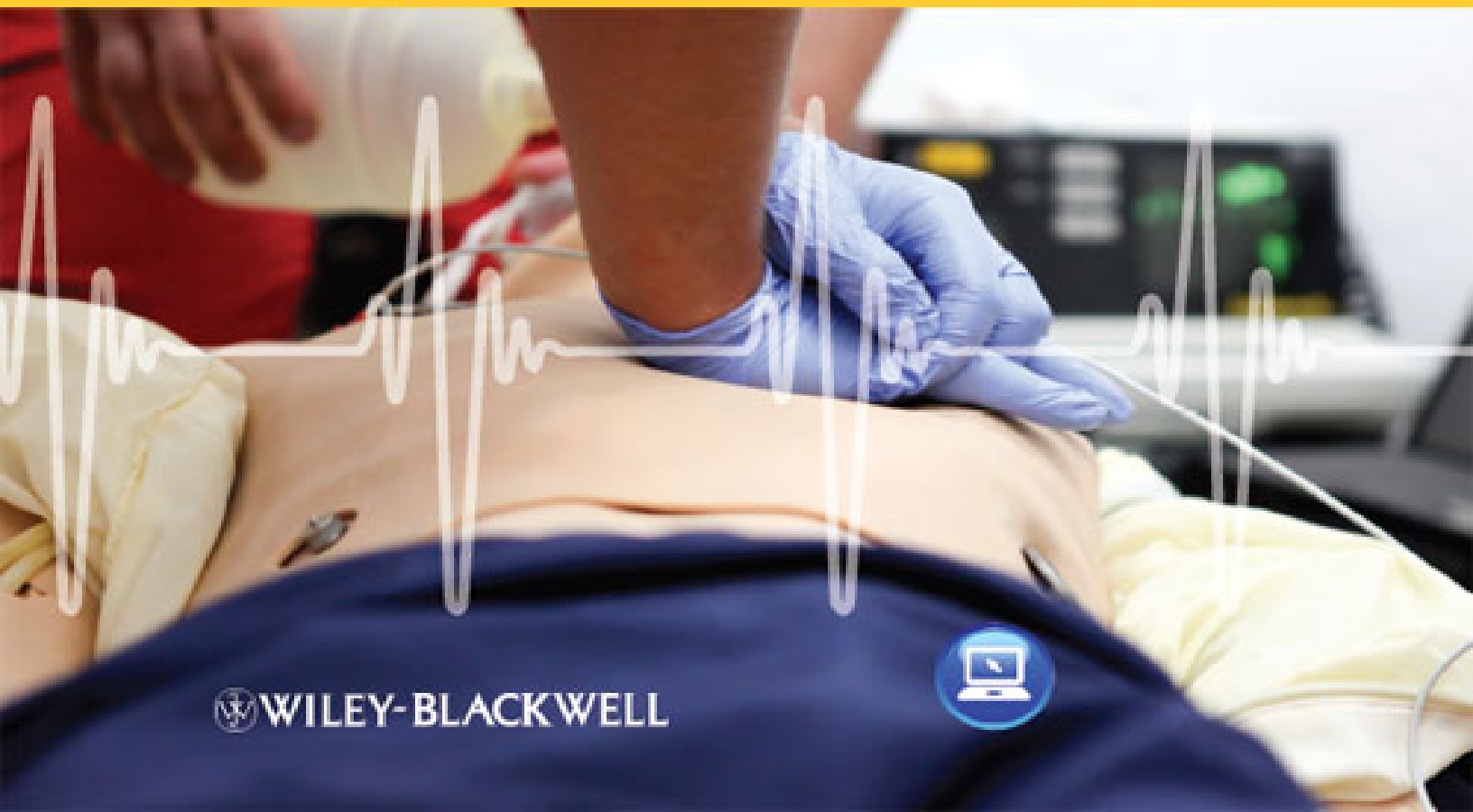
Emergency Medicine Simulation Workbook

A TOOL FOR BRINGING THE CURRICULUM TO LIFE

Edited by Traci L. Thoureen and Sara B. Scott



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Contents

Companion website

This book is accompanied by a companion website:

www.wiley.com/go/thoureen/simulation/workbook

The website includes:

- Imaging and laboratory results pertinent to each case study.
- Powerpoint format suitable for printing out, downloading, or real-time use on-screen during the simulation sessio.
- Additional video clips to simulate sonogram results are presented for the ruptured ectopic pregnancy case study (Chapter 8).

