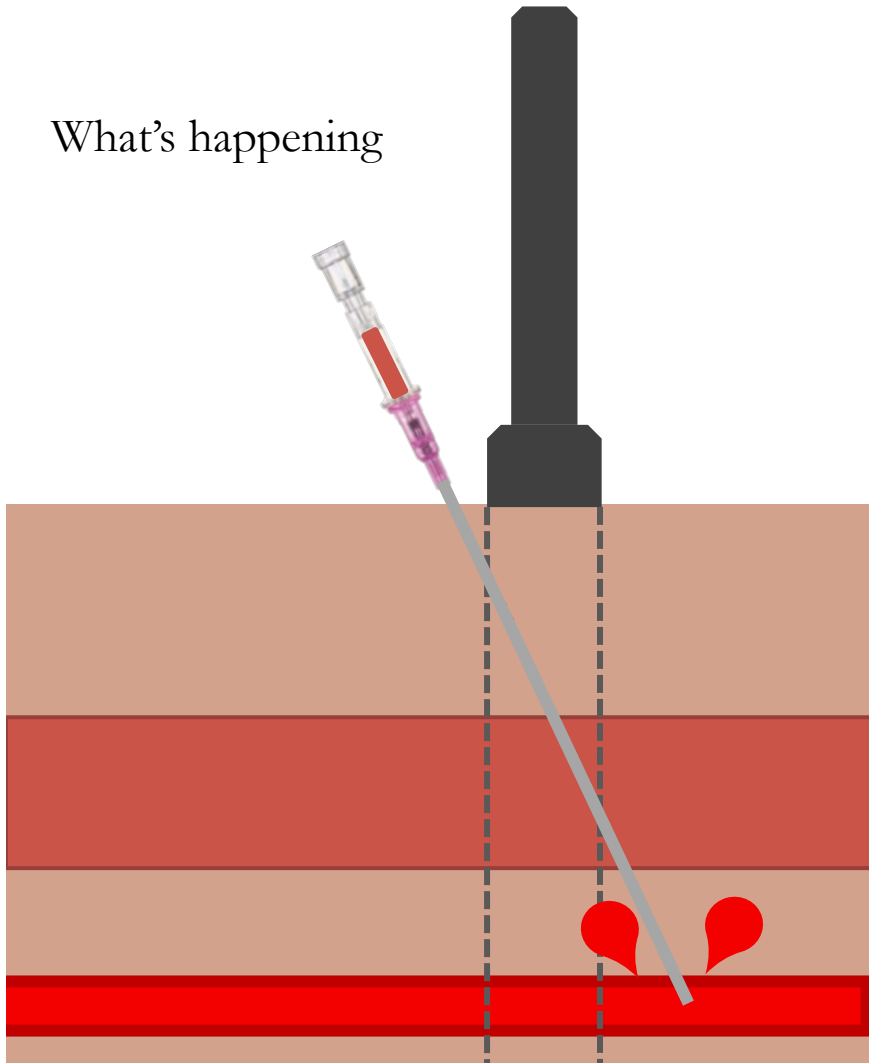




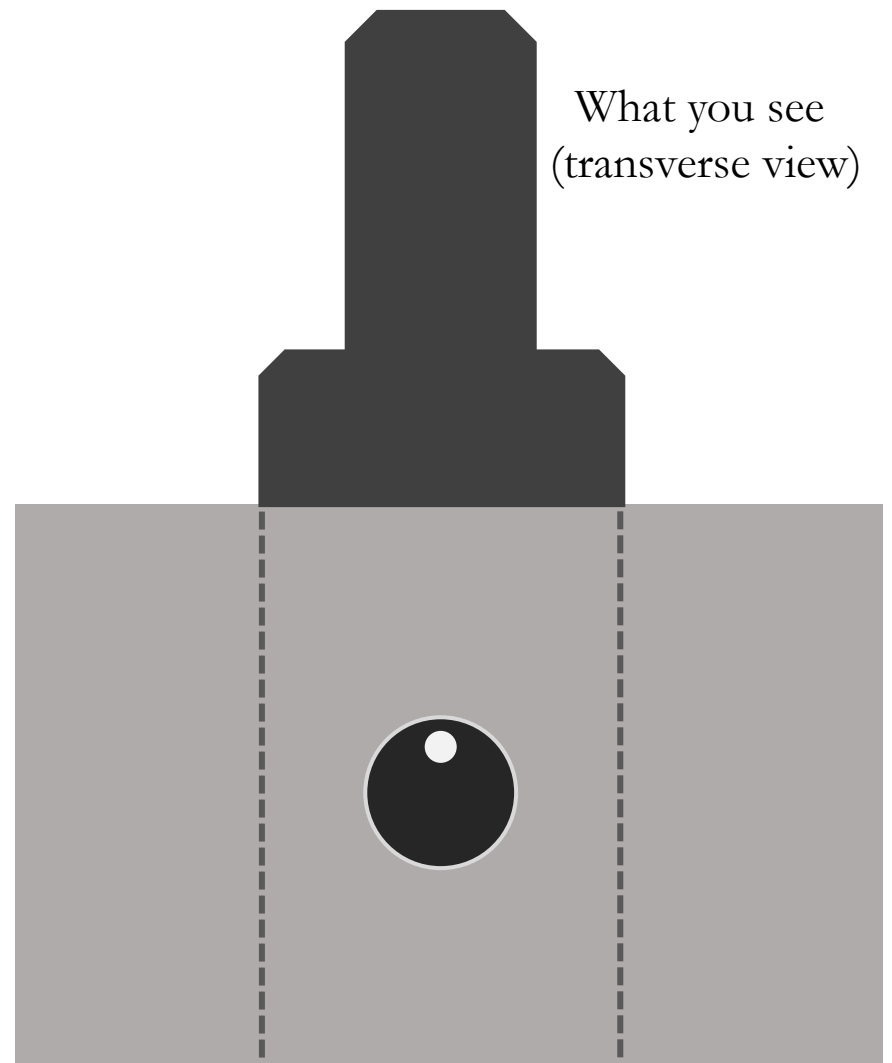
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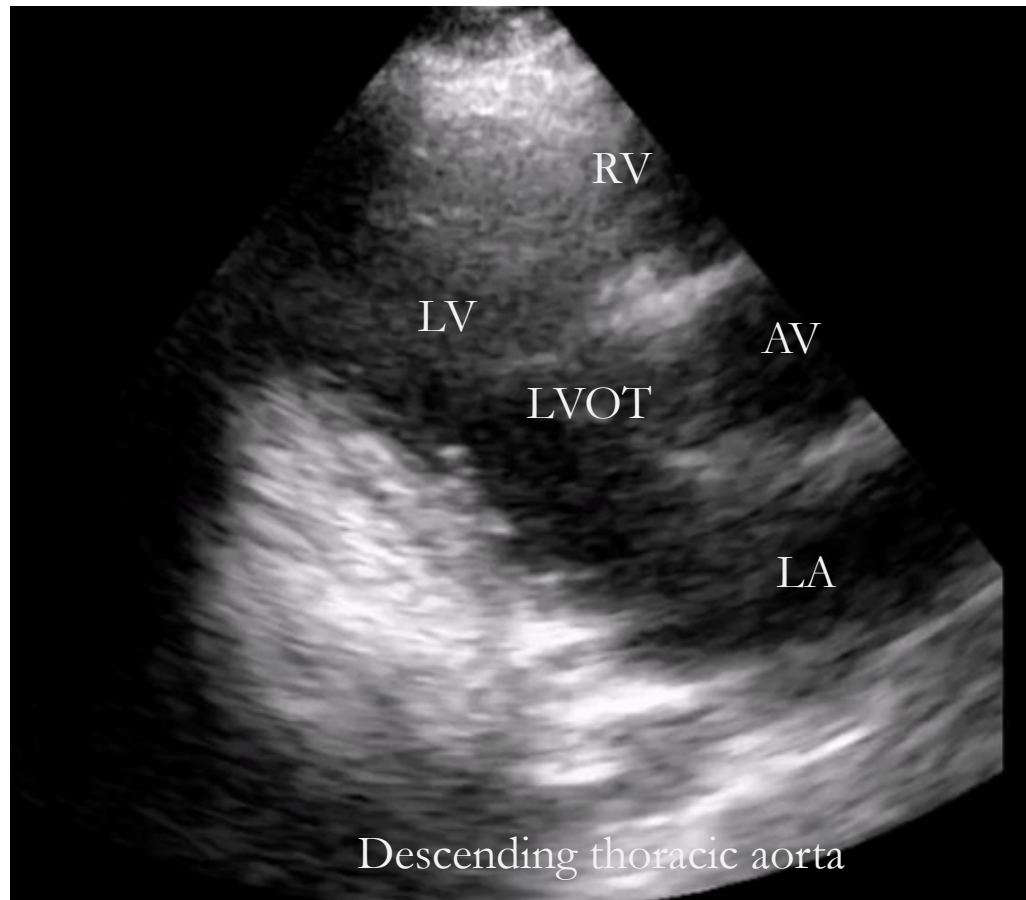
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- Though not standard practice for inpatient nurses, it IS safe to draw labs off a newly placed IV (this slightly increases the risk of losing the IV)
- If non-urgent and your patient has advanced CKD, it’s helpful to discuss basilic access with a nephrologist (though sometimes use is unavoidable in an emergency)

