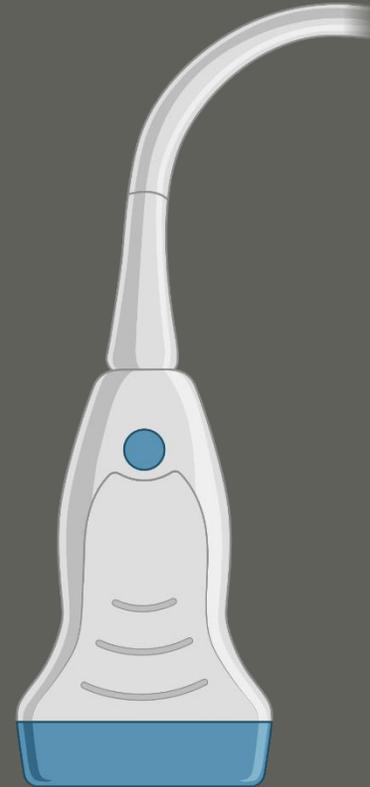


Is point-of-care ultrasound an extension of
the physical exam or a formal study?
- “Yes”

Brandon Fainstad, MD
University of Colorado
February 10th, 2023



Created with BioRender.com

Disclosures

- No financial disclosures

*Audience
response

What is your level of experience with point-of-care ultrasound?

- a) I looked at a machine once
- b) I have some experience, but I don't use it in clinical practice
- c) I occasionally incorporate ultrasound into clinical decision-making
- d) I routinely incorporate ultrasound into clinical decision-making
- e) I am an ultrasound leader and/or educator

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Text **CHRISTINEWES031** to **22333** once to join

What is your level of experience with point-of-care ultrasound?

I looked at a machine once

I have some experience, but I don't use it in clinical practice

I occasionally incorporate ultrasound into clinical decision-making

I routinely incorporate ultrasound into clinical decision-making

I am an ultrasound leader and/or educator

Learning Objectives

at the end of this talk participants should be able to:

1. Describe the **value and implications of using POCUS** as an augmentation of the physical exam.
2. **Apply Bayesian reasoning to bedside exam** findings (including POCUS) to enhance pre-test probabilities.
3. Explain the **added value and required tools to achieve a more formalized POCUS** exam.

Case 1a

A 50-year-old presents to clinic with **a red, painful, and swollen right** leg that developed over the past 3 days. He has never had a DVT but did take a 3-hour plane trip a week ago. He reports subjective chills but is **afebrile** and hemodynamically stable. Leg is warm and **erythematous with ill-defined margins**. You are concerned it could be cellulitis, venous stasis dermatitis, or DVT.

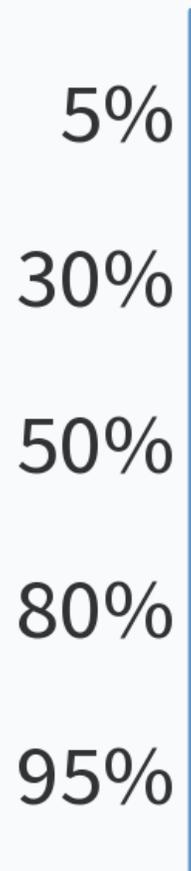
What is your pre-test probability for DVT?

- a) 5%
- b) 30%
- c) 50%
- d) 80%
- e) 95%

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What is your pre-test probability for DVT?

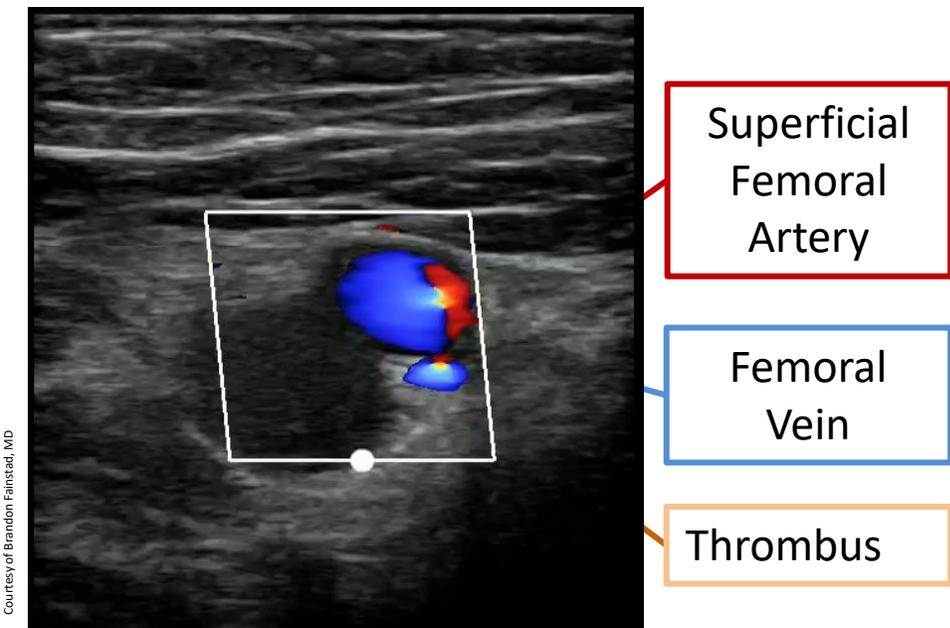


Case 1a

50-year-old presents to clinic with a red, painful and swollen **right** leg that developed over the past 3 days. He has never had a DVT but did take a 3-hour plane trip a week ago. He reports subjective chills but is afebrile and hemodynamically stable.

Leg is warm and erythematous with ill-defined margins. You are worried it could be cellulitis or DVT.

You obtained a bedside lower extremity vascular ultrasound...



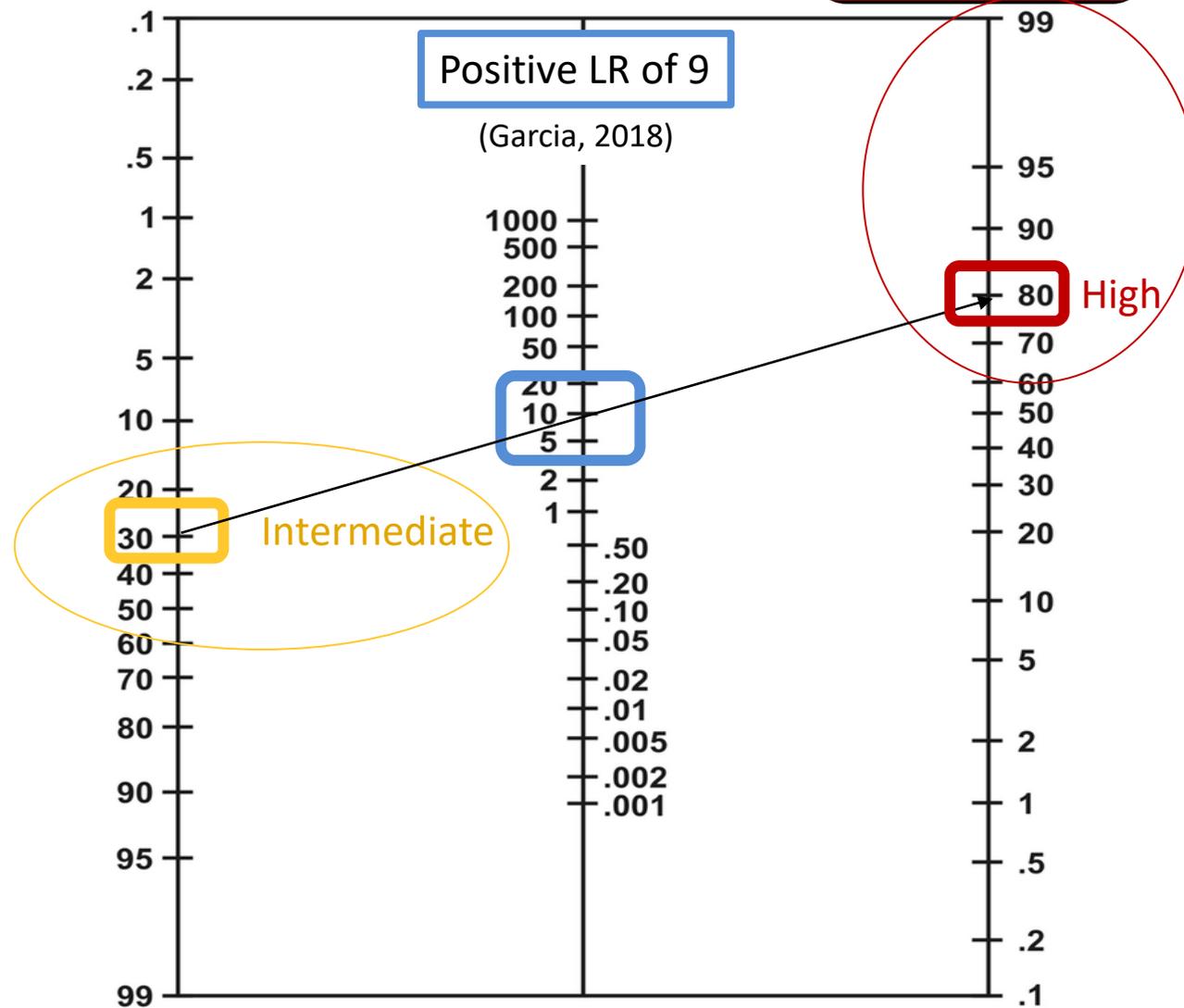
What is your interpretation?

DVT?

Pre-Pocus Probability (%)?

DVT POCUS Likelihood Ratio

What is your Post-POCUS Probability (%)?



Is point-of-care ultrasound an extension of the physical exam or a formal study?

It depends on:

1. Clinical question.
2. Provider's skill set.
3. Time.
4. Available equipment and infrastructure.

When poll is active, respond at pollev.com/christinewes031

Text **CHRISTINEWES031** to **22333** once to join

Is point-of-care ultrasound an extension of the physical exam or a formal study? It depends on:

Clinical question.

Provider's skill set.

Time

Available equipment
and infrastructure

When do you photograph a rash to put into the chart?

Is there diagnostic uncertainty?

Is it mild or severe?

Is it expected to improve?

Is there benefit from external review?



