“Appropriate Ordering of CTA in the Diagnostic Workup of Pulmonary Embolism Improves Patient Safety by Reducing Harmful Radiation Exposure and Improves the Quality of Care by Reducing the Overall Treatment Cost”
Team Collaborators

Taylor D. Hicks, MD
Hallie Baer, MD
CS&E Participant
Edna Cruz, RN, CPHQ, CPPS - CS&E Facilitator
Norma Garza, MBA, RVS, RDMS, Senior Manager

Sponsors
James Barker, MD, CPE, VP/Medical Director, UHS
Mark G. Davies, MD, PhD, MBA, Professor & Chief, Vascular /Endovascular Surgery
Aim Statement

To decrease the amount of inappropriately ordered CTAs in the MICU / 5th Floor Medical and the ED by mid-December 2016.
Project Milestones

Team Created - 8/16
AIM statement created - 8/16
Weekly Team Meetings Began - 8/16

Background Data - 9/16
Brainstorm Sessions – 9/16
Workflow - 9/16
Fishbone Analyses – 9/16

Interventions Implemented 10/17/16
Analysis - Ongoing
CS&E Presentation – 1/13/17

The Team used the Plan, Do, Study, Act Model for Improvement
Pulmonary embolism (PE) is the third most common cause of cardiovascular death, affecting between 300,000 to 600,000 patients annually. Presenting symptoms are non-specific, resulting in the reflexive decision to evaluate with computed tomography pulmonary angiography (CT PE protocol), which is not without risk and has a low diagnostic yield (10-20%). However, clinical tools such as Wells’ Criteria and D-dimer levels are validated non-radiographic methods of ruling out PE and effectively reduce diagnostic time, cost, and potential complications.

Bibliography


Theoretical Flow Process of CTA in Diagnosing PE

- **Lack Informed Decision Making Process**
  - **Use CTA as Primary Dx Tool**
  - **Order CTA**

Do you think patient may have PE?

- **Poor Clinical Assessment**

Actual Patient Flow Process
Use of CTA in Diagnosing PE

- **65 Y/O Female with Right Renal Artery Aneurysm admitted for elective Open Repair.**
- **PMHx notable for atrioventricular tachycardia managed with Beta Blocker.**
- **Tolerated Procedure without Incident. Transferred to SICU Post-Op.**
- **Heart Rate noted to increase to 120 overnight.**

- **Home Beta Blocker resume on POD#1 @ 11:39am**
- **Tachycardia peaks at 140. Otherwise, normotensive, afebrile, saturating ≥ 92% on NC, with stable labs and exams.**
- **CT PE/Abd/Pelvis ordered @ 14:53. Notable only for Atlectasis.**
- **Within 24 hours of resuming home beta blocker, tachycardia resolved.**
Caused by CTA ordering in Diagnosing PE

Materials
- Risks of radiation
- Use of contrast material has risks
- Use CTA as primary: Easy to order tool to Dx PE
- Poor Dx with PE heavily weighted

Process/Methods
- Emphasis on PE as Core Measure/Medical Legal
- Lack standardized process to Dx PE
- Wells score not followed
- CTA use is not without risks
- CTA use is needlessly costly

People

Machines

Problem Statement
Inappropriate CTA ordering in Dx PE
Pareto of Patient Location
Total Exams = 700

Patient Location Volume
Diagnostic Rate for CT PE in the Emergency Department
p-Chart of Data Jan - Jun 2016

Diagnostic % of PEs in the ED

Jan-16   Feb-16   Mar-16   Apr-16   May-16   Jun-16
11.1%    5.6%     1.4%     7.9%     11.8%    0.0%

UCL 11.1%
CL 5.6%

Diagnostic Rate for CT PE in the Emergency Department
p-Chart of Data Jan - Jun 2016
Diagnostic Rate for CT PE on the 5th Floor
p-Chart of Data Jan - Jun 2016

Diagnostic % of PEs on the 5th Floor

- CL 3.5%
- UCL 58.7%

Jan-16 Feb-16 Mar-16 Apr-16 May-16 Jun-16

- Jan-16: 8.3%
- Feb-16: 0.0%
- Mar-16: 0.0%
- Apr-16: 10.0%
- May-16: 0.0%
- Jun-16: 58.7%
## Action Plan

**Aim Statement:** To decrease the amount of inappropriately ordered CTAs in the MICU, 5th Medical and ED by Mid-December 2016.

