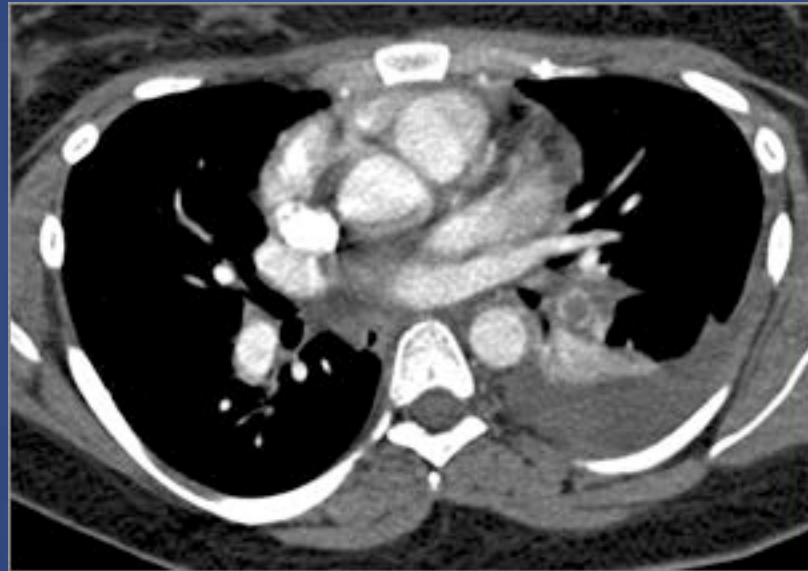


Pulmonary Emergencies



Emergency Medicine Clerkship Lecture Series

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Learning Objectives

- Review commonly encountered pulmonary emergencies
- Understand the critical decisions and interventions involved in their management
- Review scoring systems and clinical decision rules that can guide diagnosis and treatment

Case 1

- 37 year old female
- Sudden onset of pleuritic chest pain
- T 99.6 HR 110 RR 20 BP 115/70
Sat 94% RA
- Lungs with good aeration and clear to auscultation bilaterally



What is your most likely diagnosis?

Differential Diagnosis

- All Major Explanations of Terrible Pain
 - Aortic Dissection
 - MI
 - Esophageal rupture
 - Tension Pneumothorax
 - Pulmonary Embolism

Pulmonary Embolism

- Challenging diagnosis due to wide range of signs and symptoms
- Estimated that there are at least 600,000 cases annually in the US
- Mortality ranges from 5% (mild PE) to 37% (PE with shock)

Pulmonary Embolism

Common Signs and Symptoms

Sign or Symptom	% of Patients
Dyspnea	82
Chest Pain	49
Cough	20
Syncope	14
Hemoptysis	7
HR > 100	40
RR > 20	60

Pulmonary Embolism

Risk Factors

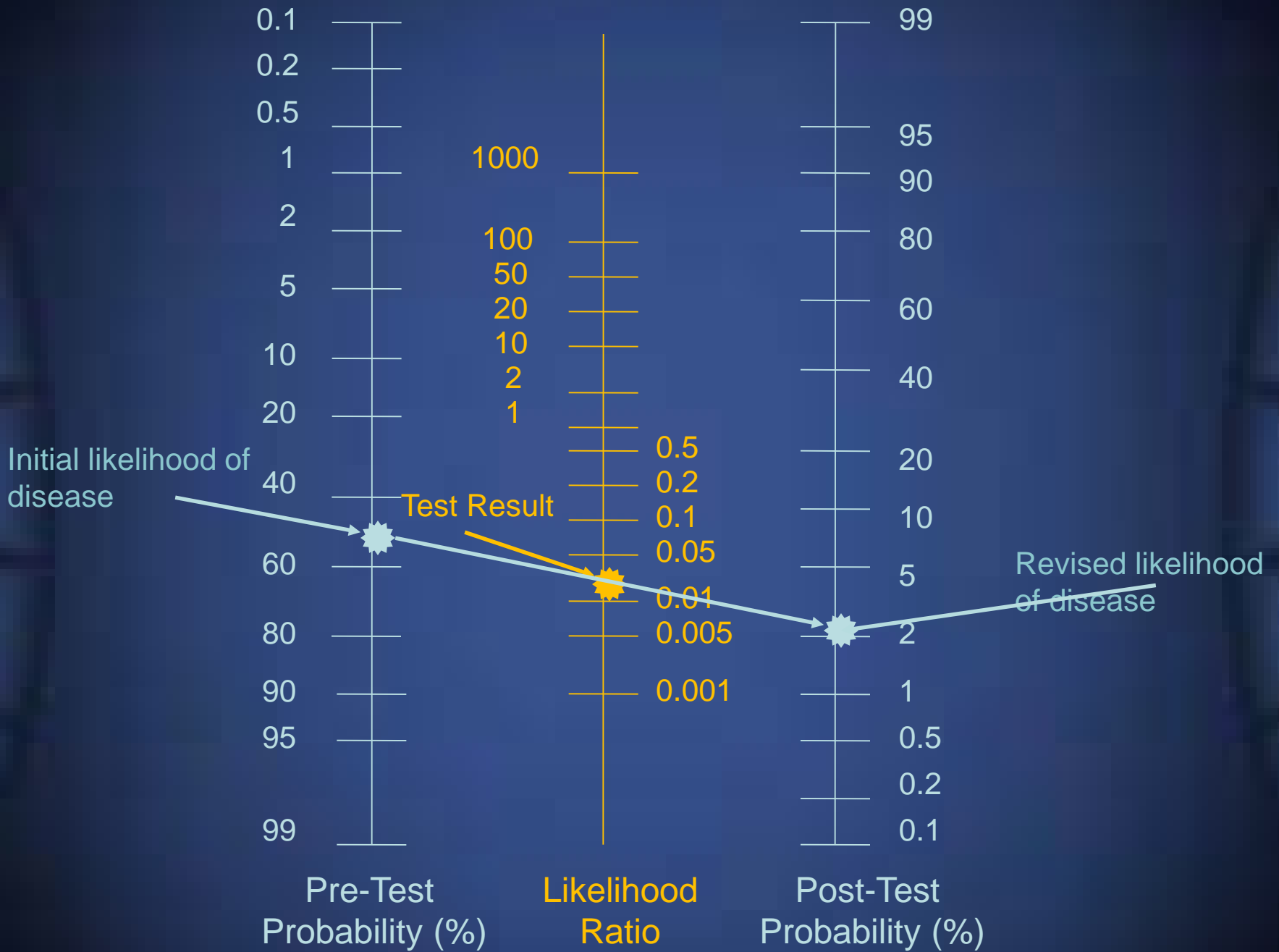
- Advanced age
- Cancer
- Major surgery
- Trauma
- Spinal cord injury
- Reduced mobility
- Immobilizer or cast
- Thrombophilia
- Protein C deficiency
- Protein S deficiency
- Factor V Leiden
- Obesity
- Pregnancy
- Hormone Replacement / OCPs