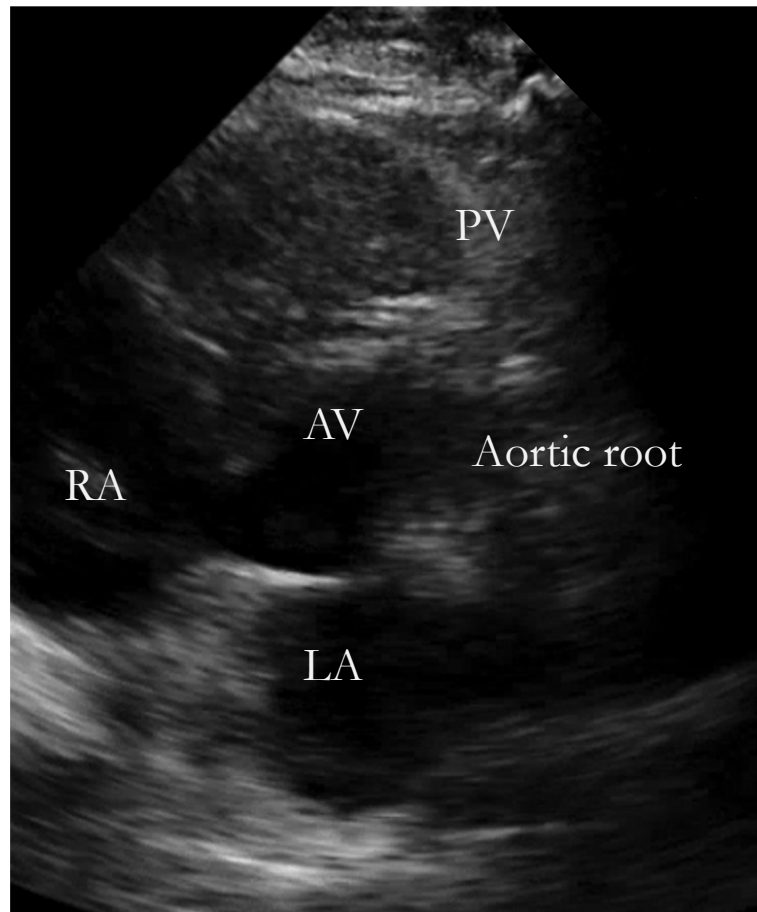
## Case #2: 36M with IVDU (on methadone) and high-grade MRSA bacteremia

- Clinical vignette:
  - A R basilic vein IV is placed, cultures are collected, and the patient starts daptomycin
  - An overnight basic bedside echo demonstrates the following on parasternal long axis