Physical Exam

POCUS



A diagnostic tool

Rapid, point-of-care

**Findings
modify disease
probability**

**Operator
dependence**

Quality control

Test characteristics

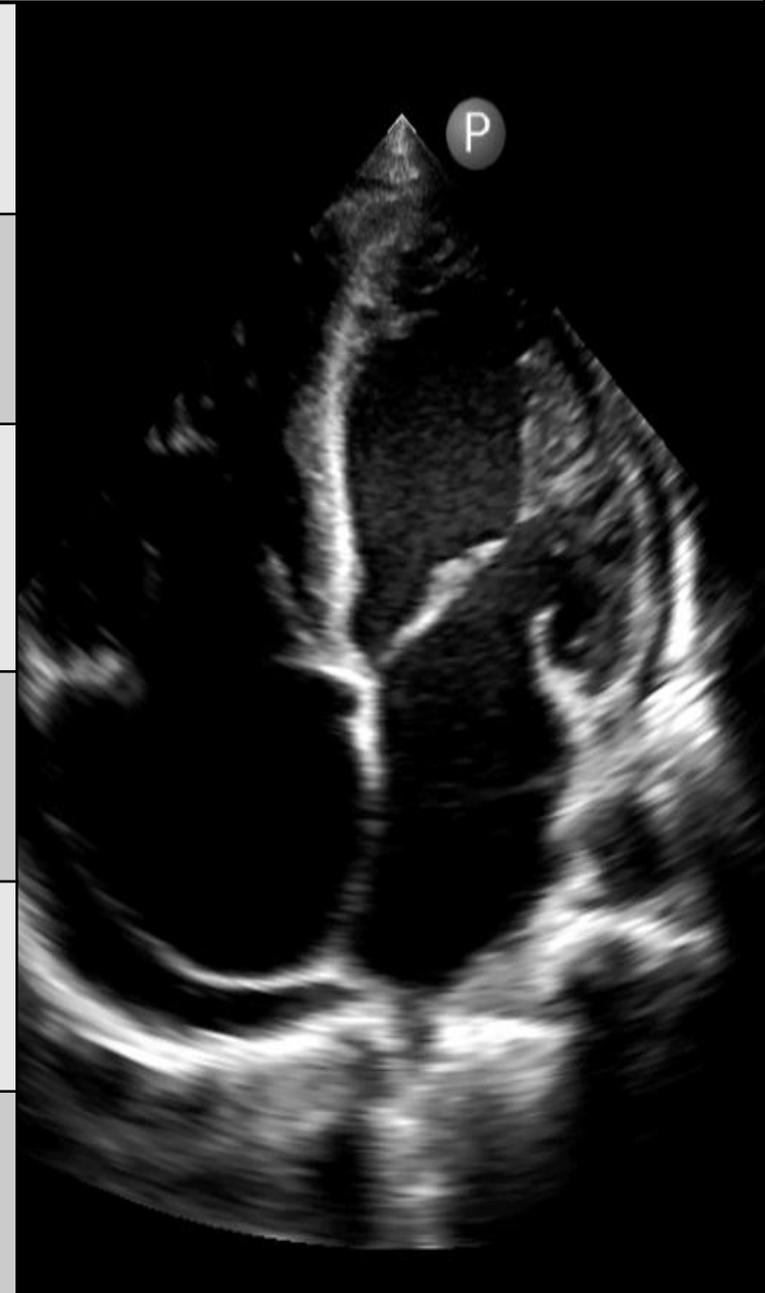


Physical Exam

POCUS



✓	A diagnostic tool	
✓	Rapid, point-of-care	
✓	Findings modify disease probability	
X	Operator dependence	
Limited	Quality control	
Limited	Test characteristics	

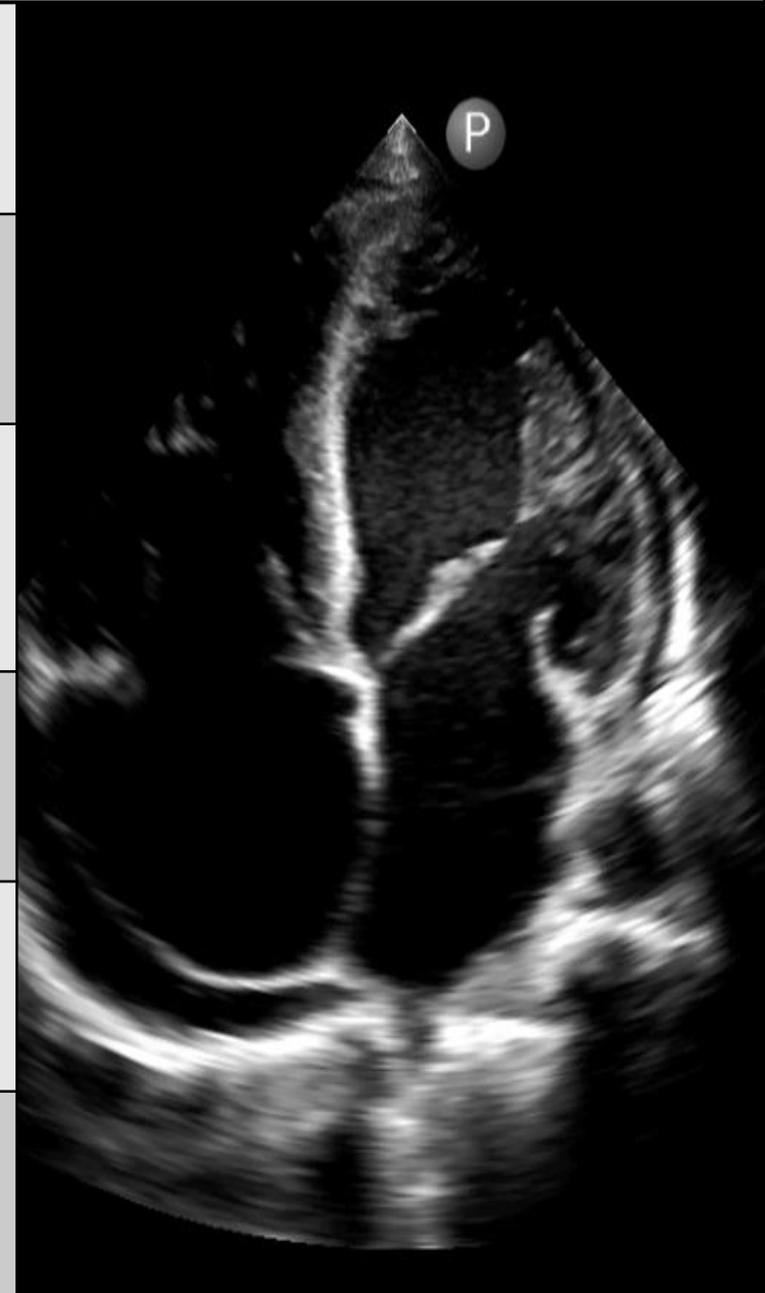


Physical Exam

POCUS



✓	A diagnostic tool	✓
✓	Rapid, point-of-care	✓
✓	Findings modify disease probability	✓
X	Operator dependence	X
Limited	Quality control	Better
Limited	Test characteristics	Better



Bayes' Theorem

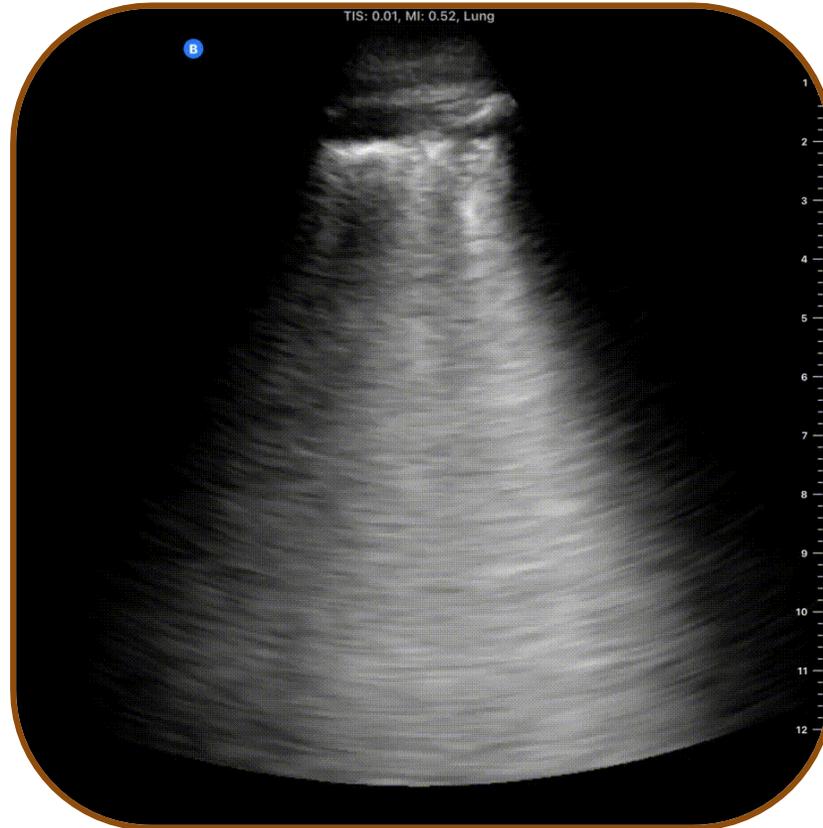
Pre-test probability

What we
already know

e.g., the likelihood a hospitalized patient's hypoxemia is due to heart failure.