Pulmonary Embolism

Risk Factor	% of Patients
Age \geq 60	63
Obesity	29
Surgery within 2 months	29
Bed rest \geq 5 days	28
Previous DVT or PE	25
Cancer	23
Trauma	11
No risk factors	19


Pulmonary Embolism

- What is the diagnostic approach to evaluating for PE?
 - Initial clinical assessment of likelihood of disease (pre-test probability)
 - Appropriate diagnostic testing
 - Revised likelihood of disease (post-test probability)



Case 1 Continued...

- 37 year old female
- Sudden onset of pleuritic chest pain
- T 98.8 HR 110 RR 20 BP 115/70
Sat 94% RA
- Lungs with good aeration and clear to auscultation
- Uses OCPs and smokes cigarettes



What is the patient's clinical probability of pulmonary embolism?

Pulmonary Embolism

- What options are available to formulate pre-test probability?
 - Clinical gestalt
 - Clinical decision rule
 - Wells score
 - Most widely used and studied
 - Geneva score
 - Charlotte rule

Pulmonary Embolism

Wells Score for PE

Factor	Value
Signs and symptoms of DVT	3
Alternative Dx less likely than PE	3
HR > 100	1.5
Prior PE or DVT	1.5
Immobilization or surgery within prior 4 weeks	1.5
Active malignancy	1
Hemoptysis	1

Two Scoring Systems: >6 high; 2-6 moderate; <2 low
≤ 4 PE unlikely; > 4 PE likely

Pulmonary Embolism

Correlation Between Risk Assessment and Probability of Pulmonary Embolism

Clinical Risk Assessment	Probability
Low	4% - 15%
Moderate	29% - 38%
High	59% - 79%

* Across multiple studies using different scoring systems

* "PE unlikely" similar to low clinical risk

Case 1 Continued...

- 37 year old female
- Sudden onset of pleuritic chest pain
- T 98.8 HR 110 RR 20 BP 115/70
Sat 94% RA
- Lungs with good aeration and clear to auscultation
- Uses OCPs and smokes cigarettes



What diagnostic tests could be performed to evaluate for PE in this patient?

Pulmonary Embolism

- **Non-Specific Tests**

- CXR
- EKG
- ABG

- **Screening Test**

- D-dimer

- **Confirmatory Tests**

- V/Q Scan
- CT angiography
- Venous ultrasound
 - DVT detection
- Pulmonary angiography

CXR

- Cannot be used as sole diagnostic test as findings are insensitive and non-specific

Finding	%
Cardiomegaly	27
Pleural effusion	23
Elevated Hemidiaphragm	20
PA enlargement	19
Atelectasis	18
Normal	24

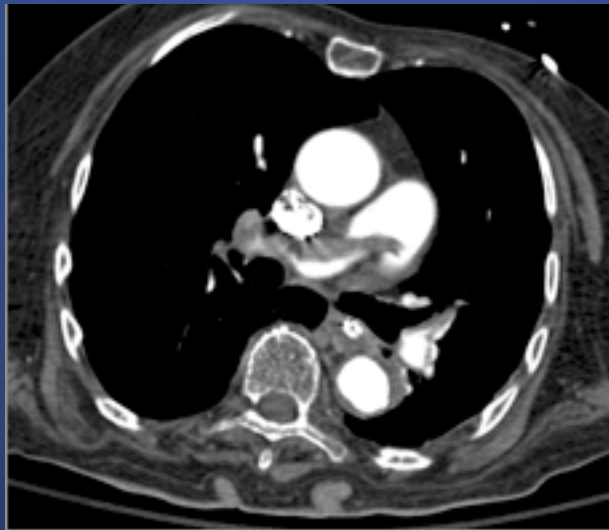
- May be useful in providing alternative diagnosis (e.g., pneumothorax, pneumonia, CHF, etc...)