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Foreword

The growth of technology-enhanced simulation training in health care over the last decade represents a transformative era in the history of medical education. No longer do “time and chance” clinical encounters alone dictate the experiential training profile of the learner; rather, realistic clinical scenarios can be animated through a combination of advanced technology and role-play, creating a safe and standardized environment in which to practice care of even the sickest patients.

This latter concept – caring for the sickest patients in the safest environment – captures a unique intersection between Emergency Medicine and modern simulation-based learning. Only with the benefit of advanced simulation tools can the sickest patients be realistically portrayed for real-time teaching and learning. This creates a unique opportunity for educators in the field of Emergency Medicine to make important contributions to modern medical education, across disciplines. This book, essentially providing a ready-to-deploy experiential curriculum that touches all specialties, represents just such an advance.

The synergy between Emergency Medicine and simulation education is not only practical, but also highlights important aspects of human cognition and learning theory that we are only just beginning to understand. Encountering a critically ill robot simulator, as paradoxical as that may sound, can reliably stimulate a unique level of emotional engagement among learners. This kind of intense engagement, in and of itself, provides a foundation for critical thought, action, and memory that many associate only with key moments of actual clinical experience – but without any of the inherent risk to real patients. Not surprisingly, medical simulation is

becoming a core element of the global patient safety effort, and simulation practice across all fields is increasingly viewed as a quality and safety imperative.

While this book represents an invaluable resource to any Emergency Medicine educator, it also provides a roadmap to help all medical educators explore the unique benefits of medical simulation. The cases chosen for inclusion are drawn from a diverse group of faculty authors across a wide range of medical teaching centers, and represent a full spectrum of pathology. The material is formatted and annotated so that cases can be tailored to novice or advanced learners, and easily deployed in a diversity of settings. Key “tips or tricks” are included to accompany case images and other patient data which complete the compendium, allowing for standardized use as part of a tailored teaching and assessment portfolio.

I have been fortunate to witness the evolution of modern simulation in health care from a handful of pioneering initiatives to a unified specialty field that is flourishing across the globe. This book represents a movement to consolidate and distribute lessons learned during this period of extraordinary growth, providing a key tool to make simulation more accessible to all medical educators.

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CHAPTER 1

Introduction: How to use this book

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Simulation has become an integral tool in medical education and the specialty of emergency medicine (EM) is no exception. Simulation curriculums have increasingly become integrated into standard EM training. In fact, as of 2008, one study reported that of 134 EM residencies surveyed in the United States, 91% used some form of simulation in their postgraduate training.[1]

With increasing utilization of simulation as a teaching tool, there has been more demand from educators for workshops and training that focus on how to teach using simulation. This workbook is designed with those demands in mind. It is meant to act as a “lesson plan” for physician educators to use at the “bedside” in the simulation laboratory or in any space that is used to conduct simulation.

This workbook is organized with the basic clinical competencies of EM in mind. The chapters incorporate topics listed by the American Board of Emergency Medicine as included in the certification examination. Each chapter includes 3–4 individual simulation cases that highlight subject material pertinent to the chapter topic. In many of the cases, alternative options are described for use with

multiple levels of learners (students, junior or senior postgraduate learners).