Likelihood ratio

New
information

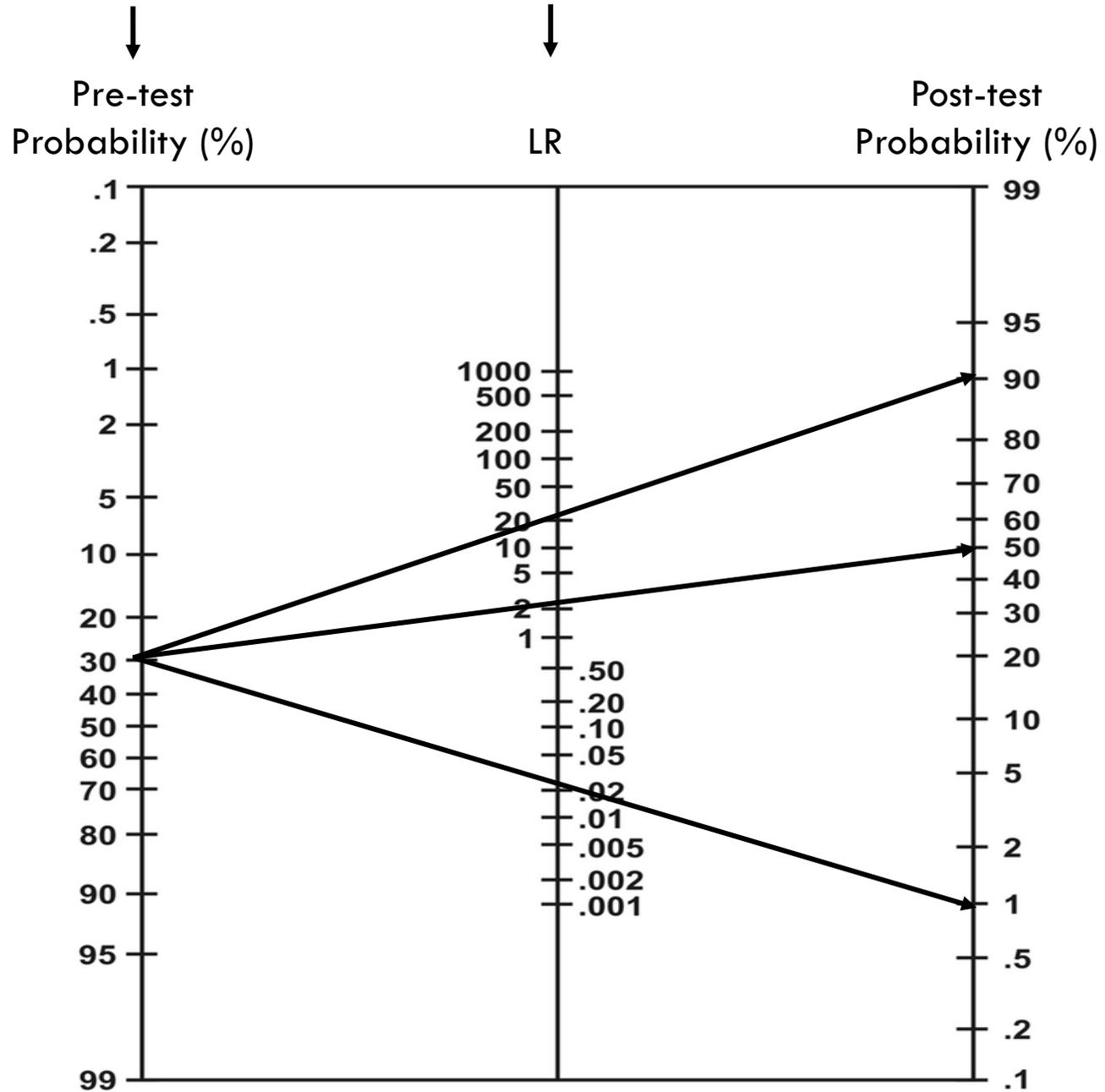


Post-test probability

Updated
knowledge

Bedside Assessment

Test or Study



Interpreting Test Results
Likelihood ratio nomogram

Bedside Assessment

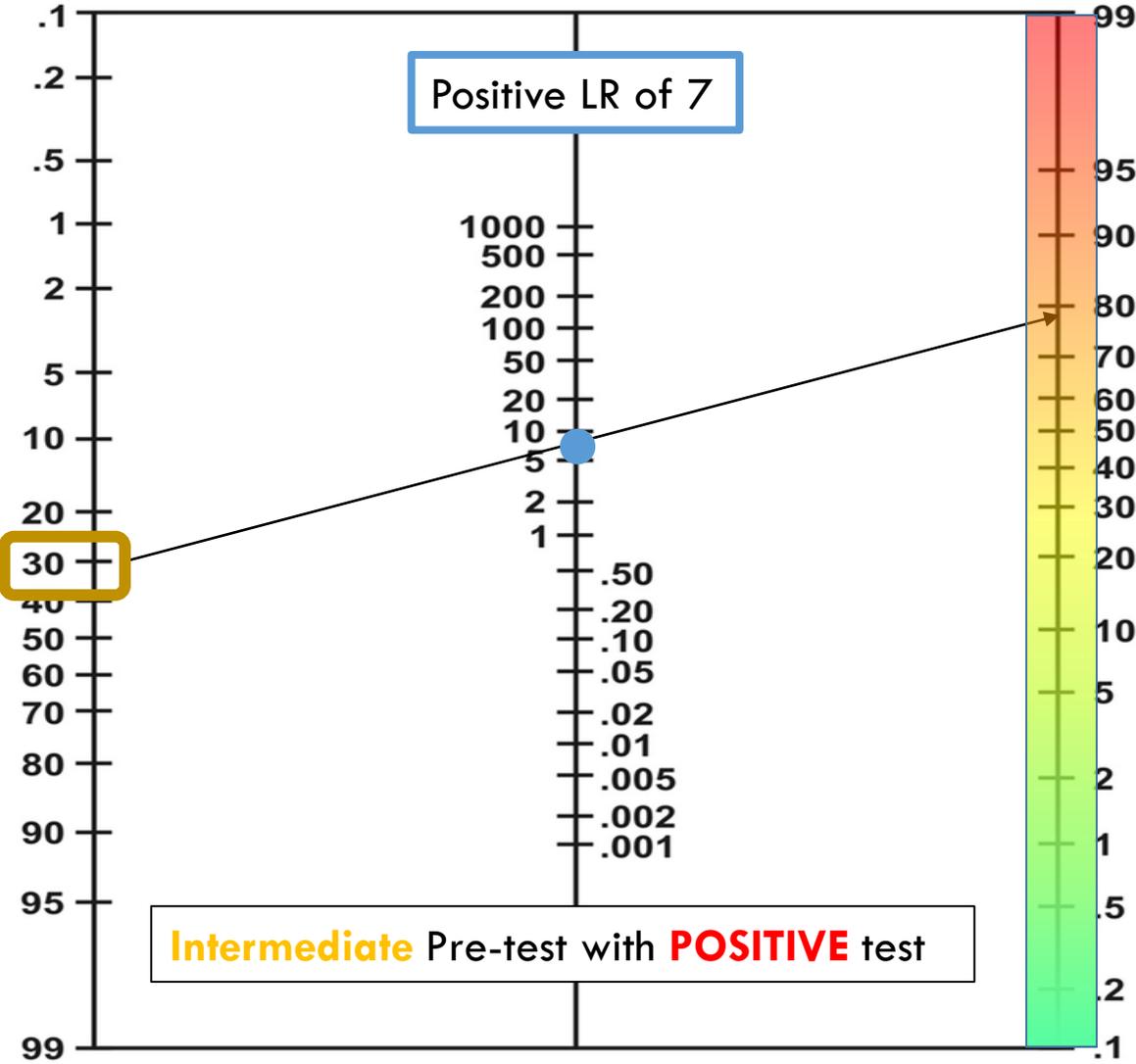
Test or Study

↓
Pre-test
Probability (%)

↓
LR

Post-Test
Probability (%)

Management



Positive LR of 7

30

Intermediate Pre-test with **POSITIVE** test

High

Intermediate

Low

Empiric
Treatment
(+/- confirmatory
formal study)

Obtain more
diagnostic
data

Defer
Diagnosis

Bedside Assessment

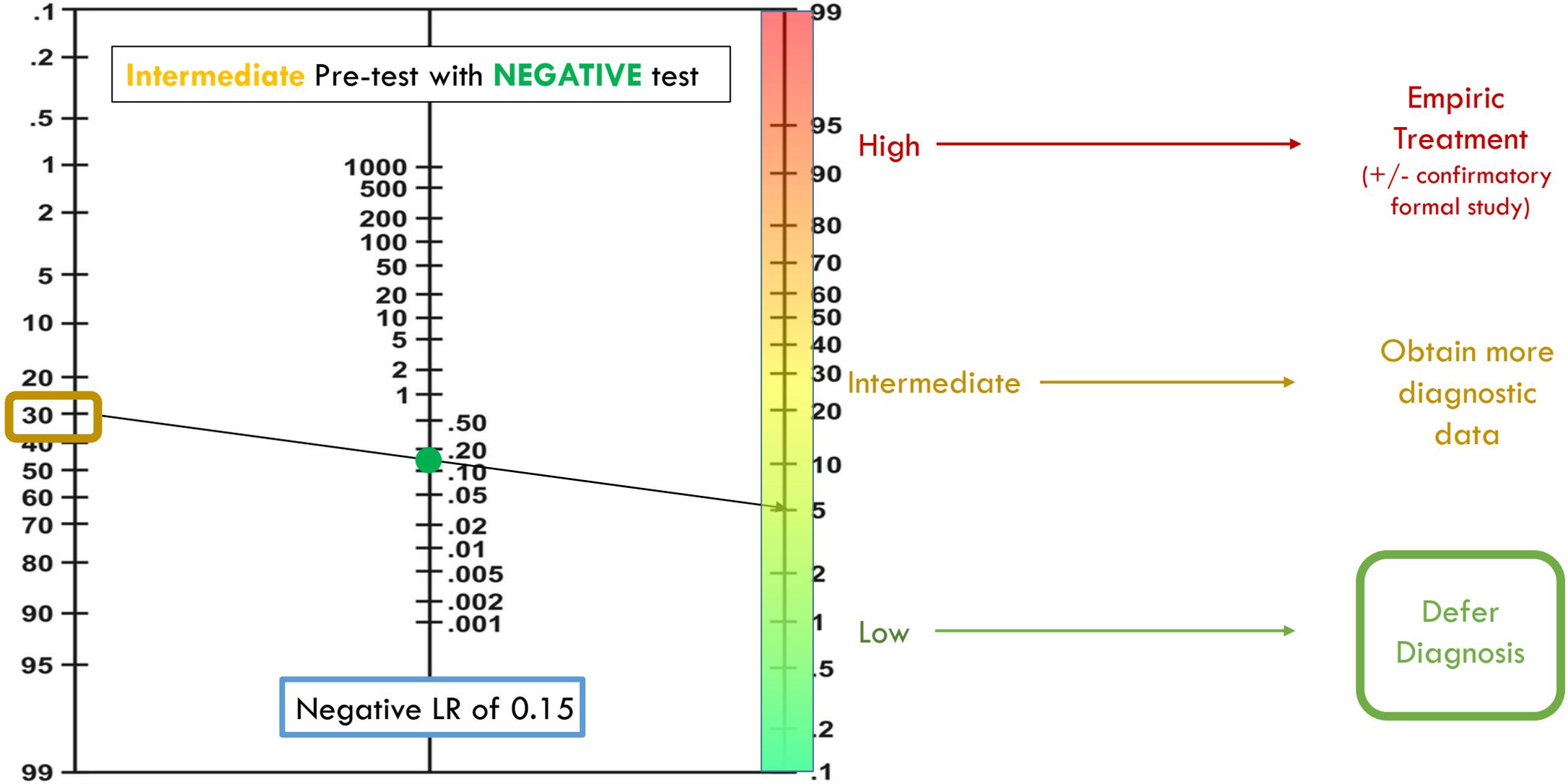
Test or Study

Pre-test Probability (%)

LR

Post-Test Probability (%)

Management



Intermediate Pre-test with NEGATIVE test

Negative LR of 0.15

High

Intermediate

Low

Empiric Treatment (+/- confirmatory formal study)