EKG

- Poor sensitivity and specificity for PE
- Range of findings
 - Normal sinus rhythm
 - Sinus tachycardia
 - Atrial fibrillation or flutter
 - Non-specific ST/T wave changes
- Can be useful in excluding alternative diagnoses like ACS or pericarditis

EKG

- In large PE, right heart strain may be seen
- Complete or incomplete RBBB
- P pulmonale (P-wave > 2.5 mm in lead II)
- T-wave inversions in V1-V4
- $S_1Q_3T_3$ pattern



ABG

- Can provide useful information in the evaluation of patients with dyspnea, but does not reliably predict pulmonary embolism.

D-dimer

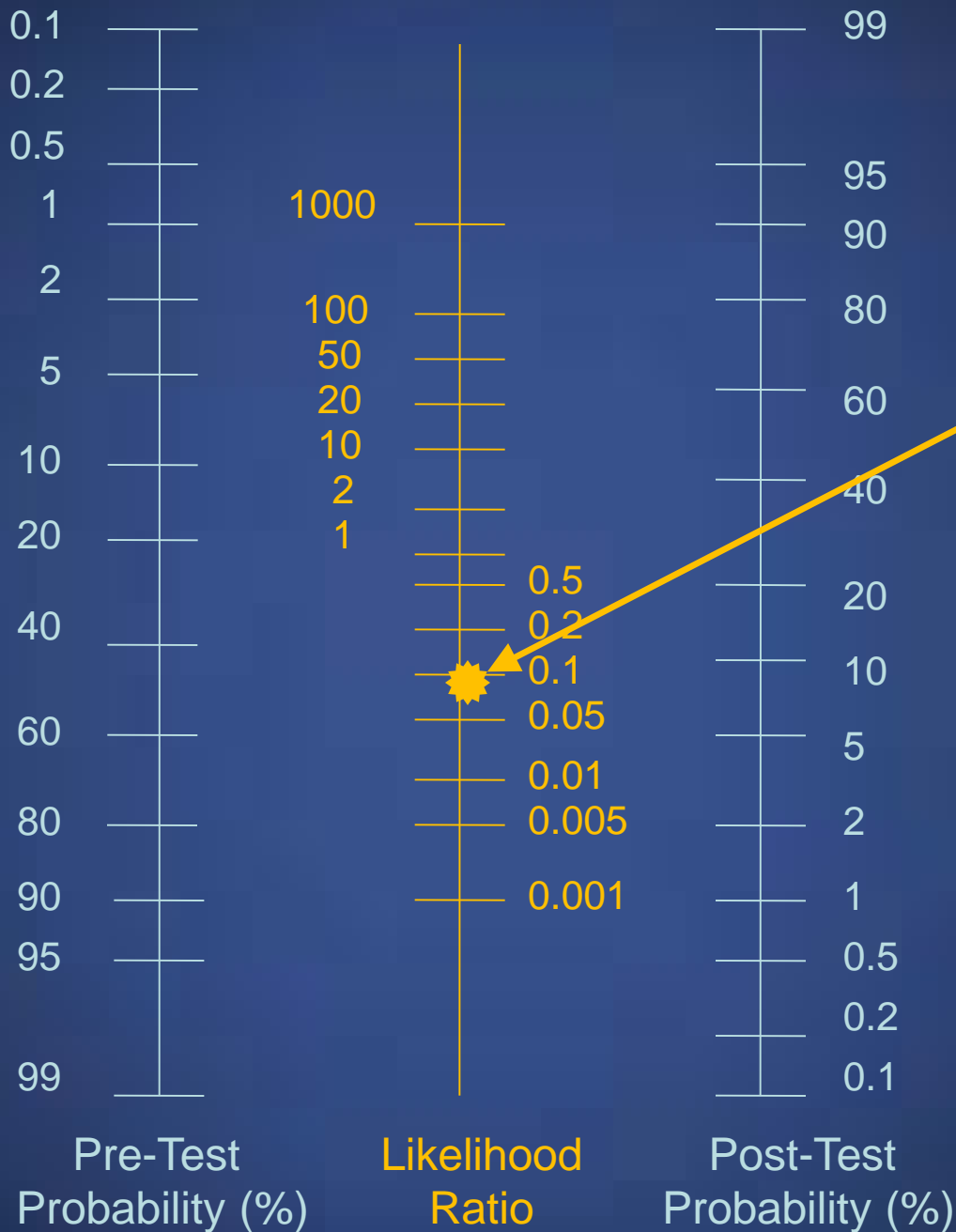
- A marker of fibrinolysis that has become important tool in the exclusion of PE in the ED
- Sensitive test that excludes PE in appropriate patient population
 - Gestalt low to moderate
 - Wells score ≤ 4 (PE unlikely)

D-dimer

- **Should not be used indiscriminately:**
 - Poor specificity: Elevated in many other conditions
 - Sepsis
 - Malignancy
 - Recent surgery
- Can lead to unnecessary testing resulting in higher costs, increased patient length of stay, and false positive diagnoses