Although each individual simulation case is unique, the presentation format for all of the cases is the same. The layout for each case starts with specific educational objectives for that case, together with a list of suggested critical actions. For those who are working within the United States postgraduate training system, we have notated the relevant Accreditation Council of Graduate Medical Education (ACGME) clinical competencies for each learning objective and critical action.

Immediately following the critical actions, you will find an outline for the case set-up. This includes a description of the physical environment, mannequin, props, distractors, and actors that are recommended for each simulation. To aid in the case set-up, an online resource is provided with this workbook (at www.wiley.com/go/thoureen/simulation/workbook) and includes imaging and laboratory studies pertinent to each case. The online resource is presented in a PowerPoint format and can be printed out, downloaded, or shown in real time on computer screens/monitors during the simulation session.

After the section on set-up, you will find a brief narrative of the case, which essentially contains the information found on most emergency department triage sheets. There is a description of the initial mannequin conditions and a case narrative which details the changes in conditions that will occur in the mannequin after a specific time interval or in response to a learner intervention. Accompanying flow sheets also outline the general sequence of actions for each case.

Throughout the case, you will see text boxes. These text boxes highlight specific details in the case that can be altered based on the degree of fidelity of your mannequin or

on the skill level of your learner. In this way, each case can be manipulated to fit your teaching needs and available resources.

At the end of each case, you will find information to aid in debriefing. Instructor notes provide basic background information for your facilitators about the specific case topic. There is also a list of potential questions that can be used during the debriefing session with your learners. Finally, you will find a list of selected reading that can be used in preparing for the simulation and some are suitable to be distributed to learners either prior to or following the simulation.

We hope that you will find this workbook a useful tool in the development or continuation of a successful emergency medicine simulation curriculum at your institution. Keep in mind that each simulation case is dynamic and can be modified in a variety of ways to suit best the needs of your learners and/or the fidelity of your mannequin. As such, this workbook provides a basic template for the design of an emergency medicine simulation curriculum for learners at any stage in their education and for facilities with varying levels of technical capability.

Reference

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CHAPTER 2

Vascular emergencies

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Pulmonary embolism

Educational goals

Learning objectives

Primary:

1. Recognize clinical signs of pulmonary embolism (PE) [*Medical Knowledge*].

2. Order appropriate diagnostic tests for PE [*Medical Knowledge*].

3. Order appropriate treatment for PE and its complications [*Medical Knowledge, Patient Care*].

Secondary:

1. Demonstrate professionalism and communication skills in consultation with other physicians and in working with ED nurse [*Interpersonal and Communication Skills, Professionalism*].

2. Direct proper disposition to/appropriate consultation with the ICU [*Systems-based Practice*].

Critical actions checklist

□ Assess airway, breathing, and circulation [*Patient Care*]

□ Place patient on cardiac monitor and establish IV access [*Patient Care*]

□ Order CT angiography (or locally appropriate imaging) and recognize signs of PE [*Medical Knowledge*]

□ Initiate proper therapy: (1) heparin and/or thrombolytic for PE, (2) high-flow oxygen/non-invasive positive-pressure ventilation/intubation for hypoxia, and (3) IV vasopressor for hypotension/shock [*Medical Knowledge, Patient Care*]

□ Call and communicate to ICU for disposition [*Interpersonal and Communication Skills, Professionalism*]

Critical actions can be changed to address the educational needs of the learner. For example, a resident preparing for the oral board examination may have more specific critical actions such as ordering a pregnancy test before radiologic imaging, etc.

Simulation set-up

Environment:

Emergency Department treatment area.

Mannequin:

Simulator mannequin, on a stretcher or hospital bed. Mannequin should be female, moulaged with left leg swelling.

This moulage may be accomplished in both high and low-tech ways. You may purchase SimLeggings™ (Eriter Creations, Stirling, AB, Canada) or, for a lower tech version, nude-colored self-adherent elastic wrap can be placed overtop of memory foam (¼–½ inch) with nude pantyhose on top, or simply a label or photograph of your desired appearance can be placed on the extremity.