## Case #2: 36M with IVDU (on methadone) and high-grade MRSA bacteremia

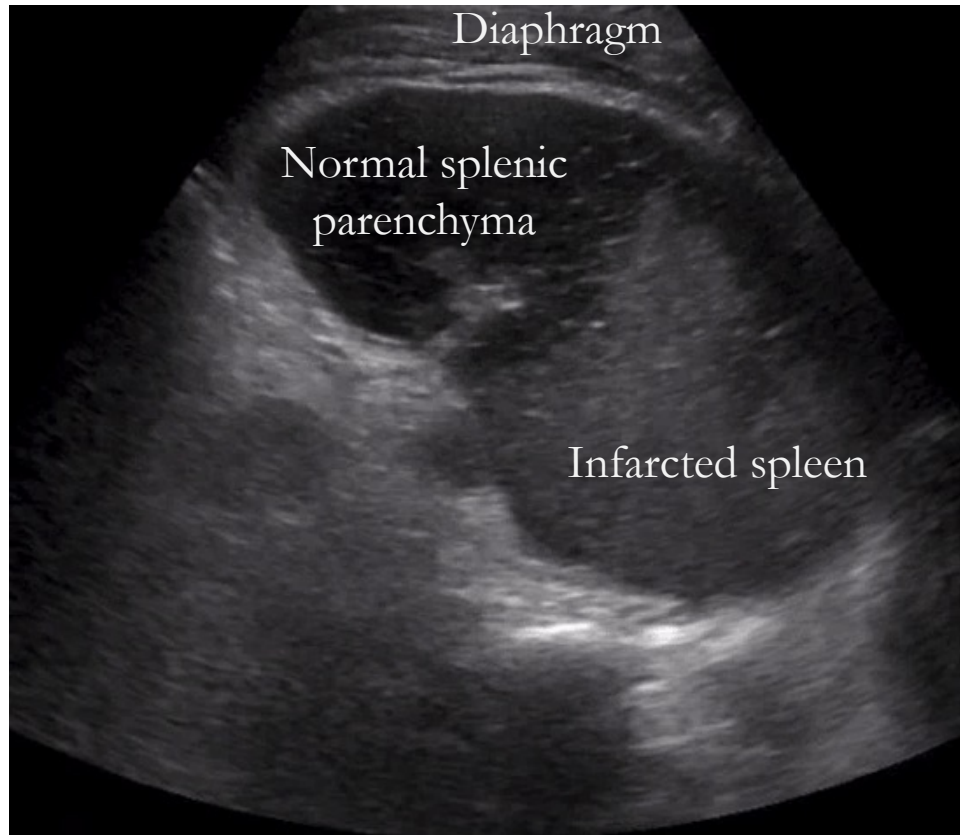
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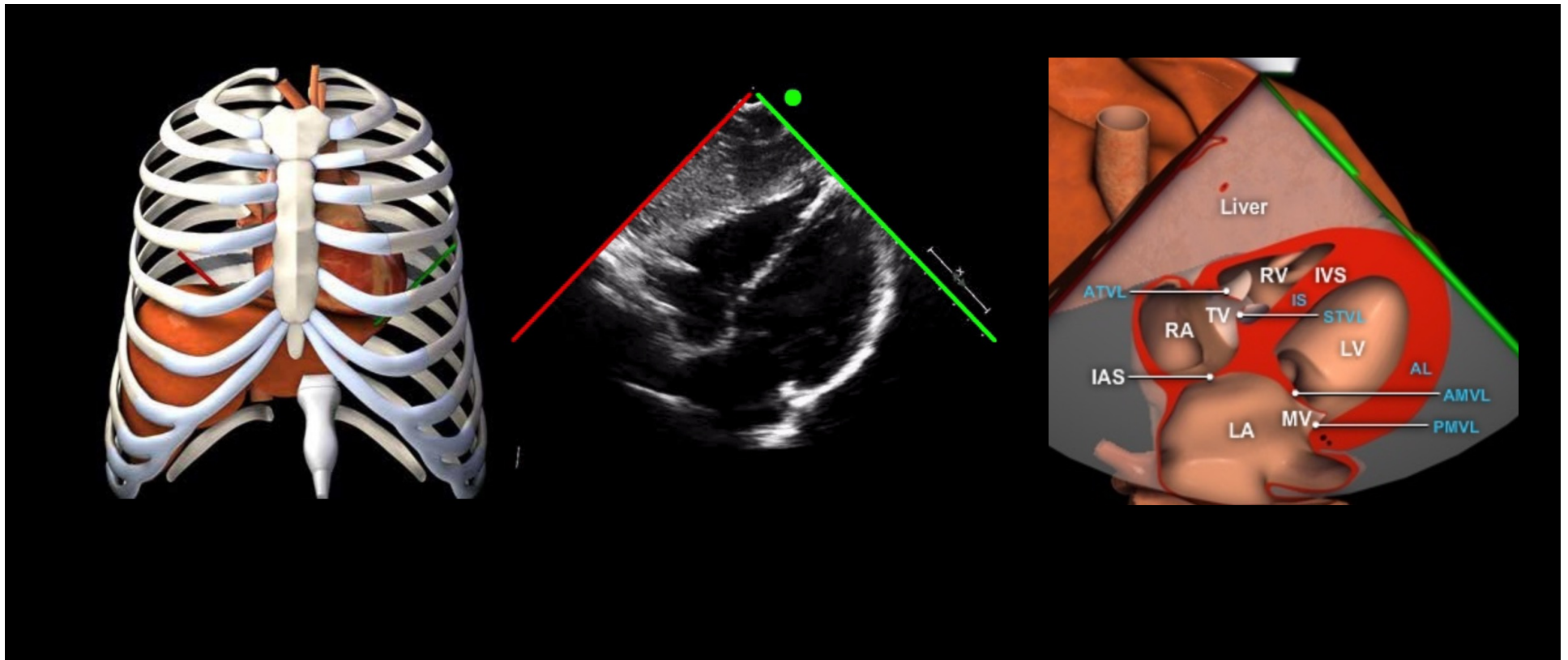
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  - An overnight basic bedside echo demonstrated an AV vegetation >1cm diameter
  - An overnight basic abdominal ultrasound demonstrated a large splenic infarct
  - You page cardiothoracic surgery first thing in the morning and they see him on a Saturday to begin surgical planning
  - A formal TTE happens 3 days later

# Case #2 How-To: Basic Bedside Echocardiogram

- Best learning resource: [Toronto Virtual Echocardiography](#) website
  - Navigate to “FOCUS” (Focused Cardiac Ultrasound) under Site Menu
- Basic cardiac POCUS can answer several **yes/no** questions:
  - Is there a large pericardial **effusion**?
  - Is there gross evidence of **tamponade** physiology?
  - Is there normal collapsibility of the **IVC**?
  - Is there evidence of significant chamber **dilatation**?
  - Is there significant ventricular **hypertrophy**?
  - Is **LVEF** **qualitatively reduced**?
  - Are there signs of significant **RV volume/pressure overload**?
  - Are there **large vegetations on the TV, MV, or AV**?
- Reliability depends on image quality and clinician training
- Requires formal TTE to confirm important findings
- Use should be viewed by residents as primarily educational unless overseen by cardiologist or POCUS-trained attending