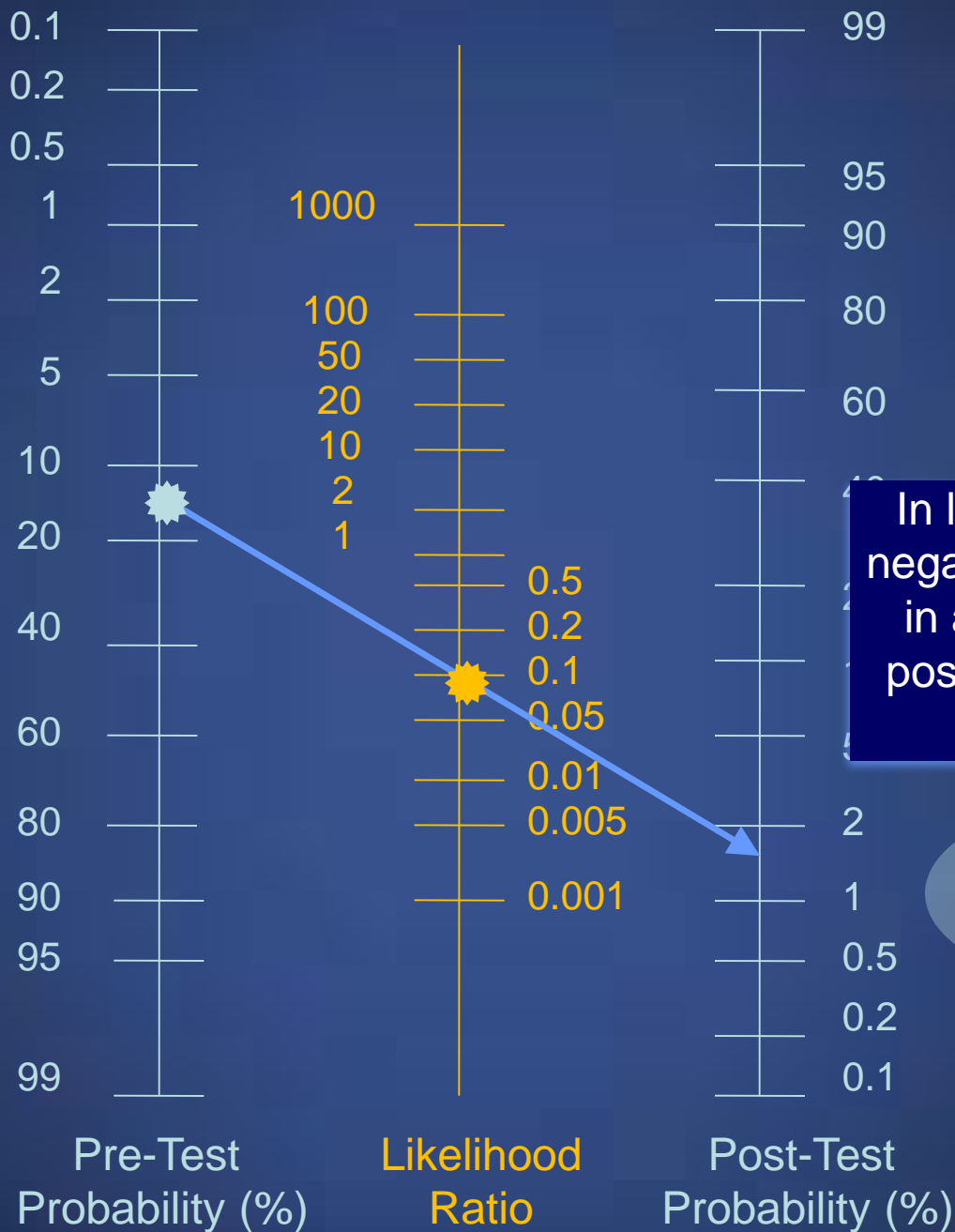
D-dimer

- Explain why a normal D-dimer does not exclude pulmonary embolism in high risk patients?