Obtain more diagnostic data

Defer Diagnosis

Bedside Assessment

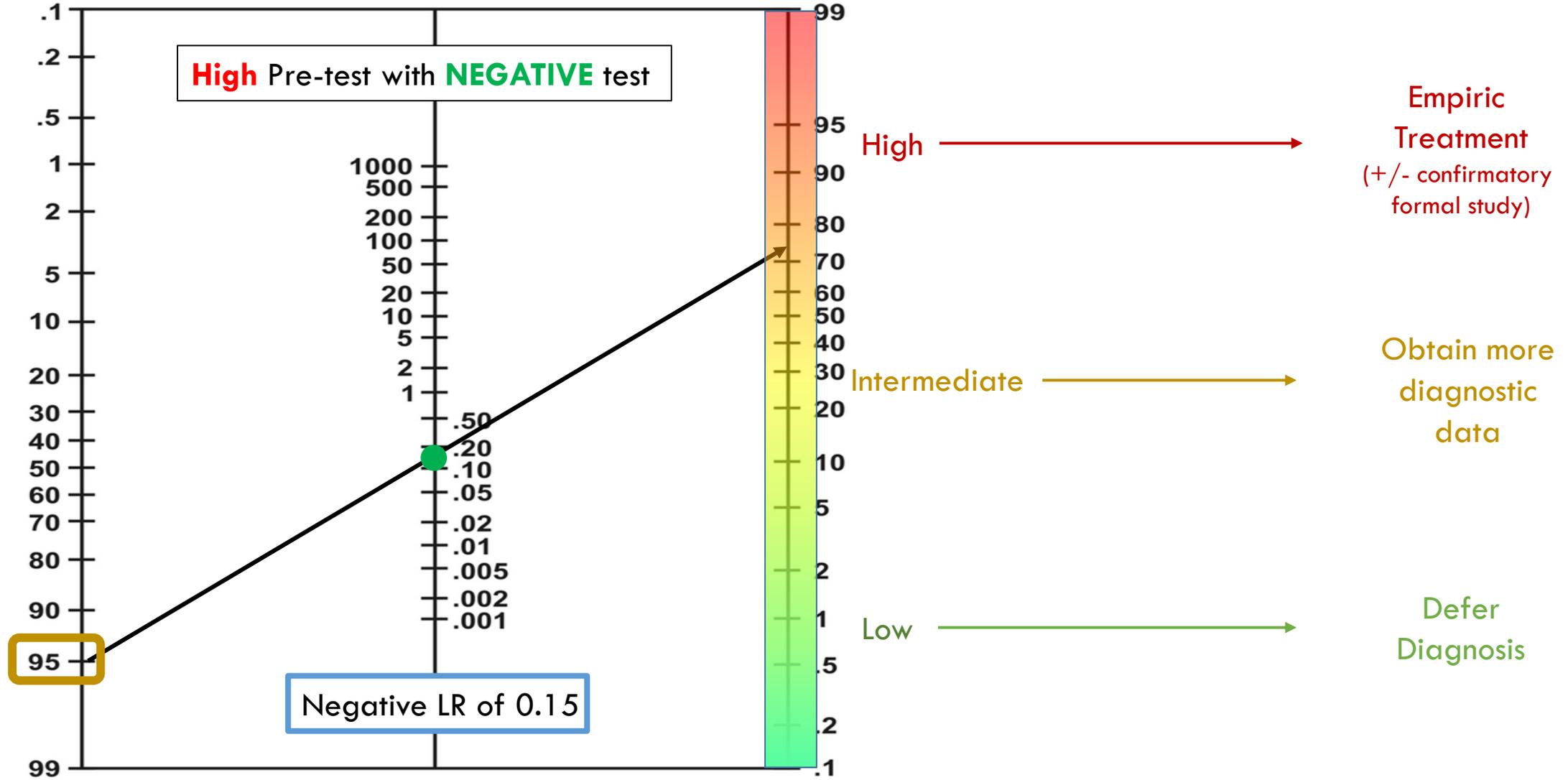
Test or Study

Pre-test
Probability (%)

LR

Post-Test
Probability (%)

Management



Disease Characteristics vs. Management

Urinary tract infection

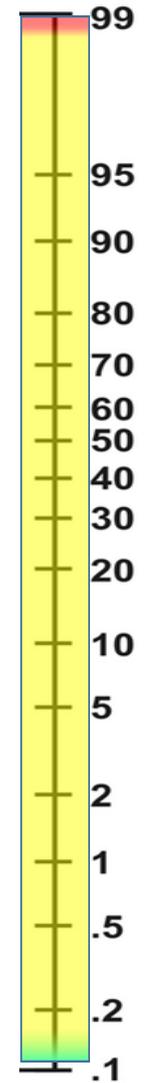
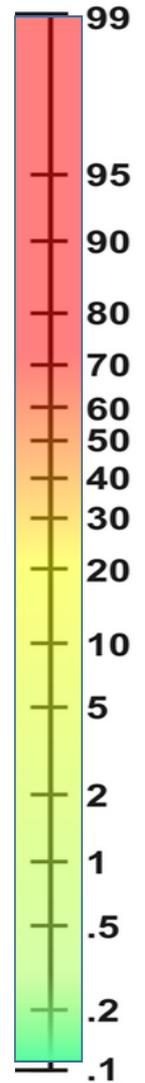
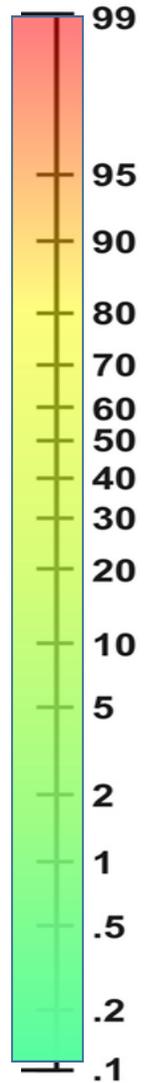
Heparin-Induced
Thrombocytopenia

Colon cancer

Treat +/-Test

Test

Defer



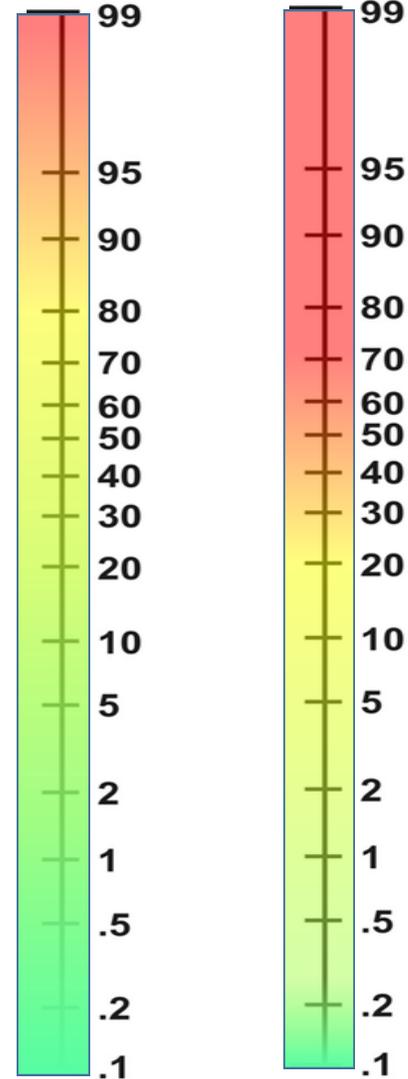
Patient characteristics vs. Management

Treat +/-Test

Test

Defer

Pulmonary embolism
Mild oxygen requirement
and normal CXR



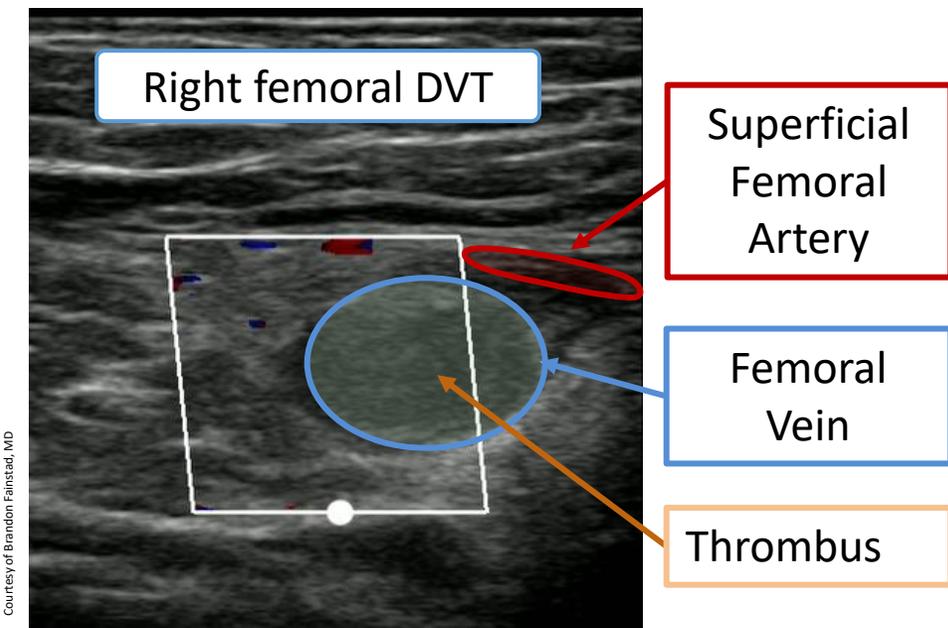
Pulmonary embolism
Severe acute hypoxic respiratory
failure and normal CXR

Case 1a

50-year-old presents to clinic with a red, painful and swollen **right** leg that developed over the past 3 days. He has never had a DVT but did take a 3-hour plane trip a week ago. He reports subjective chills but is afebrile and hemodynamically stable.