# How-To: Basic Bedside Echocardiogram

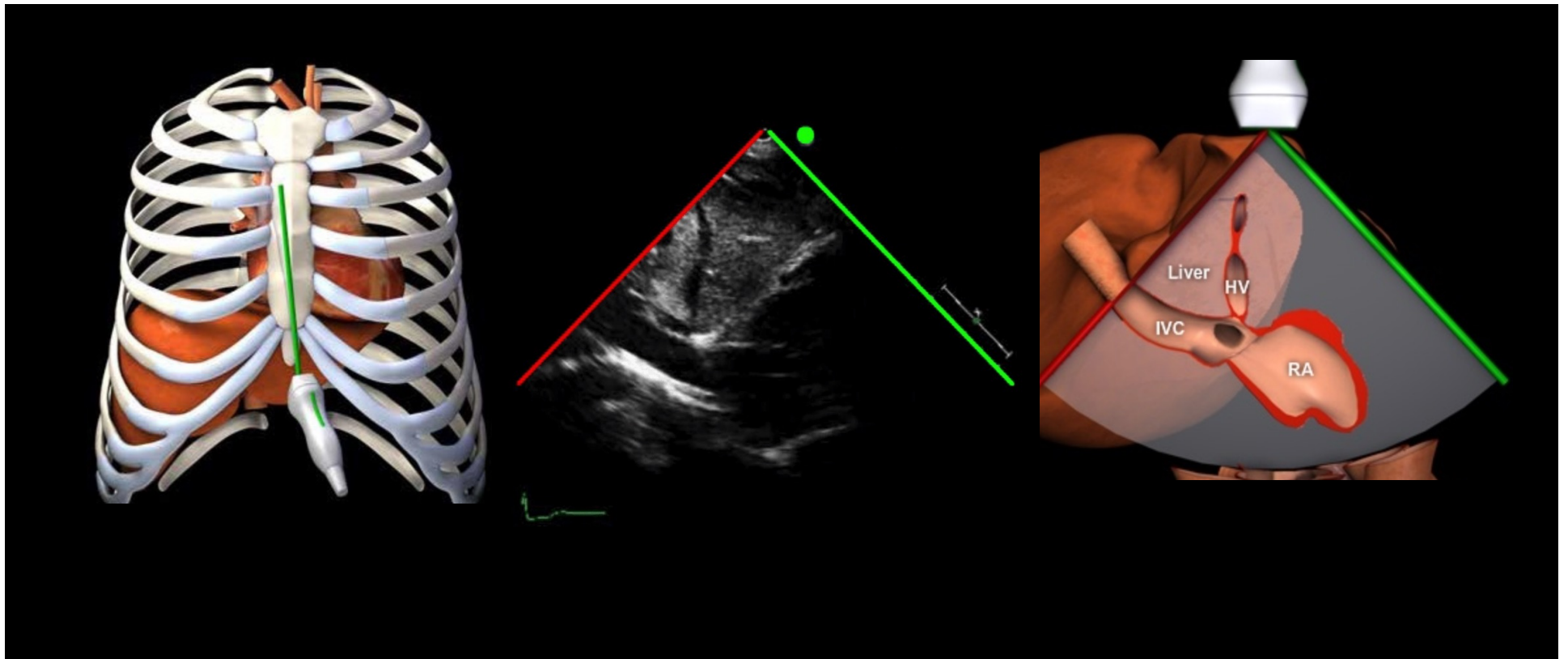
## *Subxiphoid View (View 1 of 5)*



Toronto General Hospital Department of Anesthesia. "Virtual Transthoracic Echocardiography." Available: [http://pie.med.utoronto.ca/tte/TTE\\_content/focus.html](http://pie.med.utoronto.ca/tte/TTE_content/focus.html) (accessed 12/18/23).

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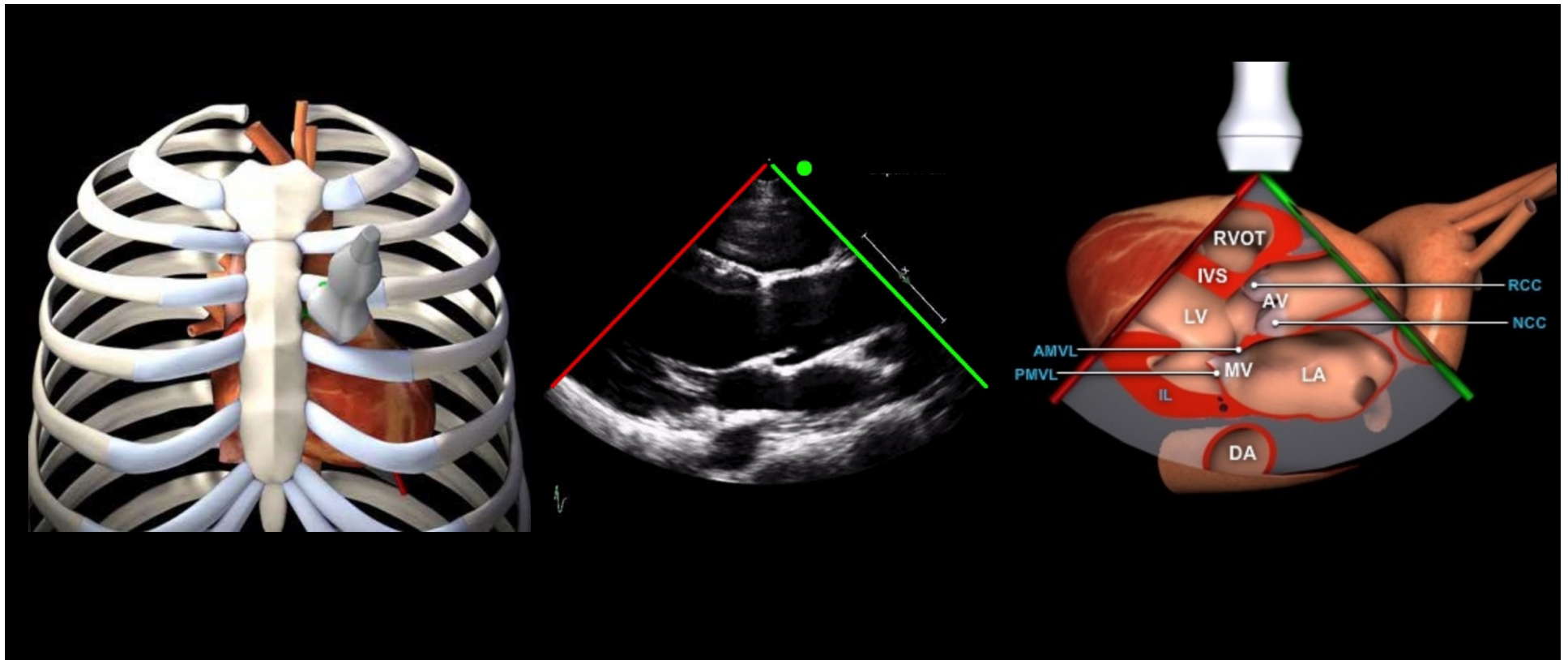
## *Inferior Vena Cava (View 2 of 5)*



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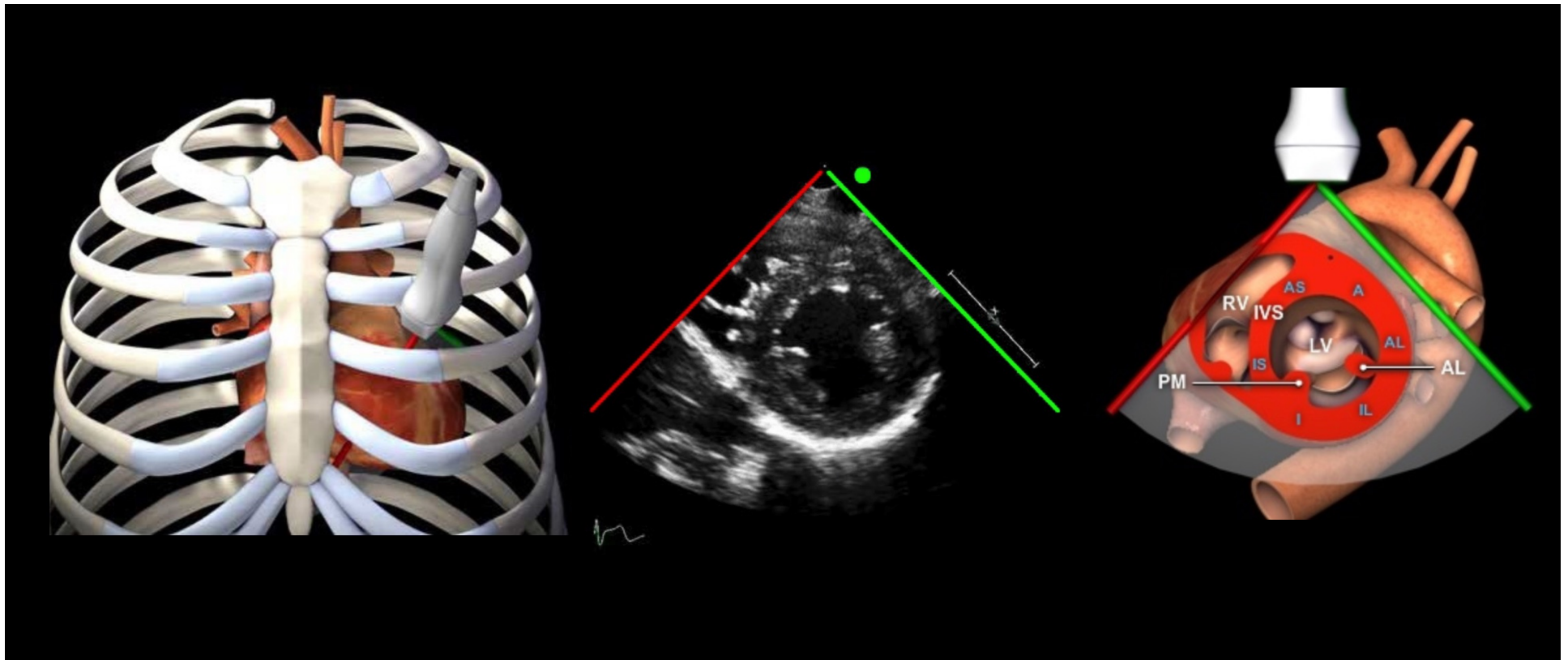
## *Parasternal Long Axis (View 3 of 5)*