Various D-Dimer rapid ELISA assays with comparable negative LR of 0.1

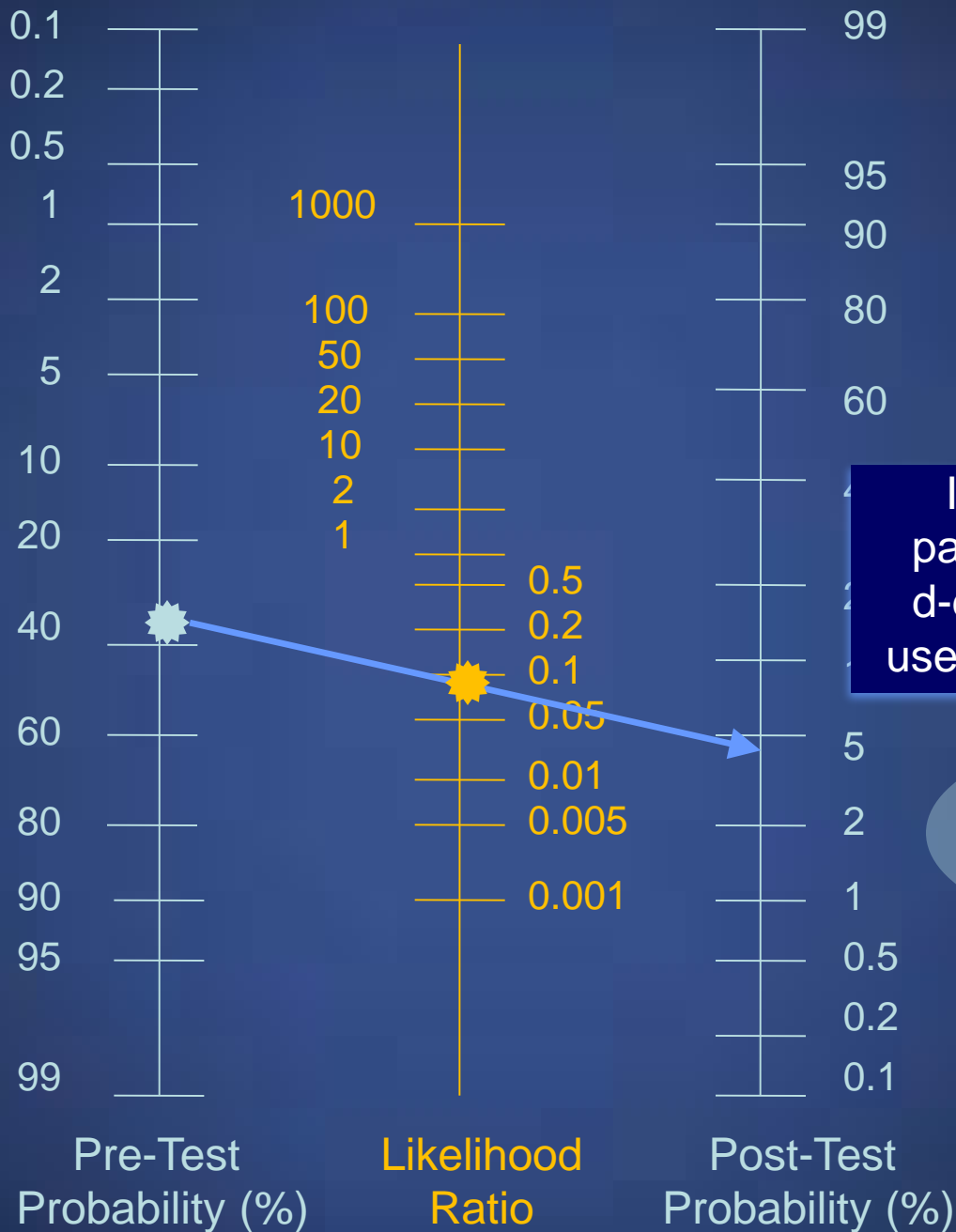
Low Risk
(4-15%)



In low risk patients, a negative d-dimer results in an acceptably low post-test probability to rule out PE

Post-test Probability < 2%

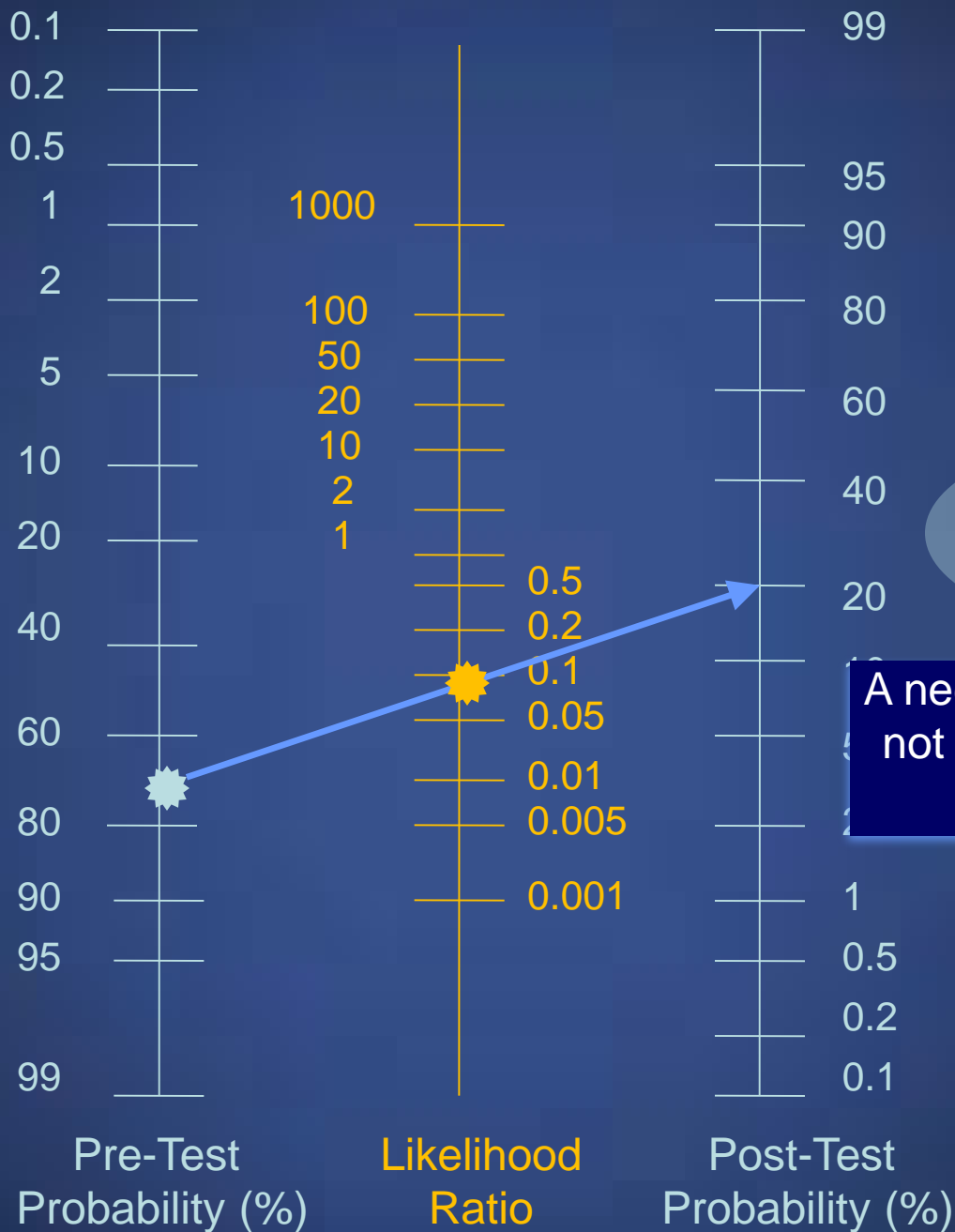
Moderate Risk
(29-38%)