Props:

To be displayed on plasma screen/computer screen or printed out on handouts in scenario room when asked

for/return from laboratory.

- Images (see online component for Pulmonary Embolism, *Scenario 2.1.ppt*, at www.wiley.com/go/thoureen/simulation/workbook)
  - ECG with sinus tachycardia.
  - Chest X-ray showing normal cardiac silhouette.
  - CT angiography of chest showing right-sided PE.
  - Venous Doppler ultrasound of left leg showing deep venous thrombosis.
- Labs (see online component as above)
  - Complete blood count.
  - Chemistry panel.
  - Coagulation panel.
  - Urinalysis.
  - Urine pregnancy test.
  - D-dimer.

Available in the treatment room:

- Basic airway and code cart.
- High-flow face mask.
- Medications:
  - Liter bags of 0.9% normal saline (NS) and lactated Ringer's (LR).
  - Rapid sequence intubation (RSI) medications pre-labeled in syringes (paralytic and induction medication of choice for your institution).
  - Heparin in pre-labeled liter bag.
  - Thrombolytic typically utilized at your institution.
- Non-invasive positive pressure airway equipment (BiPAP or CPAP).

Distractor:

None.

Actors:

- Husband (optional). Available to provide additional information either in person or via telephone.
- Patient voice is female. Patient should sound short of breath, speaking in truncated sentences at the beginning of the scenario.
- ED nurse can start IVs and administer medications/fluids. The nurse does have some medical knowledge base and may cue learners if needed.
- ICU physician can be available via “phone consultation.”

Case narrative

Scenario background

A 27-year-old female with shortness of breath and pleuritic chest pain that started this morning. She used her albuterol inhaler a few times this morning without any improvement in her symptoms. She reports a mild cough and chest discomfort with the cough. No fever or orthopnea.

Background may be presented prior to case, by husband, or given as a triage sheet.

CC: Shortness of breath.
PMH: Asthma.
Meds: Albuterol inhaler, oral contraceptive pill.
Allergies: None.
Family Hx: Unremarkable.
Social Hx: Smokes one pack per day, occasional alcohol, no illicit drugs. She was recently married and returned one week ago from honeymooning in Europe (she lives in the United States).

Travel history can be volunteered or given only if asked to adjust to level of learners.

Initial scenario conditions

Patient is tachypneic, anxious:

“I just … can’t … breath … it hurts … it feels … tight …”

VS: Temp. 37.5 °C (99.5 °F), HR 118, RR 24, BP 110/60, O_2 sat 91% RA.

Heart: Tachycardia, no murmurs.

Lungs: Tachypneic, equal bilaterally, clear to auscultation.

Extremities: Left lower leg swollen, calf is slightly tender if palpated by the examiner.

Physical examination findings not available on your mannequin can be reported verbally if asked for by learners, e.g. left leg swelling can be reported by patient if asked by the participants if none of the suggested moulage techniques listed above are available for your scenario.

See the flow diagram in Figure 2.1 for further scenario changes described below.