Toronto General Hospital Department of Anesthesia. "Virtual Transthoracic Echocardiography." Available: [http://pie.med.utoronto.ca/tte/TTE\\_content/focus.html](http://pie.med.utoronto.ca/tte/TTE_content/focus.html) (accessed 12/18/23).

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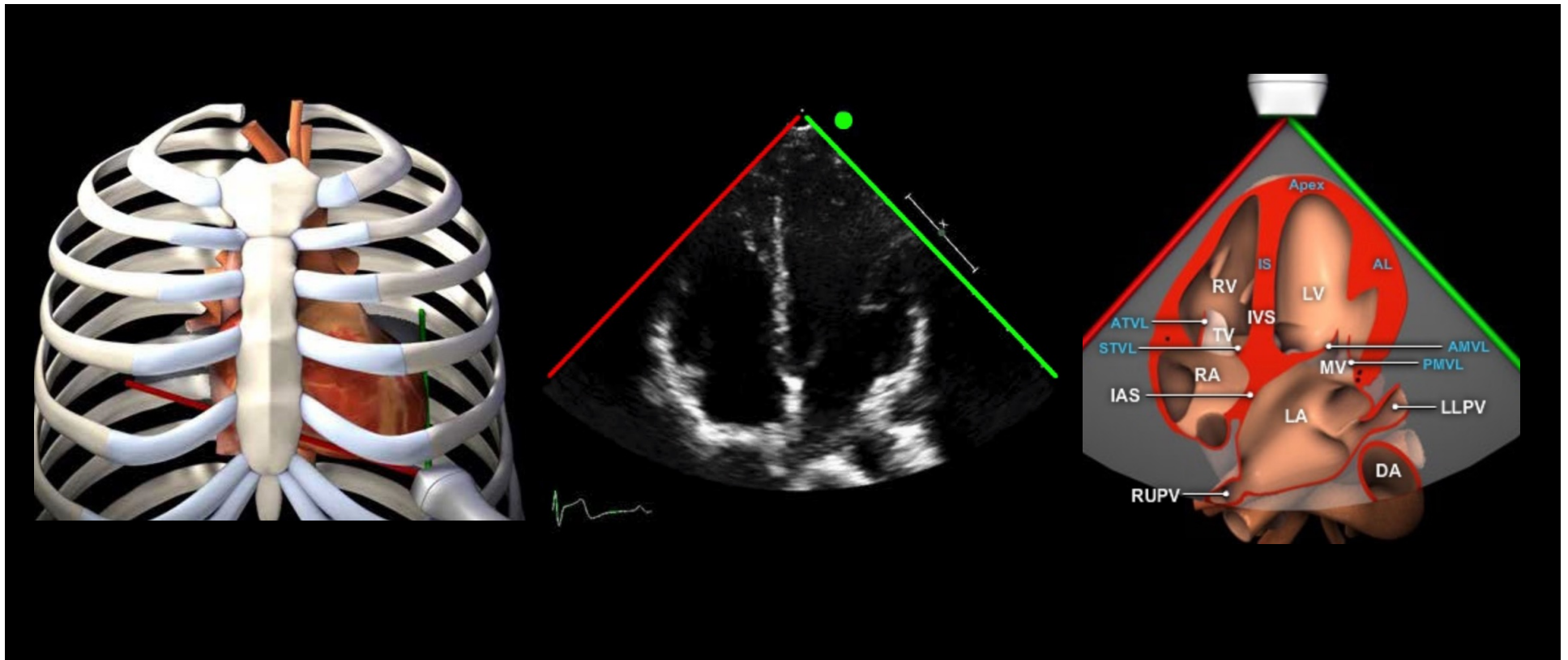
## *Parasternal Short Axis (View 4 of 5)*



Toronto General Hospital Department of Anesthesia. "Virtual Transthoracic Echocardiography." Available: [http://pie.med.utoronto.ca/tte/TTE\\_content/focus.html](http://pie.med.utoronto.ca/tte/TTE_content/focus.html) (accessed 12/18/23).