In moderate risk patients, a negative d-dimer may still be useful in excluding PE

Post-test Probability < 5%

High Risk
(59-79%)



Too high!

Post-test
Probability > 15%

A negative d-dimer does
not exclude PE in high
risk patients

V/Q Scan

- Reported in terms of probability based on the pattern of matched and/or unmatched perfusion defects. Results:
 - Normal, low, intermediate, or high probability
- Use limited as most common result is a non-diagnostic study (intermediate or indeterminate)

V/Q Scan

Post-Test Probability of PE

Scan Category	Clinical Probability		
	High	Mod	Low
High	96%	88%	56%
Intermediate	66%	28%	16%
Low	40%	16%	4%
Normal	0%	6%	2%

CT Angiography

- Replacing V/Q scanning as imaging test of choice
- Allows for direct visualization of clot and can provide alternative diagnosis
- Use limited by contrast nephropathy, iodine allergy, and concern over radiation exposure



CT Angiography

- Overall sensitivity is 83% with specificity of 96%
- Performance is reader and scanner (single-detector vs multidetector) dependent
- Performance best when there is concordance between clinical probability and test result

	Clinical Probability		
	High	Moderate	Low
PPV of CTA	96%	92%	58%
NPV of CTA	60%	89%	96%

Stein PD, et al. *N Engl J Med.* 2006;354:2317-27.

Venous Ultrasound

- Detects DVT in 13-15 % of patients with suspected PE and 29% of patients with proven PE
- Useful adjunctive study when the results of CTA or V/Q scan is discordant with clinical probability
- Appropriate first-line study in pregnant patients
 - A positive study can avoid exposure to ionizing radiation



Treatment

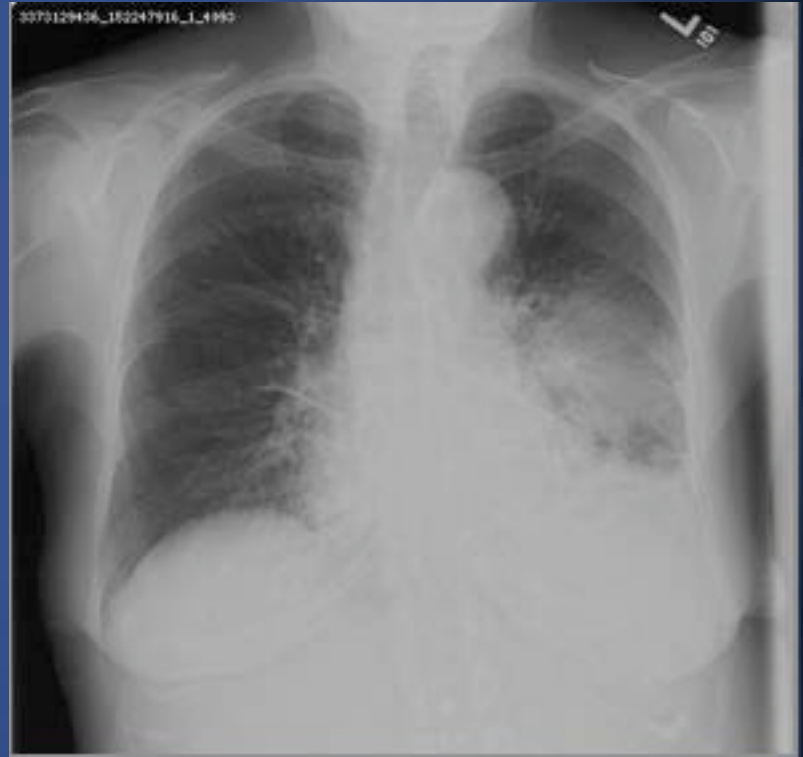
- Anticoagulation
 - Unfractionated heparin
 - Low-molecular-weight heparin
- Treatment should be initiated in high risk patients while awaiting test results
- Thrombolysis is indicated in patients with PE complicated by shock
 - Role of patients with sub-massive PE (RV dysfunction without hypotension) controversial
 - D/w vascular surgery

Case 2

- 75 year old female
- Difficulty breathing and cough
- T 101.2 HR 115 RR 24 BP 105/65
Sat 90% RA
- Awake with normal mental status
- Lungs with left sided crackles

Case 2

- ED safety net:
 - IV established
 - Oxygen administered
 - Placed on monitor
- CXR obtained