Case narrative, continued

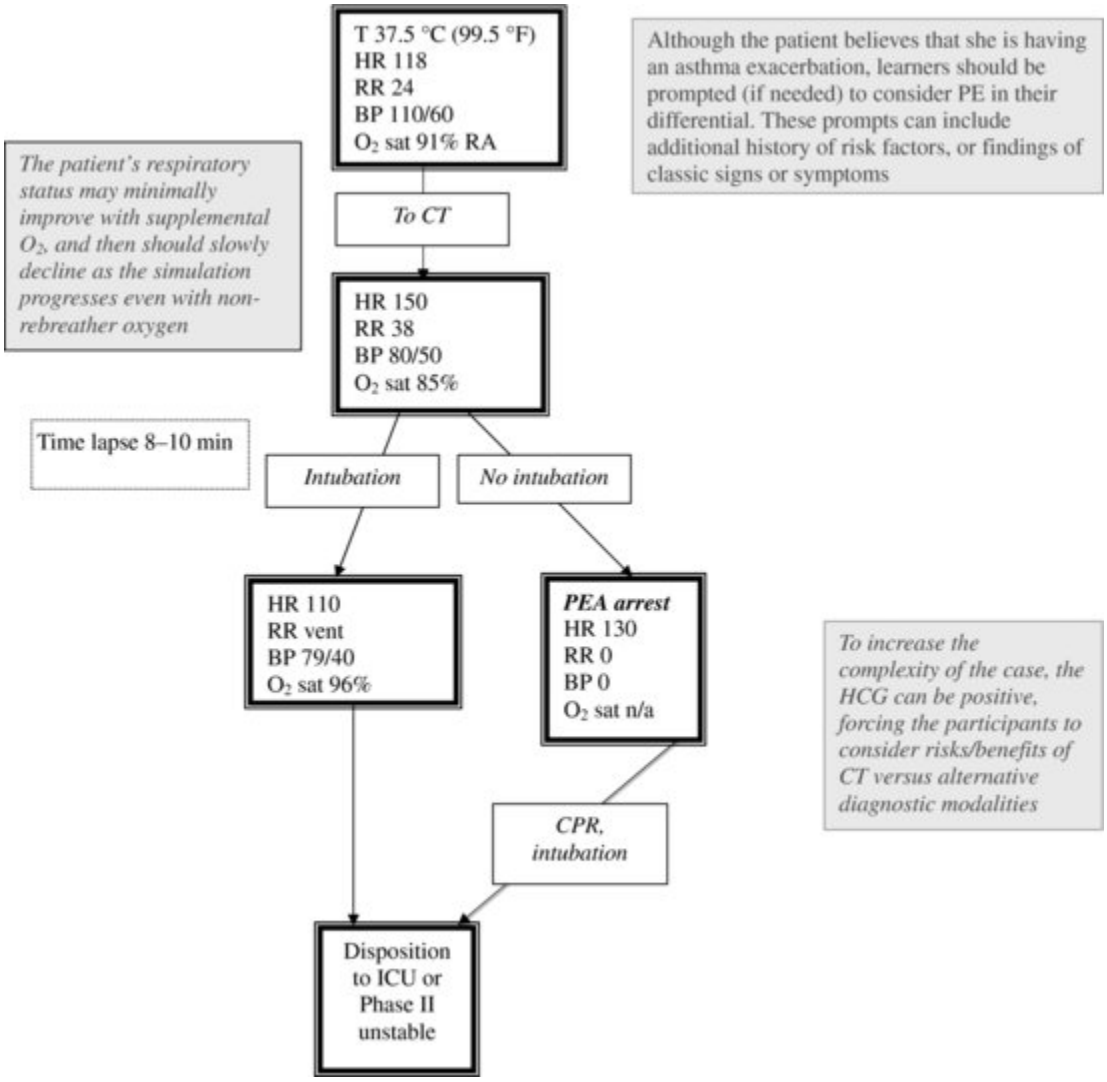
The respiratory distress will continue and gradually worsen as the scenario progresses, despite bronchodilator treatment and supplemental oxygen. Diagnostic tests (mainly imaging) should be ordered prior to decompensation of the patient, but may also be obtained after intubation and stabilization if the learner does not pick up on prompts.