# How-To: Basic Bedside Echocardiogram

## *Apical Four-Chamber (View 5 of 5)*



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### Mini-Case #3



SH9W  
Special Pathogens Unit



ACTIVATE SWITCH  
TO OPERATE

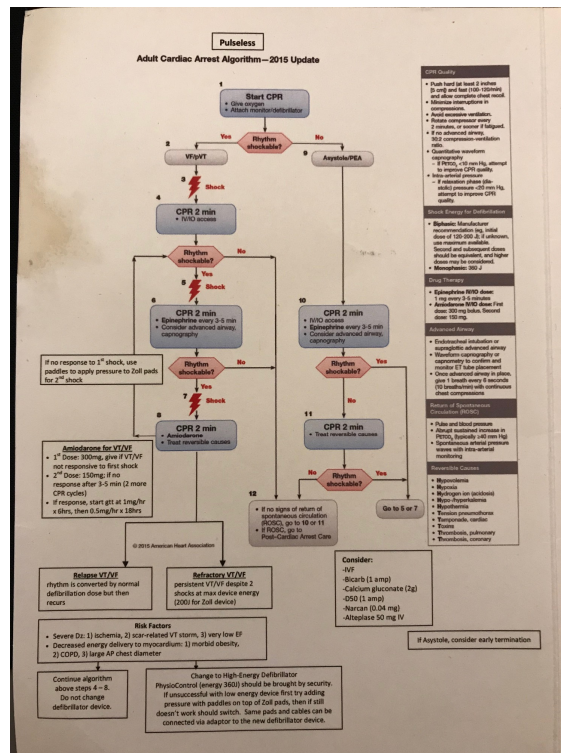
Special Pathogen Unit

SPU Dedicated Staff ONLY Beyond This Point

# Case #3: 70F with ARDS due to COVID-19 transferred from OSH in 5/2020

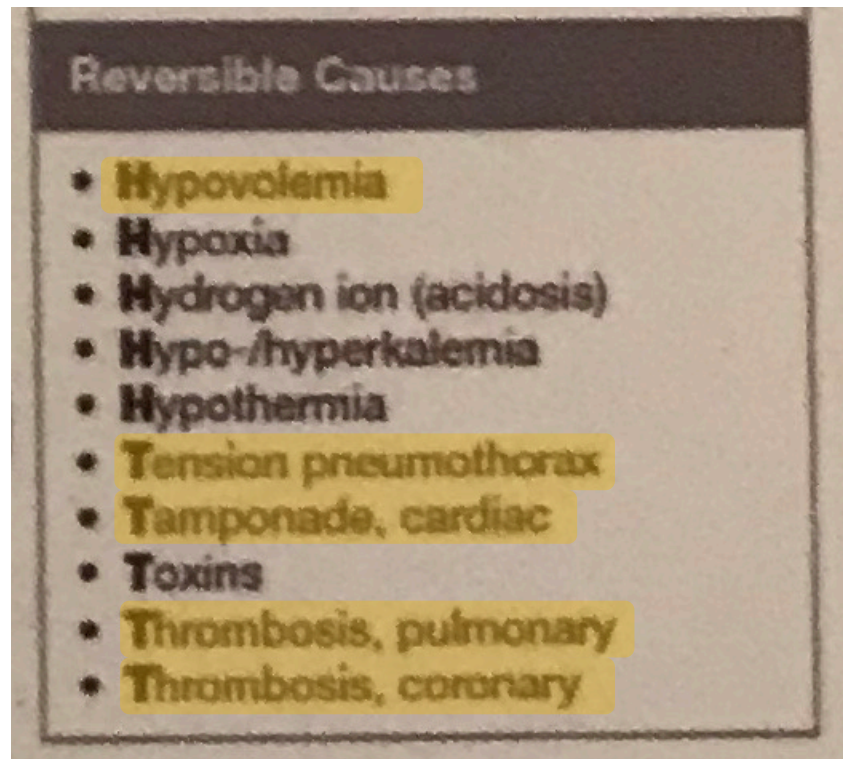
- Clinical vignette:

- Intubated at OSH and placed on BiPAP machine due to acute shortage of ventilators
- Transferred to BWH overnight; during RT transition to in-house ventilator, PIPs rise rapidly and she experiences a PEA arrest in front of the admitting MICU team
- CPR immediately initiated; you grab your stethoscope and the ultrasound for use during a pulse/rhythm check
- You can't hear clear breath sounds on either side during bag-valve-mask ventilation



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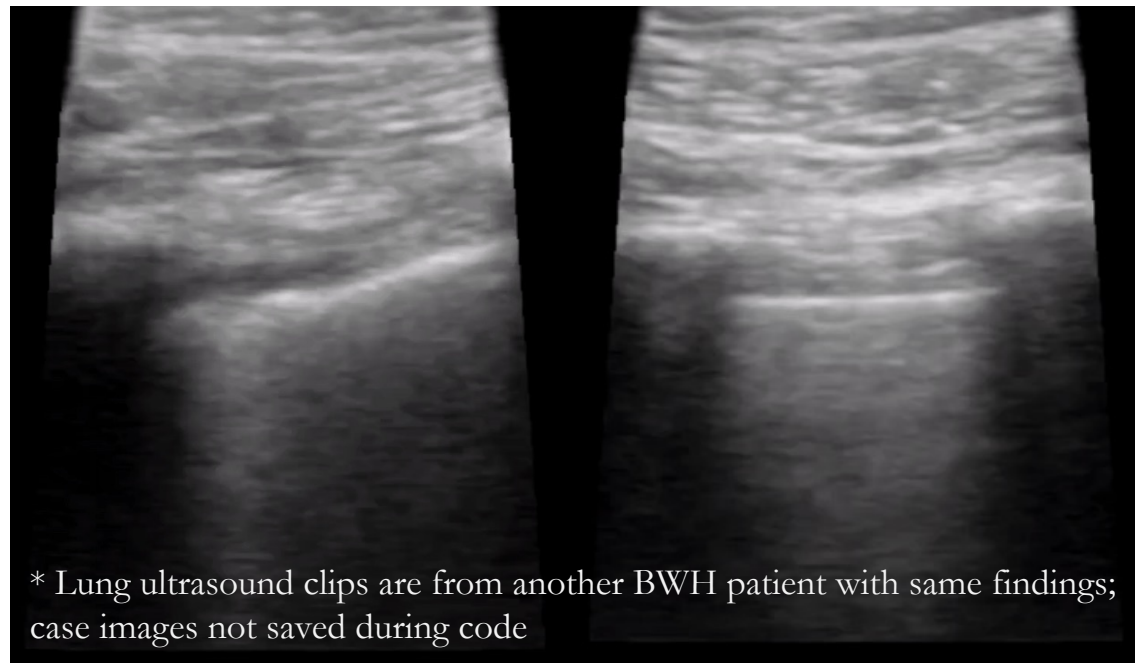


## Case #3: 70F with ARDS due to COVID-19 transferred from OSH in 5/2020

- Clinical vignette:
  - During a pulse/rhythm check, you use the linear probe already at bedside for CVC placement and scan her anterior lung apices during bag-valve-mask ventilation