Pneumonia

Pneumonia

In the United States:

- Approximately 5 million cases a year resulting in over a million hospitalizations
- In 2004, 8th leading cause of death
- Leading cause of death from infectious disease

Pneumonia

- What are the critical decisions and interventions in this patient's care?
 - Resuscitation
 - Diagnostic testing
 - Appropriate antibiotic selection and timely administration
 - Appropriate disposition

Diagnostics

Patients with suspect pneumonia should have:

- Chest X-ray
- Pulse oximetry
- Blood cultures prior to antibiotic administration in admitted patients

Blood Cultures

- The utility of blood cultures in the treatment of community acquired pneumonia is controversial
- Obtaining blood cultures prior to antibiotics in admitted patients currently considered a federal core measure of quality of care
- Optional for outpatients
- More likely to affect management in certain conditions
 - ICU admission
 - Cavitory Infiltrate
 - Leukopenia

Community Acquired Pneumonia (CAP)

Commonly identified pathogens

- *Streptococcus pneumoniae* (most common)
- *Mycoplasma pneumoniae*
- *Haemophilus influenzae*
- *Chlamydophila pneumoniae*
- *Legionella*
- *Staphylococcus aureus*
- Gram-negative bacilli
- Respiratory viruses

“Atypical” Organisms

Mycoplasma
Chlamydophila
Legionella

Drug-Resistant Organisms

Some patients presenting to the ED are at greater risk of drug-resistant organisms due to:

- Comorbidities
 - Chronic heart, lung, liver or renal disease
 - Diabetes
 - Malignancy
 - Immunosuppression (HIV, sickle cell disease, chemotherapy)
- Recent antibiotic use (within 3 months)
- Contact with healthcare system

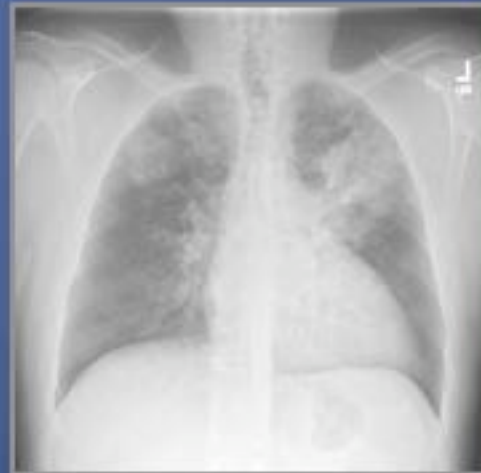
Tuberculosis

- Emergency department patients should be assessed for TB risk factors
 - HIV
 - Residence in country with high prevalence of TB
 - Homelessness
 - Incarceration
 - Alcoholism and IV drug use
- Symptoms include fatigue, night sweats, weight loss, and hemoptysis

Tuberculosis

Chest X-ray Findings

- **Active Disease**
 - Infiltrates or cavitary lesions – classically in upper lungs but may appear anywhere
 - Hilar or mediastinal adenopathy



Case 2 Continued...

- 75 year old female
- Difficulty breathing and cough
- T 101.2 HR 115 RR 24 BP 105/65 Sat 90% RA
- Awake with normal mental status
- Lungs with left sided crackles
- Patient from nursing home

Start broad spectrum antibiotics



Pneumonia

Disposition

- Which patients with CAP need to be admitted to the hospital?
 - Moderate to high mortality risk
 - Hypoxia
 - Poor treatment compliance
 - Unreliable follow-up
 - Poor social network
 - Home situation
 - Finances

Pneumonia

- What scoring systems are available to determine a patient's mortality risk?
 - Pneumonia Severity Index (PORT Score)
 - CURB-65

Pneumonia Severity Index

Patient Characteristic		Points
Demographic	Age: Male	Age
	Age: Female	Age -10
	Nursing home resident	+10
Comorbidities	Neoplastic Disease	+30
	Liver Disease	+20
Physical Exam	SBP < 90	+20
	RR ≥ 30	+20
Laboratory	Sodium < 130	+20
	Hematocrit < 30	+10

*Examples of risk factors. Not complete list.

Pneumonia Severity Index

Risk	Risk Class	Points
Low	I - II	≤ 70
Low	III	71-90
Moderate	IV	91-130
High	V	>130

* Risk Classes I-III eligible for outpatient treatment

* Risk Classes IV-V should be admitted

Case 3

- 25 yo F with asthma arrives by EMS with SOB and wheezing
- Appears in moderate distress
- T 99 HR 125 RR 30 BP 125/85
Sat 96% on face mask

Asthma

Chronic disorder characterized by:

- Airflow obstruction
 - Secondary to bronchoconstriction, airway edema, and airway remodeling (fibrosis, smooth muscle hypertrophy, mucus hypersecretion)
- Bronchial hyperresponsiveness
 - Exaggerated response to stimuli
- Underlying inflammation

Asthma

How do you determine the severity of an asthma exacerbation?