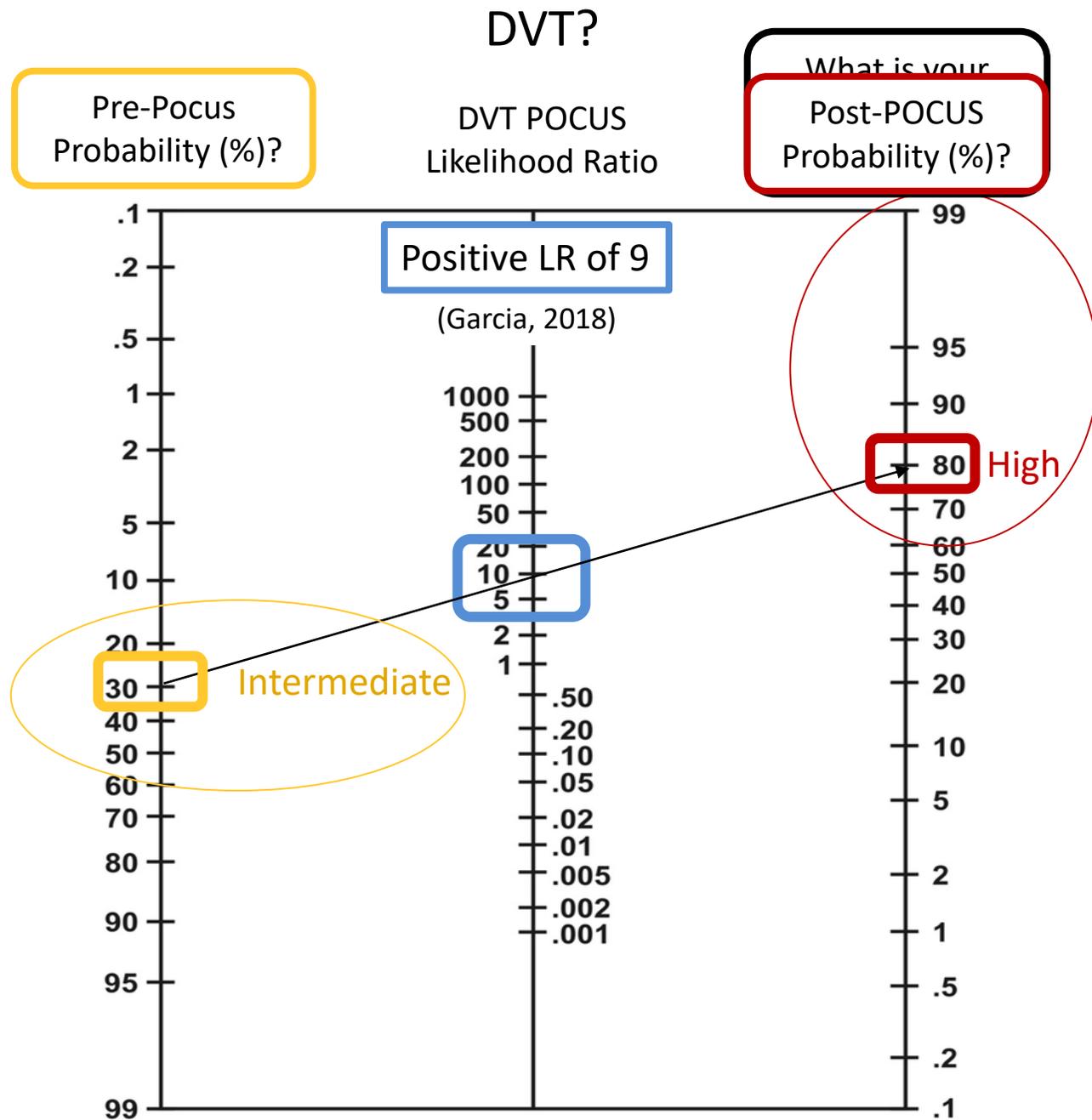
Leg is warm and erythematous with ill-defined margins. You are worried it could be cellulitis or DVT.

You obtained a bedside lower extremity vascular ultrasound...



Assuming pain is moderate, how would you manage this patient?

Initiate DOAC? Order a d-dimer?
Order a formal study? Document as a formal?

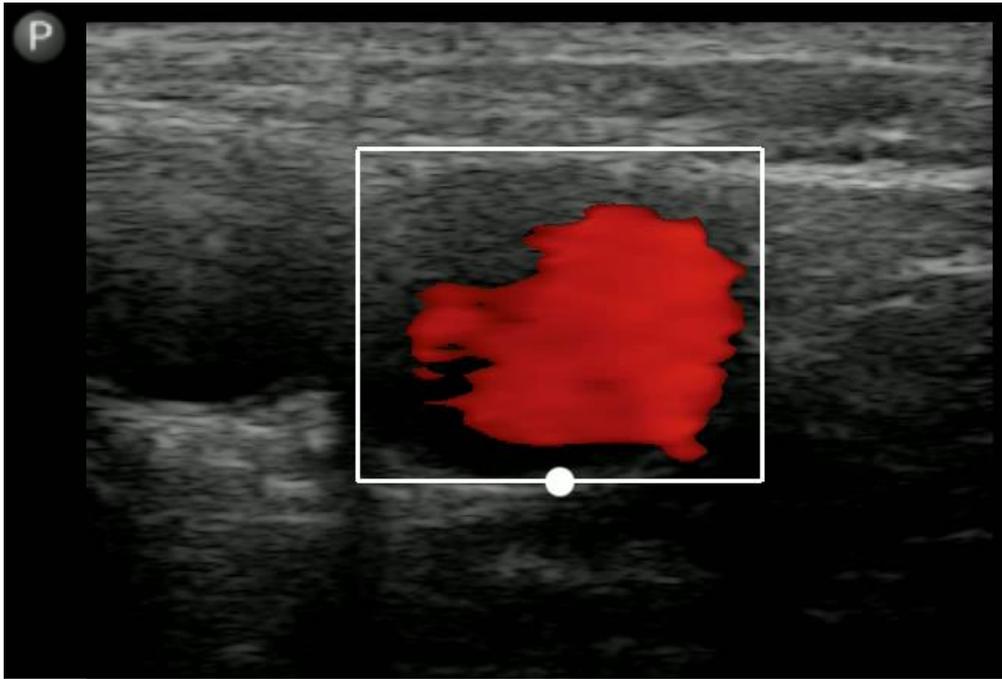


Case 1b – Same presentation, different POCUS

exam

50-year-old presents to clinic with a red, painful and swollen right leg that developed over the past 3 days. He has never had a DVT but did take a 3-hour plane trip a week ago. He reports subjective chills but is afebrile and hemodynamically stable. Leg is warm and erythematous with ill-defined margins. You are worried it could be cellulitis or DVT.

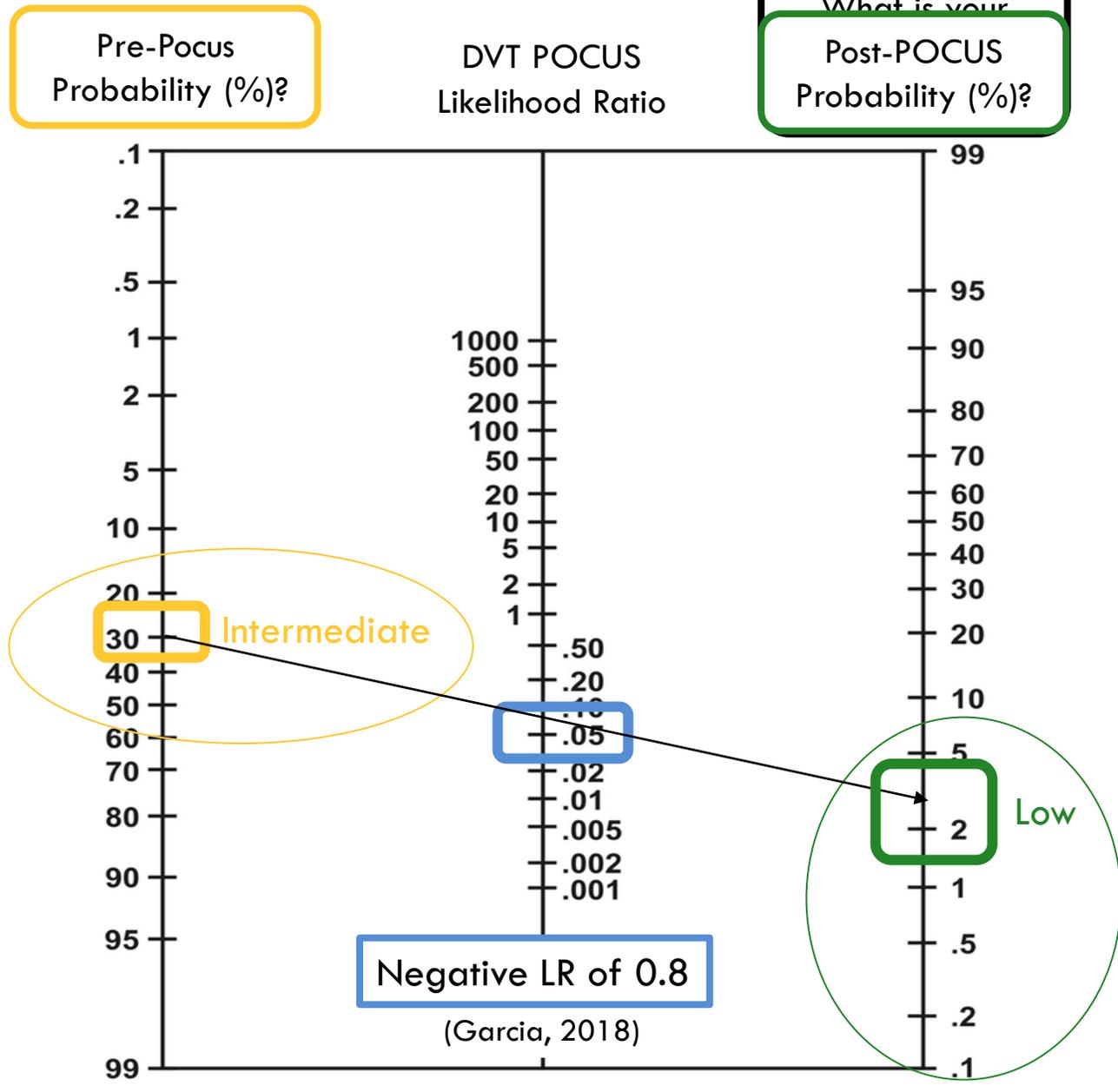
You obtained a bedside 2-region lower extremity vascular ultrasound exam with similar imaging throughout the exam...



What is your extremity DVT?

What is your extremity cellulitis?

DVT?



Negative LR of 0.8

(Garcia, 2018)

Case 1a

70-year-old presents to clinic with a red, painful and swollen right leg that developed over the past 3 days after **returning from a 9-hour flight**. He previously **had a provoked DVT 10 years ago but is no longer on AC**. He reports subjective chills but is afebrile and hemodynamically stable, **BMI 35**. Leg is warm and erythematous with ill-defined margins.

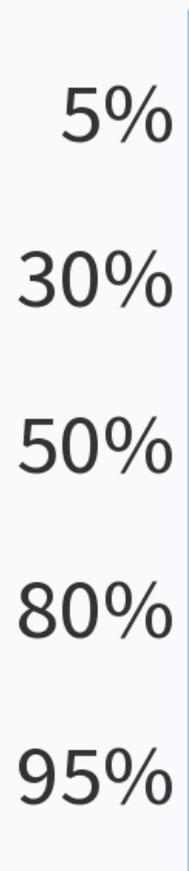
What is your pre-test probability for DVT?

- a) 5%
- b) 30%
- c) 50%
- d) 80%
- e) 95%

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What is your pre-test probability for DVT?