<table>
<thead>
<tr>
<th>Action Strength</th>
<th>Action Driver (Taken from Flow or Cause &amp; Effect Diagram)</th>
<th>Action</th>
<th>Who?</th>
<th>Why? (Choose one)</th>
<th>Start Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strong</td>
<td>CTA is not without risks Risk of Radiation and Contrast use Excess needless costs</td>
<td>Educate &amp; Train Physicians (MICU, 5th Medical, ED)</td>
<td>Dr. Taylor Hicks</td>
<td>Standardize Simplify</td>
<td>10/17/2016</td>
</tr>
</tbody>
</table>
## Modified Wells criteria: clinical assessment for pulmonary embolism

<table>
<thead>
<tr>
<th>Clinical Symptoms</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical symptoms of DVT (leg swelling, pain with palpation)</td>
<td>3.0</td>
</tr>
<tr>
<td>Other diagnosis less likely than pulmonary embolism</td>
<td>3.0</td>
</tr>
<tr>
<td>Heart rate &gt;100</td>
<td>1.5</td>
</tr>
<tr>
<td>Immobilization (≥3 days) or surgery in the previous four weeks</td>
<td>1.5</td>
</tr>
<tr>
<td>Previous DVT/PE</td>
<td>1.5</td>
</tr>
<tr>
<td>Hemoptysis</td>
<td>1.0</td>
</tr>
<tr>
<td>Malignancy</td>
<td>1.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Probability</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional clinical probability assessment</td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>&gt;6.0</td>
</tr>
<tr>
<td>Moderate</td>
<td>2.0 to 6.0</td>
</tr>
<tr>
<td>Low</td>
<td>&lt;2.0</td>
</tr>
<tr>
<td>Simplified clinical probability assessment*</td>
<td></td>
</tr>
<tr>
<td>PE likely</td>
<td>&gt;4.0</td>
</tr>
<tr>
<td>PE unlikely</td>
<td>≤4.0</td>
</tr>
</tbody>
</table>

Process Intervention for Diagnosing Pulmonary Embolism

Suspect PE

Calculate Wells Score

High Risk

Intermediate Risk

Low Risk

Proceed to CTA

Draw D-Dimer

D-Dimer Elevated?

YES

NO

No CTA
CT Pulmonary Embolism
IT e-Note Template

**CT PE Protocol Clinical Indications**

<table>
<thead>
<tr>
<th>Clinical Indication</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart Rate greater than 100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Signs or symptoms of DVT (leg swelling, pain with palpation)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Immobility (&gt; 3 days) or Surgery (within past 4 weeks)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hemoptysis</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**CT Pulmonary Embolism IT e-Note Template**

<table>
<thead>
<tr>
<th>Item</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malignancy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Previous DVT or PE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is PE the most likely diagnosis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CT PE Protocol Score</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Diagnostic Rate for CT PEs Performed at UHS
p-Chart of Data Jan - Dec 2016

Diagnostic % of PEs Performed at UHS

Jan-16  Feb-16  Mar-16  Apr-16  May-16  Jun-16  Nov-16  Dec-16
9.9%  6.8%  6.0%  6.9%  12.7%  6.9%  7.3%  6.8%  21.8%  6.7%  6.8%  12.7%  0.8%
Diagnostic Rate for CT PE in the Emergency Department
p-Chart of Data Jan - Dec 2016

Diagnostic % of PEs in the ED

Jan-16  Feb-16  Mar-16  Apr-16  May-16  Jun-16
11.1%  5.6%  1.4%  7.9%  11.8%  7.3%

Nov-16  Dec-16
8.0%  6.9%  7.3%  15.1%

UCL
Diagnostic Rate for CT PE on the 5th Floor
p-Chart of Data Jan 0 Dec 2016

Diagnostic % of PEs on the 5th Floor

Jan-16: 8.3%
Feb-16: 0.0%
Mar-16: 0.0%
Apr-16: 10.0%
May-16: 0.0%
Jun-16: 3.5%
Nov-16: 18.2%
Dec-16: 29.8%
NEXT STEPS