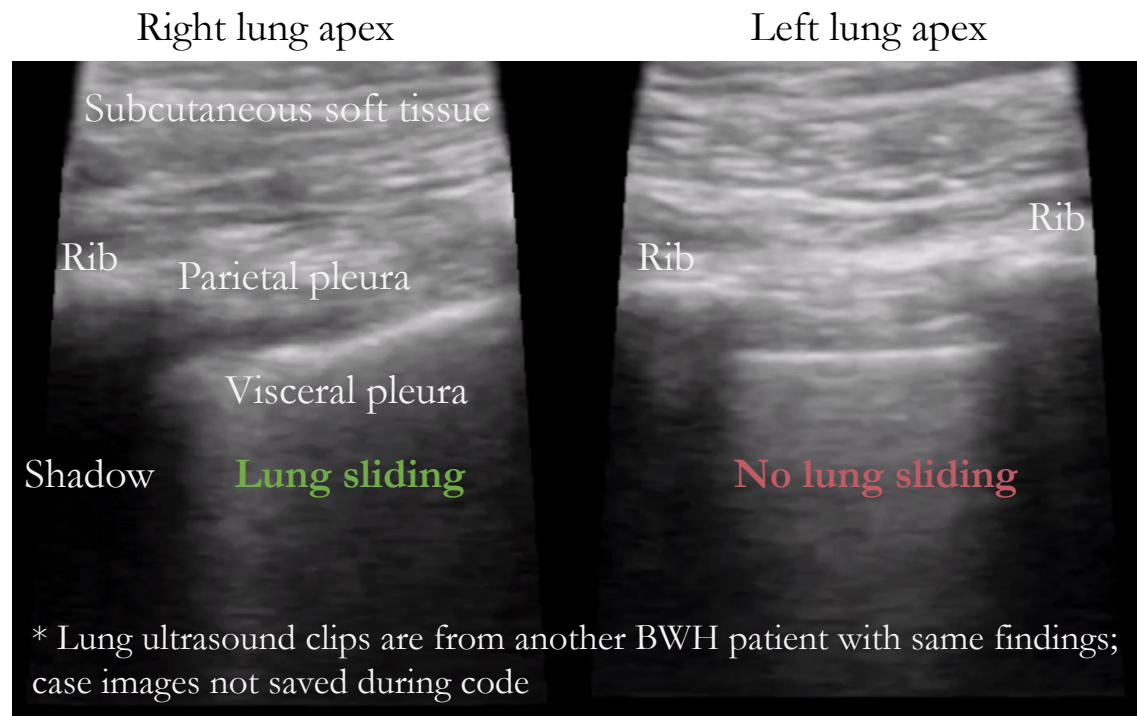
Right lung apex

Left lung apex



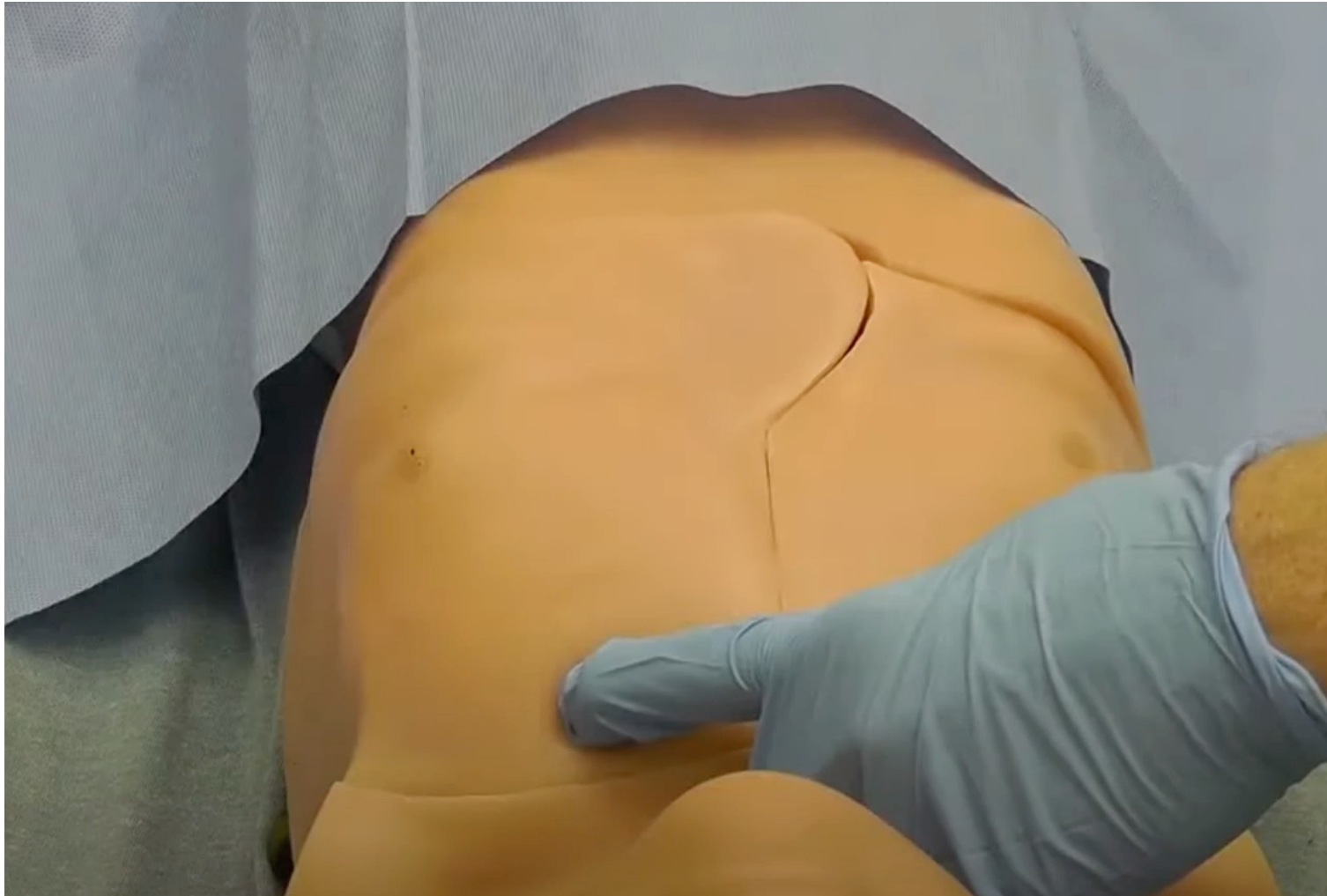
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  - A team member STAT pages thoracic surgery; the resident is 5 minutes away



## Bedside Needle Decompression

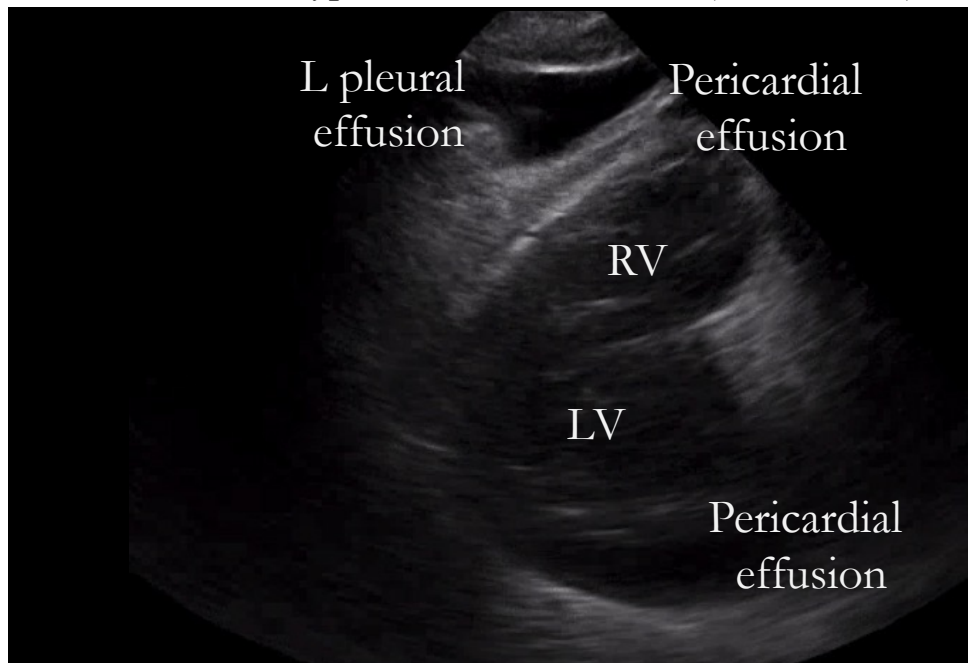
*(please discuss with your attending before attempting, even in a Code Blue scenario)*



## Case #3: 70F with ARDS due to COVID-19 transferred from OSH in 5/2020

- Clinical vignette:
  - Bedside needle decompression at the left lung apex results in a whoosh of air and immediate ROSC
  - Thoracic surgery arrives several minutes later and places a left-sided chest tube
  - Serial CXRs demonstrate resolution of the left-sided tension pneumothorax
  - A subsequent basic bedside echo does demonstrate suspected myocarditis and a moderate pericardial effusion without signs of tamponade (likely unrelated to arrest)

Sub-xyphoid cardiac window (after ROSC)



IVC (after ROSC)