Case 1c – Different presentation, different POCUS exam

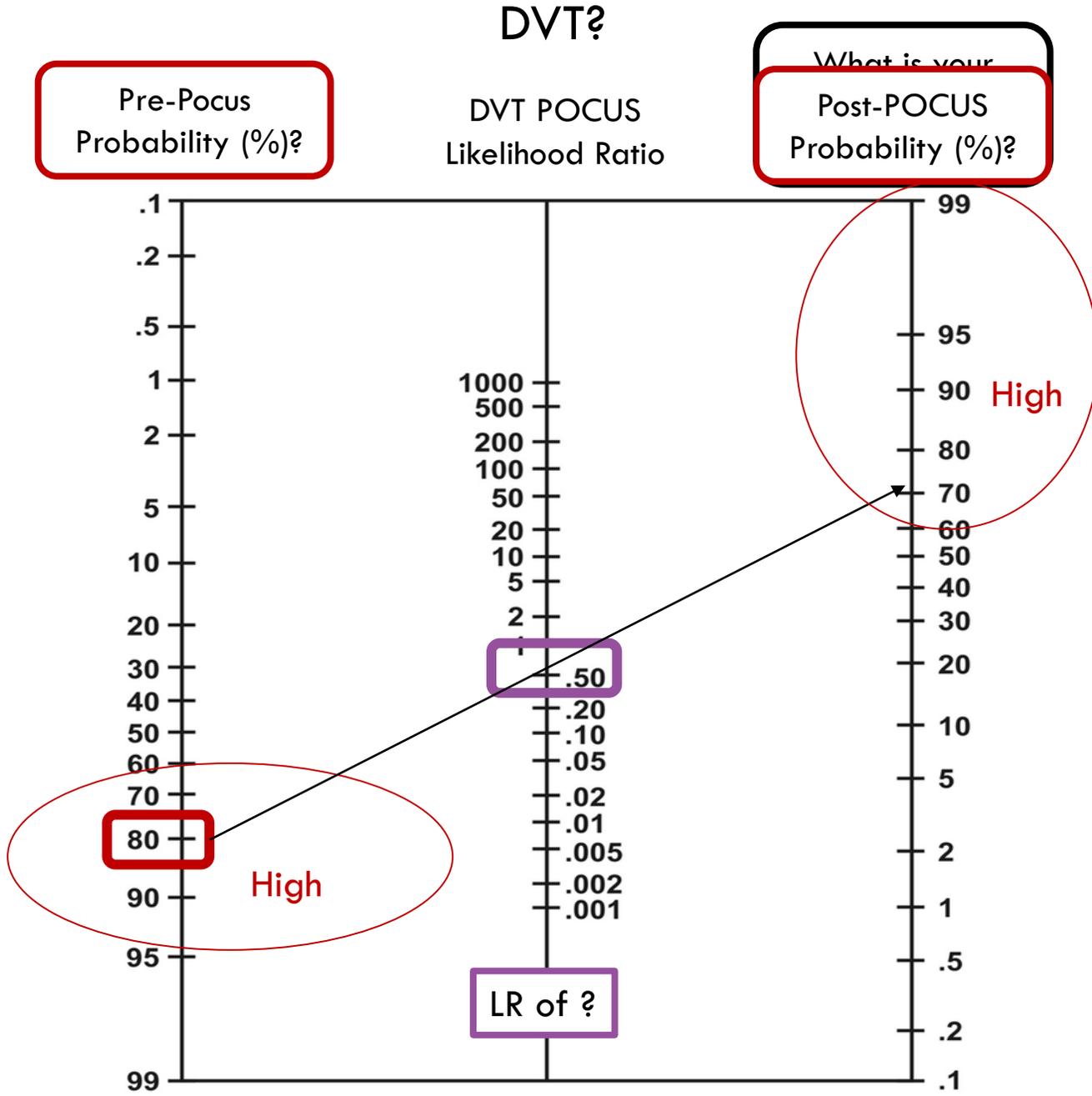
70-year-old presents to clinic with a red, painful and swollen right leg that developed over the past 3 days after returning from a 9-hour flight. He previously had a provoked DVT 10 years ago but is no longer on AC. He reports subjective chills but is afebrile and hemodynamically stable, BMI 35. Leg is warm and erythematous with ill-defined margins.

You obtained a bedside 2-region lower extremity vascular ultrasound exam with similar imaging throughout the exam...



What is your Inconclusive interpretation?

What is your next step in D-dimer? Formal study? management?



Case 2a

60-year-old woman with COPD and CHF presents to **clinic** with sub-acute worsening of **SOB and a non-productive cough**, worse when lying flat. She is afebrile, BP 155/80, HR 74, RR 22, **90% on room air**, BMI 36. It is difficult to assess JVD, there are mild bibasilar crackles and expiratory wheezing when she lies flat on the exam table.

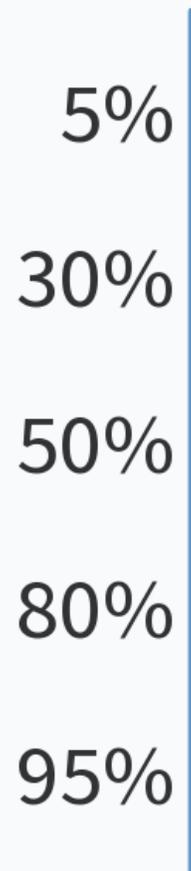
What is your pre-test probability for CHF?

- a) 5%
- b) 30%
- c) 50%
- d) 80%
- e) 95%

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Text **CHRISTINEWES031** to **22333** once to join

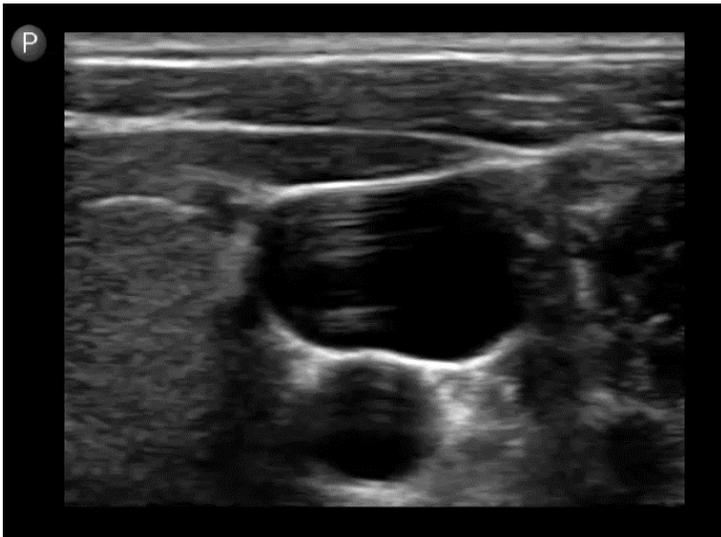
What is your pre-test probability for CHF?



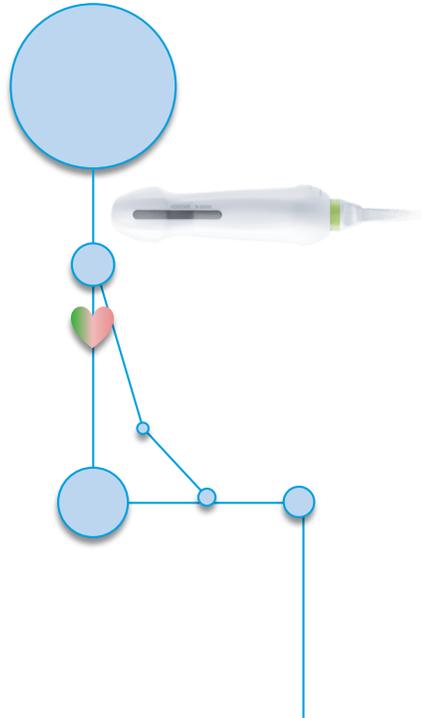
Case 2a

60-year-old woman with COPD and CHF presents to **clinic** with sub-acute worsening of **SOB and a non-productive cough**, worse when lying flat. She is afebrile, BP 155/80, HR 74, RR 22, **90% on room air**, BMI 36. It is difficult to assess JVD, there are mild bibasilar crackles and expiratory wheezing when she lies flat on the exam table.

Using a handheld ultrasound you assess the JVP 5cm above the clavicle with the patient sitting upright...

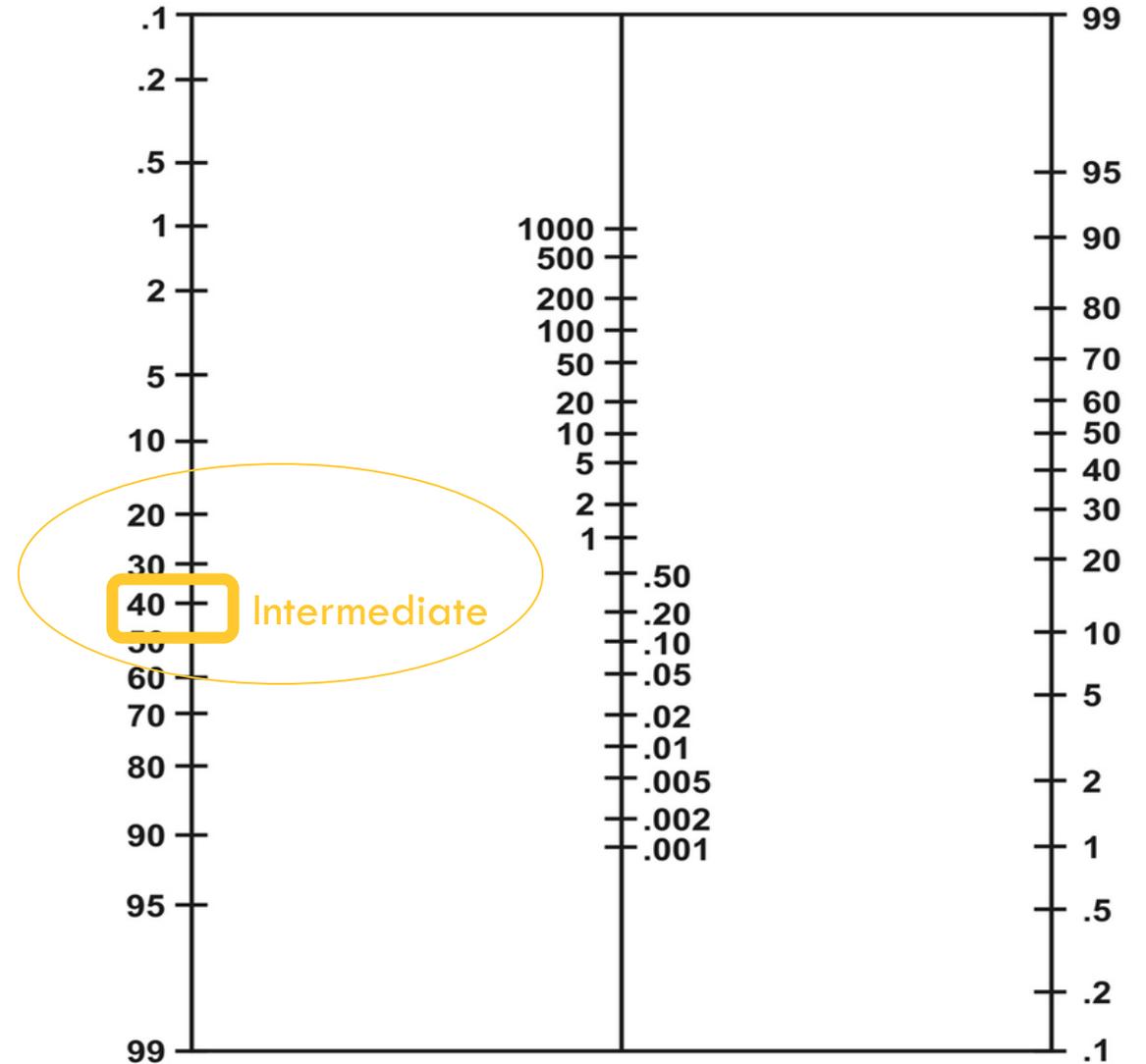


Right Atrial Interpretation



Decompensated CHF?