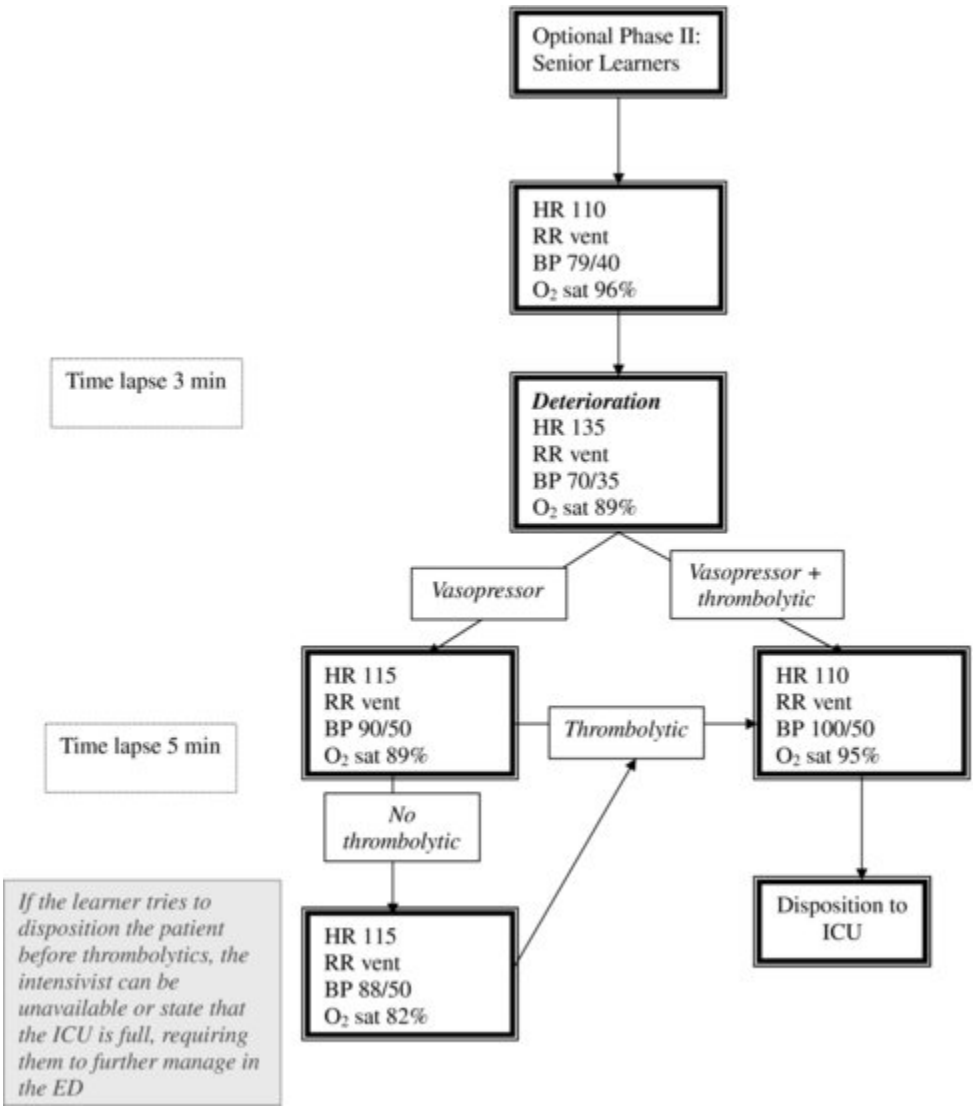
Whether or not the correct diagnosis of PE is made, the patient will continue to deteriorate and develop hypoxia and hemodynamic instability in the form of significant hypotension. At this point, the patient should be intubated and mechanically ventilated. If not intubated, the patient will go into pulseless electrical activity (PEA) rhythm and require resuscitation. You may make the option for students and junior learners to have the case end after intubation and heparin administration.

For senior learners, you can move on to Phase II and the patient will have worsening hypoxia and hypotension necessitating vasopressors and thrombolytics for stabilization.

Ultimately, the learner will need to admit the patient to an ICU level of care. However, if the learners try to admit the patient to the ICU prior to thrombolytics, the intensivist may be “unavailable” or state that the ICU is full and the patient must be managed in the ED until they have a bed.

Figure 2.1 Scenario flow diagram: pulmonary embolism.