• Identify additional adopters of the new process
• Monitor use of the e-Note Template
• Report e-Note Template utilization
• Modify CT physician order process for effectiveness
• Address this process improvement with University Hospital System (UHS) Administration to gain their support for continued use of the e-Note Template
• Spread best practice throughout the UHS
Prevention of CT PE Complications

• Contrast Induced Nephropathy (CIN): 4.96% (95% CI: 3.79 - 6.47) ¹

• Contrast Media Hypersensitivity Reaction: .7 - 3.1% ²

---


Financial Return On Investment

- UHS is paid a fixed amount by Medicare and many private insurance contracts.
- Any monies remaining after all care is rendered add to the profit margin.
### Financial Return On Investment

**Pre-Intervention Cost Analysis based on Wells Score**

<table>
<thead>
<tr>
<th>Wells Score</th>
<th>Direct Cost ($108.66)</th>
<th>Indirect Cost ($688.81)</th>
<th>Total Cost ($797.47)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Wells Score (250)</td>
<td>$27,165.00</td>
<td>$172,202.50</td>
<td>$199,367.50</td>
</tr>
<tr>
<td>Intermediate/High Wells Score (450)</td>
<td>$48,897.00</td>
<td>$309,964.50</td>
<td>$358,861.50</td>
</tr>
<tr>
<td>Total (700)</td>
<td>$76,062.00</td>
<td>$482,167.00</td>
<td>$558,229.00</td>
</tr>
</tbody>
</table>

### Financial Return per Patient based on Wells Criteria

<table>
<thead>
<tr>
<th>Wells Criteria</th>
<th>Cost</th>
<th>Potential Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Risk</td>
<td>$0.00</td>
<td>$797.47</td>
</tr>
<tr>
<td>Intermediate Risk (D-dimer only)</td>
<td>$243.25</td>
<td>$554.22</td>
</tr>
<tr>
<td>High Risk (CT Angio PE)</td>
<td>$797.47</td>
<td>-</td>
</tr>
</tbody>
</table>
Maintaining the Gains

• The physician continues to maintain CT ordering autonomy

• e-Note requires mandatory documentation
  • Lowers the risk of failure to appropriately diagnose and treat
  • No adverse results from using D-Dimer
  • Demonstrates quality care

• Analysis of documentation via research staff support

• Continued physician education based on data results per unit
Maintaining the Gains: Current Best Practice

Choosing Wisely
An initiative of the ABIM Foundation

American College of Radiology

Five Things Physicians and Patients Should Question

1. Don’t do imaging for uncomplicated headache.
   Imaging headache patients absent specific risk factors for structural disease is not likely to change management or improve outcome. Those patients with a significant likelihood of structural disease requiring immediate attention are detected by clinical screens that have been validated in many settings. Many studies and clinical practice guidelines concur. Also, incidental findings lead to additional medical procedures and expenses that do not improve patient well-being.

2. Don’t image for suspected pulmonary embolism (PE) without moderate or high pre-test probability of PE.
   While deep vein thrombosis (DVT) and PE are relatively common clinically, they are rare in the absence of elevated blood d-Dimer levels and certain specific risk factors. Imaging, particularly computed tomography (CT) pulmonary angiography, is a rapid, accurate, and widely available test, but has limited value in patients who are very unlikely, based on serum and clinical criteria, to have significant value. Imaging is helpful to confirm or exclude PE only for such patients, not for patients with low pre-test probability of PE.

3. Avoid admission or preoperative chest x-rays for ambulatory patients with unremarkable history and physical exam.
   Performing routine admission or preoperative chest x-rays is not recommended for ambulatory patients without specific reasons suggested by the history and/or physical examination findings. Only 2 percent of such images lead to a change in management. Obtaining a chest radiograph is reasonable if acute cardiopulmonary disease is suspected or there is a history of chronic stable cardiopulmonary disease in a patient older than age 70 who has not had chest radiography within six months.
Thank you and . . .

Any Questions?