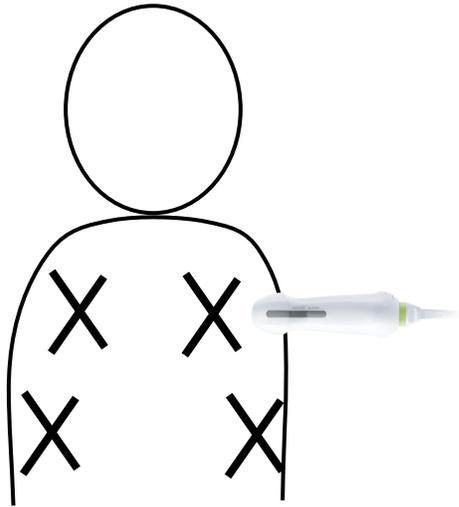
Pre-Pocus Probability (%)?



Case 2a

60-year-old woman with COPD and CHF presents to **clinic** with sub-acute worsening of **SOB and a non-productive cough**, worse when lying flat. She is afebrile, BP 155/80, HR 74, RR 22, **90% on room air**, BMI 36. It is difficult to assess JVD, there are mild bibasilar crackles and expiratory wheezing when she lies flat on the exam table.

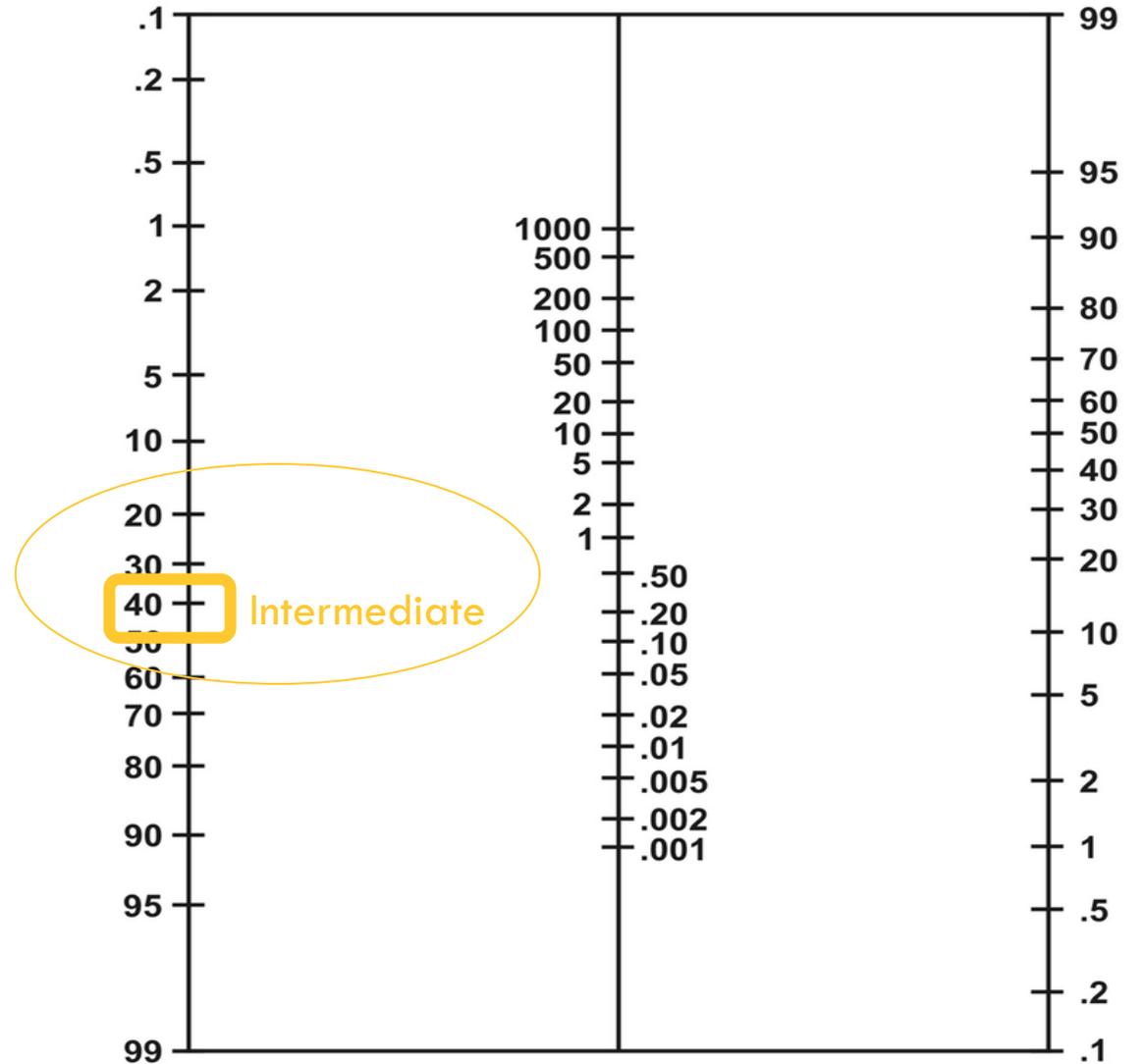
You now perform lung ultrasound and obtain similar images in four anterior quadrants of the chest



Diffuse Bilateral B-profile?

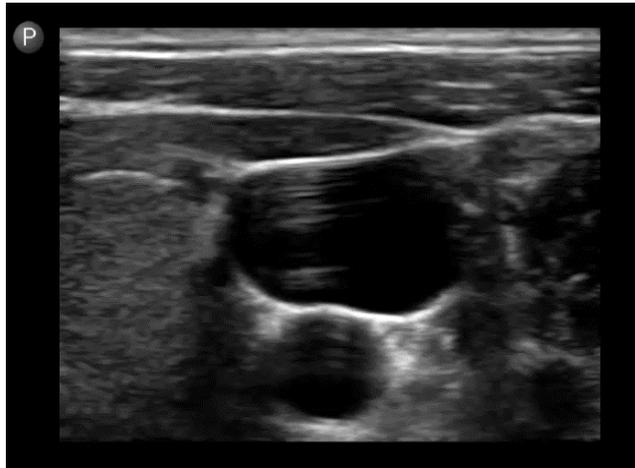
Decompensated CHF?

Pre-Pocus Probability (%)?



Case 2a

60-year-old woman with COPD and CHF presents to **clinic** with sub-acute worsening of **SOB and a non-productive cough**, worse when lying flat. She is afebrile, BP 155/80, HR 74, RR 22, **90% on room air**, BMI 36. It is difficult to assess JVD, there are mild bibasilar crackles and expiratory wheezing when she lies flat on the exam table.



Right Atrial Pressure > 12cm



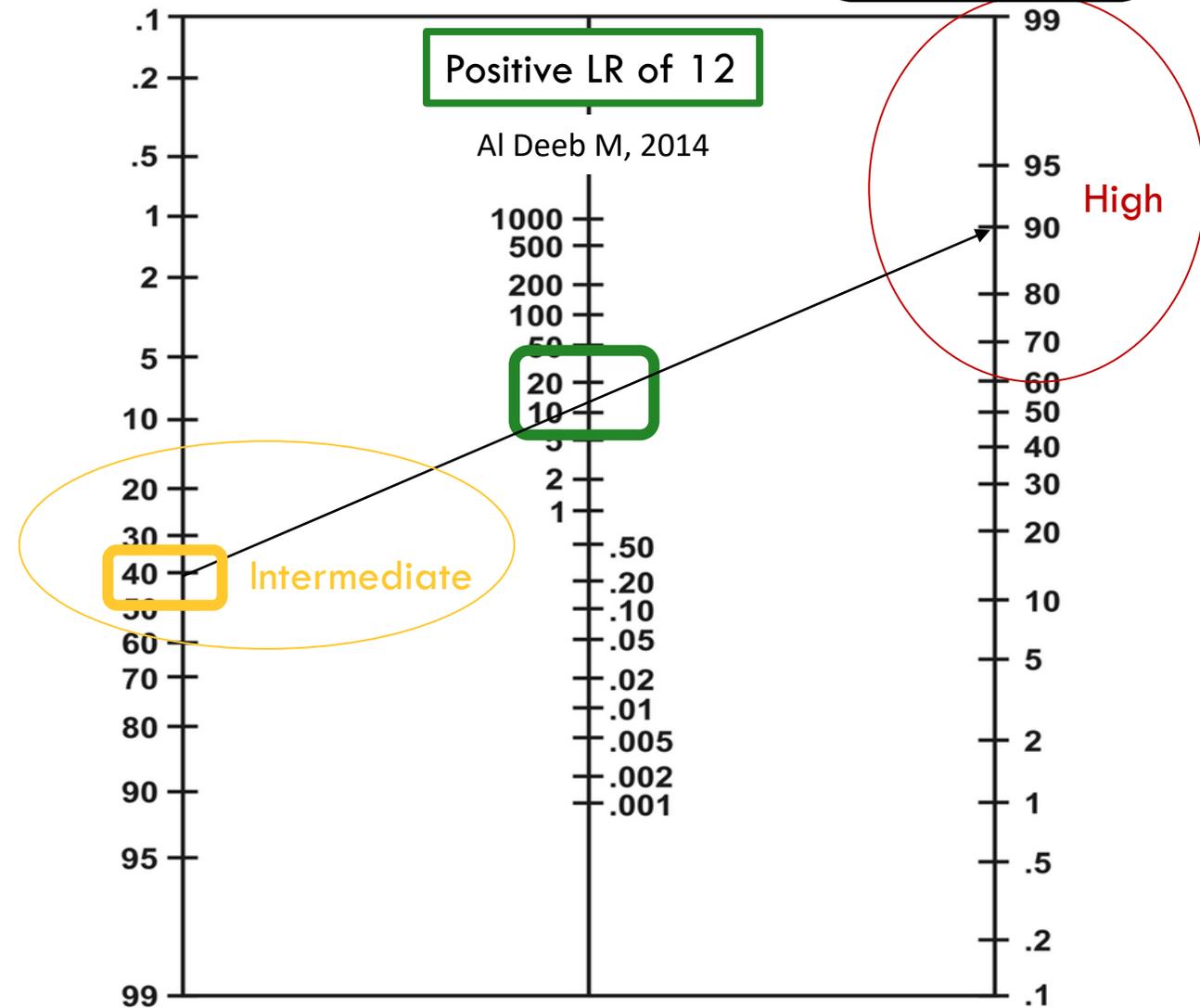
Diffuse bilateral B-profile

Decompensated CHF?