Instructor notes

Pathophysiology

PE describes the process where a pulmonary artery is occluded by thrombus, fat, air, or amniotic fluid:

- Impaired gas exchange due to ventilation/perfusion (VQ) mismatch.
- Increased pulmonary vascular resistance.
- Increased wall tension in the right ventricle → bulging of the interventricular septum → compression of the left ventricle → decreased in cardiac output.

Clinical features

- Dyspnea is the most common chief complaint.
- Other symptoms:
  - Pleuritic pain.
  - Cough.
  - Hemoptysis.
  - Syncope.
- Clinical signs can include:
  - Tachypnea.
  - Tachycardia.
  - Hypoxia.
  - Low-grade fever.
  - Neck vein distention.
  - Examination findings consistent with DVT, i.e. extremity swelling.

Diagnosis

- Clinical decision rules
  - Risk-stratifying tools that do not definitively rule out PE.[3]
  - PERC (pulmonary embolism rule-out criteria): If all eight are positive there is <2% chance of PE:
    - Age <50 years.
    - Pulse <100 beats/min (–1).
    - O_2 sat ≥95%.
    - No hemoptysis.
    - No estrogen use.
    - No surgery/trauma requiring hospitalization within 4 weeks.
    - No prior venous thromboembolism (VTE).
    - No unilateral leg swelling.
  - Wells criteria: Assigns risk of PE based on points; >7.5 points is high-risk group, ≤4 points is low-risk group.

        - Clinical signs and symptoms of DVT (+3).
        - PE as most likely diagnosis (+3).
        - Tachycardia (+1.5).
        - Immobilization for at least 3 days or recent surgery within 4 weeks (+1.5).
        - History of PE or DVT (+1.5).
        - Hemoptysis (+1).
        - History of malignancy (+1).
- Imaging
    - CT angiogram:
        - Preferred modality.
        - PE is indicated by a filling defect within the pulmonary artery.
    - Ventilation-perfusion scan:
        - High probability for a PE indicated by a segmental area of decreased perfusion that has normal ventilation.
    - Venous ultrasound of the lower extremities:
        - The loss of vein compressibility in the legs indicates a DVT.
        - A negative study cannot definitively rule out PE.
- Less specific diagnostic tests include:
    - D-dimer serum assay:
        - May use in groups assessed as low risk to rule out PE.
    - Electrocardiogram:
        - Sinus tachycardia.
        - S1Q3T3 (inverted S in lead I, Q wave and inverted T wave in lead III).
        - Right ventricular strain pattern.
    - Chest X-ray:
        - Usually normal, but may show focal oligemia (Westermark’s sign), peripheral wedge-shaped

density (Hampton’s hump), or enlarged right descending pulmonary artery (Palla’s sign).

Management

- Supplemental oxygenation ± ventilatory support.
- Anticoagulation:
  - Unfractionated heparin is usually the initial drug of choice:
    - Initial bolus 80 units/kg followed by initial infusion rate 18 units/kg/h. Titrate to therapeutic activated partial thromboplastin time of twice the control value.
- Inotropic support:
  - Dobutamine:
    - Positive inotrope and a pulmonary vasodilator, making it a prime choice during right heart failure caused by PE.
    - Initial rate: 2 µg/kg/min.
- High-morbidity patients:
  - Surgical embolectomy.
  - Thrombolysis:
    - Tissue plasminogen activator (tPA): 100 mg IV over 2 h.

Debriefing plan

Plan for ~30 min for discussion.

Potential questions for discussion

- What other diagnoses should be considered in a patient who presents like the woman in this case?
- What risk factors for PE should be ascertained in the history?

- What decision rules (PERC, Wells) are available to aid in risk stratification, and how should they be used?
- How and when should a D-dimer test be used?
- What are the characteristic ECG findings of pulmonary embolism?
- How do the diagnostic work-up and treatment choices change if the patient is pregnant?
- What is the vasopressor of choice in right heart failure due to PE?

Selected reading

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Aortic dissection

Educational goals