## Case #3 How-To: POCUS in an RRT or Code Blue

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- *Key principles:*
  - Imaging is never a higher priority than high-quality compressions
  - Only consider once you have become skilled in image acquisition and interpretation
  - Attempt 1 window per pulse/rhythm check with explicit permission from code leader
  - Clearly and concisely announce findings, if any, to code leader
  - Limited benefit and risk of harm with using presence/lack of organized cardiac activity on POCUS to prognosticate based on cardiac activity

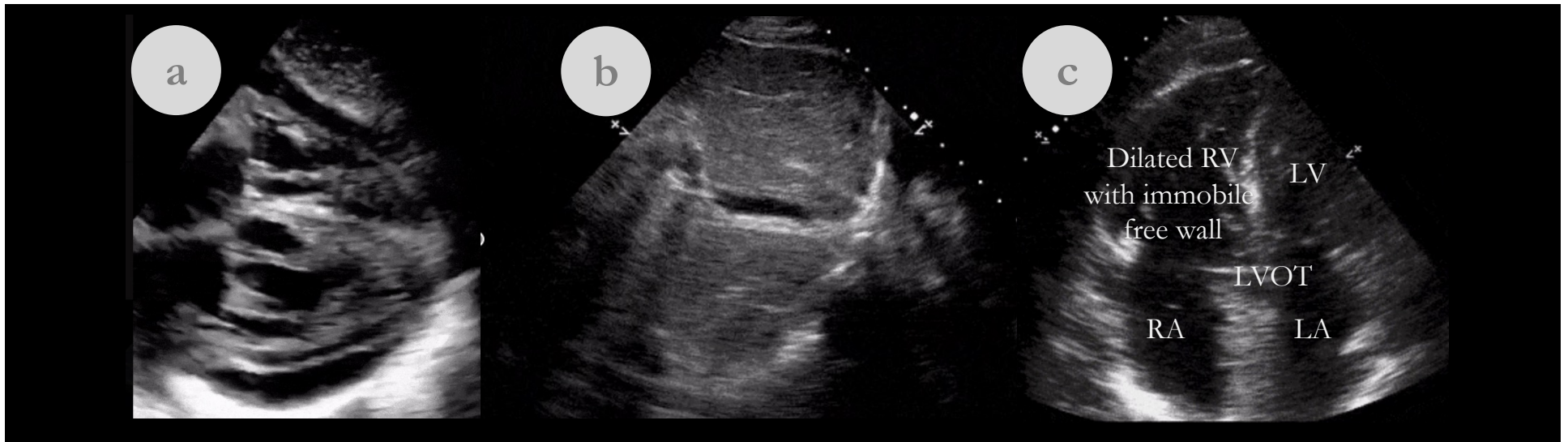


# Case #3 How-To: POCUS in an RRT or Code Blue

- *Target images and questions:*

1. Sub-xyphoid cardiac window:

- a) Is there a large effusion? If so, is there RV diastolic collapse (tamponade)? May require ROSC to see tamponade physiology.
- b) Are the ventricles dramatically underfilled (hypovolemia/hemorrhage, tension ptx)? Can support by imaging IVC (fully collapsing?).
- c) Is the RV enlarged and hypocontractile (massive PE or severe pHTN)? May require ROSC to see contractility. If intubating, beware “RV death spiral!”



These are 3 representative clips from 3 different patients (not ours)  
from The Pocus Atlas



# Case #3 How-To: POCUS in an RRT or Code Blue

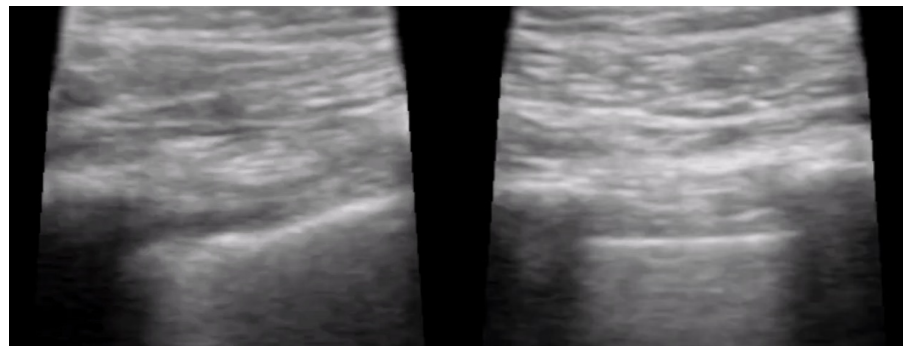
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2. Lung apices:

- a) Is there lung sliding bilaterally during bag-mask-valve breath delivery (pneumothorax vs possible esophageal vs R mainstem intubation)? Beware false positives like advanced COPD. Ask someone else to listen for breath sounds.
- b) If uncertain, evaluate with M-mode and evaluate diaphragmatic excursion with breath delivery.



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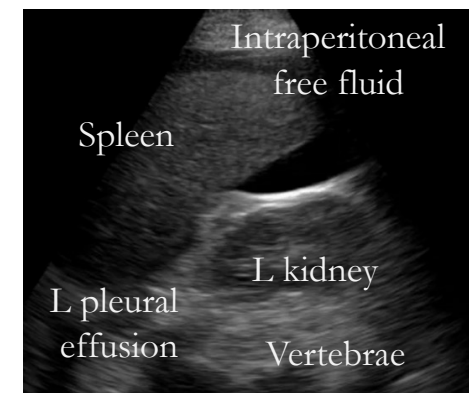
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3. RUQ, LUQ:

- a) Is there large-volume possible hemoperitoneum?



# Free Online Resources for POCUS Learning

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*Highest yield early on:*

- CORE Ultrasound's "[5 Minute Sono](#)" website
- The Curbsiders Podcast episode #108, "[POCUS for the Internist](#)"
- Stanford Emergency Medicine "[Sono Doc Game](#)" for web browser
- University of Toronto's "[Focused Cardiac Ultrasound](#)" website
- MGH [White Book Procedures section](#) and MGH [Gray Book](#)

*For deeper dives:*

- ACP [POCUS pathway](#) didactic resources (available if you have MKSAP)
- "[POCUS Geek](#)" YouTube channel (among many others)
- "[POCUS Atlas](#)" website
- "[SonoSupport](#)" app for phone/tablet

## Options for Building a Bedside Ultrasound Skillset during Residency

- Explore an elective with BWH/MGH Division of Emergency Ultrasound
  - Contact: Dr. Calvin Huang; [ckhuang@partners.org](mailto:ckhuang@partners.org)
- Take a two-day MGH Bedside Ultrasound short course in December using funds from your residency pathway track
  - <https://cmecatalog.hms.harvard.edu/bedside-ultrasound>
- Complete American College of Physician's [POCUS pathway](#)
  - Online courses free to ACP members (which you are for MKSAP)
- Earn Society of Hospital Medicine's [POCUS Certificate of Completion](#)
  - Credential if aiming to incorporate POCUS centrally into your clinical career
- Obtain your own device (Butterfly vs Lumify) via a grant application, funds from your pathway, or moonlighting \$hifts
  - MGB Center of Expertise in Medical Education [project grant](#)
  - BWH Research Institute [Microgrants](#)
  - Massachusetts Medical Society [InfoTech Award](#)
- Always order a formal ultrasound to confirm clinically relevant findings (positive or negative), then review the pros' images and reports for QA