B-Lines for Cardiogenic Pulmonary Edema

What is your Post-POCUS Probability (%)?

Pre-Pocus Probability (%)?



Case 2a

70-year-old woman **with ILD** and CHF presents to **clinic** with sub-acute worsening of **SOB and a non-productive cough**, worse when lying flat. She is afebrile, BP 155/80, HR 74, RR 22, **90% on room air**, BMI 36. It is difficult to assess JVD, there are **diffuse crackles** and expiratory wheezing when she lies flat on the exam table.

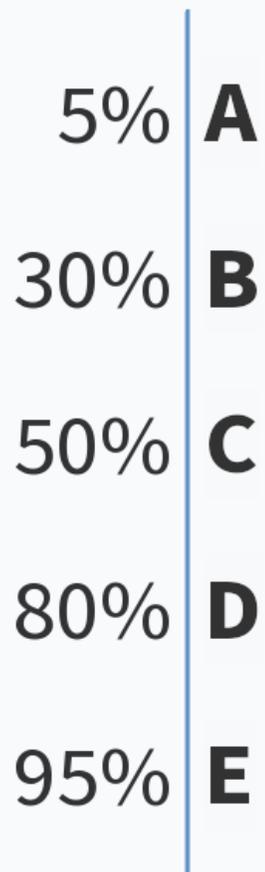
What is your pre-test probability for CHF?

- a) 5%
- b) 30%
- c) 50%
- d) 80%
- e) 95%

Respond at pollev.com/christinewes031

Text **CHRISTINEWES031** to **22333** once to join, then **A, B, C, D, or E**

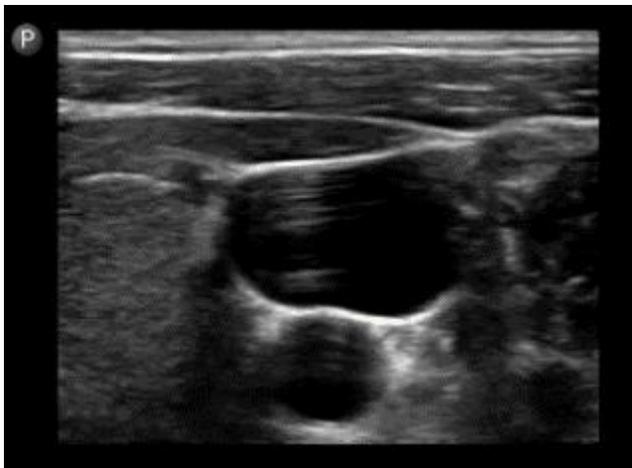
What is your pre-test probability for CHF?



Case 2b

70-year-old woman with ILD and CHF presents to clinic with sub-acute worsening of SOB and a non-productive cough, worse when lying flat. She is afebrile, BP 155/80, HR 74, RR 22, 90% on room air, BMI 36. It is difficult to assess JVD, there are diffuse crackles and expiratory wheezing when she lies flat on the exam table.

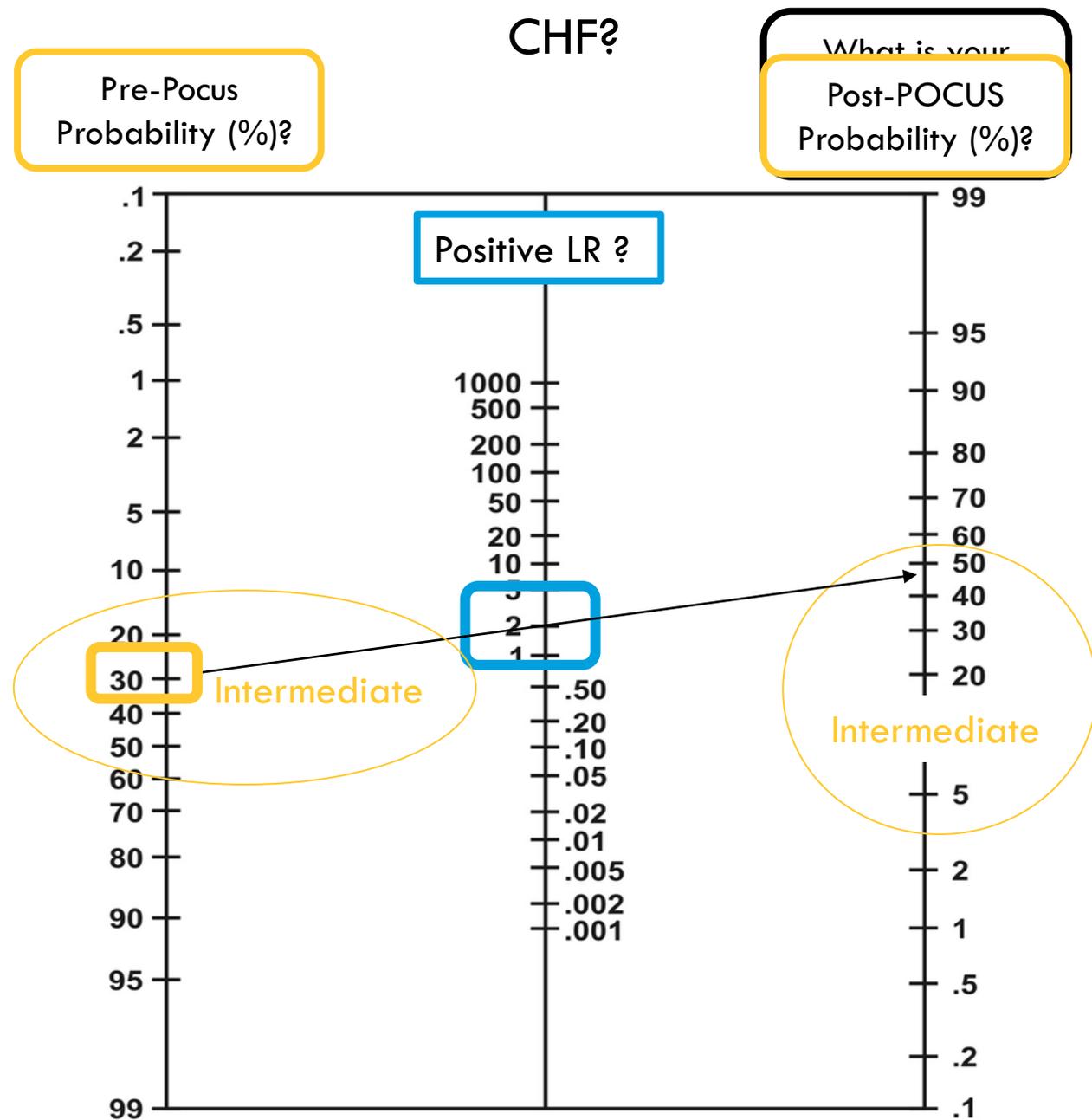
You assess RAP by JVP and perform a lung ultrasound with similar findings to those seen in Case 2a.



Right Atrial Pressure > 12cm Diffuse bilateral B-profile

But what positive LR would you use for elevated RAP and diffuse B-lines for the diagnosis of decomp CHF in this case?

Decompensated CHF?



Formalized POCUS exam

Building blocks

Continuum of formality

Bill for exam

"Formal ultrasound" – equivalent to radiology

Document impression in EHR

"Formal POCUS" – recording and uploading images with interpretation to a PACS and EHR. Often including quality assurance with formal review process.

Image and impression to PACS

Impression in "middleware"

Images stored in "middleware"

Report findings as portion of exam

Perform bedside scan

Indication and pre-test probability

"Informal POCUS" – use of real time bedside ultrasound without recorded images or interpretation.

Formalized POCUS exam

Building blocks

Value added

Bill for exam

Document impression in EHR

Image and impression to PACS

Impression in "middleware"

Images stored in "middleware"

Report findings as portion of exam

Perform bedside scan

Indication and pre-test probability

Reimbursement & reduce duplicate studies

Coordination of care & comparison over time

Quality Assurance

"Certification" – Third party designation.

"Credentialing" – Institutional privileging.

Enhanced accuracy of bedside assessment

How formal “should” the exam be?

Building blocks

Emergency setting

e.g., Tamponade or ectopic pregnancy

Bill for exam

Document impression in EHR

Image and impression to PACS

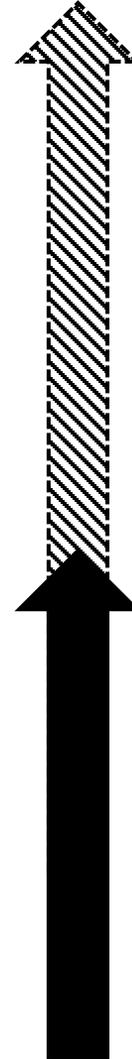
Impression in “middleware”

Images stored in “middleware”

Report findings as portion of exam

Perform bedside scan

Indication and pre-test probability



Document a **time-sensitive, serious clinical finding** that may justify an intervention **before a confirmatory study** is performed

How formal “should” the exam be?

Building blocks

Bill for exam

Document impression in EHR

Image and impression to PACS

Impression in “middleware”

Images stored in “middleware”

Report findings as portion of exam

Perform bedside scan

Indication and pre-test probability

Normal or non-urgent findings

e.g., soft tissue abscess or gallstones



Document a **finding** that may **NOT be critical clinically or billed for**. Allows for overreads, quality assurance, image portfolio

How formal “should” the exam be?

Building blocks

Bill for exam

Document impression in EHR

Image and impression to PACS

Impression in “middleware”

Images stored in “middleware”

Report findings as portion of exam

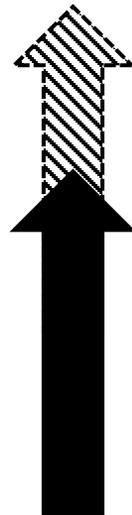
Perform bedside scan

Indication and pre-test probability

Routine bedside assessment

e.g., trending volume status in acute HF

Aid **clinical decision-making** in the moment in a scenario that **images will NOT be helpful** to other providers or later in time



Programmatic and Institutional Resources

- ACP statement in support of IM POCUS
- 3rd party QA options
- Podcast discussion of IM POCUS
- Curriculum Building
- Credentialing
- Billing
- Legal Reviews



Educational POCUS Resources

- Selected online educational content
- Key Conceptual Articles
- Example of Internal Medicine societal evidence-based clinical guidelines



Appreciation

Drs. Amiran Baduashvili, Nilan Schnure, Cameron Baston
&
ACP CO committee and support staff

Take home concepts for the clinical integration of POCUS

1. Commit to your pre-test probability and determine the exam test characteristics before integrating POCUS findings (or any diagnostic study) into clinical management.
2. The degree to which a provider 'should' formalize their POCUS exam depends on the clinical question, the clinical setting, and the available infrastructure.

Brandon Fainstad, MD – brandon.fainstad@cuanschutz.edu