- Symptoms
- Signs
- Functional assessment

Asthma Exacerbation

	Mild	Moderate	Severe	Respiratory Arrest Imminent
Symptoms				
Talks in	Sentences	Phrases	Words	
Alertness	May be agitated	Usually agitated	Usually agitated	Drowsy or confused
Signs				
RR	Increased	Increased	Often > 30	
HR	< 100	100-120	>120	Bradycardia
Wheeze	Moderate	Loud	Usually Loud	Absent
Functional Assessment				
PEF	≥ 70%	40-69%	<40%	<25%
SaO ₂	>95%	90-95%	<90%	

Risk Factors for Death From Asthma

Asthma History

- Previous intubation or ICU admission
- ≥ 2 Hospitalizations for asthma in past year
- ≥ 3 ED visits for asthma in past year
- Hospitalization or ED visit for asthma in past month

Social History

- Low socioeconomic status
- Illicit drug use
- Psychosocial problems

Comorbidities

- Cardiovascular disease
- Psychiatric disease

Diagnostic Studies

- Most patients with asthma do not require any labs or imaging
- ABGs can be considered in severe exacerbations to evaluate PCO_2
 - Patients with an asthma exacerbation hyperventilate, so a “normal” PCO_2 of 40 is a concern for pending respiratory failure
- Chest X-ray not routinely recommended but may be used when there is suspicion for CHF, pneumothorax, or pneumonia

Treatment

What medications can be used in the initial treatment of an acute asthma exacerbation?

- Short-Acting β_2 -Agonists (SABAs)
- Corticosteroids
- Anticholinergics
- Systemic β_2 -Agonists

Beta-agonists

- Bronchodilators that relax smooth muscle (ex: albuterol)
- Recommended in treatment for all patients
- **Methods of Delivery**
 - MDI with spacer as effective as nebulizer in mild to moderate exacerbations
 - Nebulizer indicated in severe exacerbations in which patient may not be able to cooperate with MDI
- **Albuterol**
 - may be given continuously in severe obstruction

Systemic β 2-Agonists

- Epinephrine and terbutaline can be administered subcutaneously
- No proven advantage over inhaled albuterol
- Rarely given

Systemic Corticosteroids

- Decrease airway inflammation
- Reduce airway hyperresponsiveness
- For moderate or severe exacerbations and patients with incomplete response to initial SABA therapy
- Oral prednisone as efficacious as IV methylprednisolone
- For outpatients, Prednisone 40-60 mg PO q day x 5-7 days

Anticholinergics

Ipratropium

- Inhibits muscarinic cholinergic receptors and reduces intrinsic vagal tone of the airway
- Recommend for use in the ED for treatment of severe exacerbations
- May be mixed in same nebulizer with albuterol (this is a duoneb)
- Repeat doses can be given every 20 minutes in first hour

Case 3 Continued...

- 25 yo F with asthma arrives by EMS with SOB and wheezing
- Appears in moderate distress
- T 99 HR 125 RR 30 BP 125/85 Sat 96% on face mask
- After an hour of albuterol and administration of steroids, patient remains with labored breathing



What additional treatments could be considered?

Adjunctive Therapy

- Consider in patients with severe exacerbation to avoid the need for intubation
- Magnesium
 - Bronchial smooth-muscle relaxation
- Heliox
 - Mixture of helium and oxygen that provides a low density gas. This is postulated to decrease airway resistance and thereby improve airflow obstruction.
- Noninvasive positive-pressure ventilation
 - Data for use in asthma still limited but preliminarily positive

COPD

- Characterized by airflow obstruction that is not fully reversible
- Caused by a variable combination of
 - Chronic airway inflammation (obstructive bronchitis)
 - Destruction of lung parenchyma (emphysema)
 - Mucus plugging
- Acute exacerbations may be triggered by viral infections, bacterial infections, or environmental exposures (e.g., air pollution)

COPD

- Exacerbations involve:
 - Worsening dyspnea
 - Increased phlegm production
 - Increased purulence of phlegm
- Hypoxemia and worsened hypercapnia may be present

COPD

Diagnostics

- Chest X-ray recommended as found to change treatment decisions in 16 to 21% of patients
 - Infiltrate
 - Pulmonary edema
- ABG when level of distress or somnolence raises concern for acute respiratory acidosis

COPD

Treatment

- **Oxygen**
 - Target saturation 90-92%
 - Excessive oxygen supplementation may lead to hypercapnea
- **Bronchodilators**
 - Both inhaled beta-adrenergic and anticholinergic agents found to be effective
- **Corticosteroids**

COPD

Treatment

- **Antibiotics**
 - Particularly beneficial in patients with severe dyspnea and increased sputum volume and purulence
- **Noninvasive Positive-Pressure Ventilation**
 - Effective in relieving severe dyspnea, acute respiratory acidosis, and hypoxic respiratory failure

Final Comments

Pulmonary Embolism

- Clinical risk assessment plays an essential role in the evaluation of suspected PE
- D-dimer cannot be used to exclude PE in high risk patients
- When there is discordance between clinical suspicion and CTPA or V/Q scan results, further testing is warranted

Final Comments

Pneumonia

- CXR is necessary for the evaluation of pneumonia
- Evaluate respiratory workload including hypoxia by pulse oximetry
- Antibiotics should be administered early once pneumonia is identified
- Antibiotic selection guided by risk factors for drug resistant organisms
- Disposition guided by mortality risk as well as social factors

Final Comments

Asthma and COPD Exacerbations

- Bronchodilators and steroids are mainstay of treatment
- Antibiotics play important role in the treatment of acute COPD but not uncomplicated asthma exacerbations
- Noninvasive positive-pressure ventilation with proven benefit in COPD and probable benefit in asthma for severe exacerbations

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www.empacs.org

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