CT PULMONARY

Hamilton General Hospital  Juravinski Henderson Hospital  Saint Joseph’s Hospital

ANGIOGRAPHY AUDIT

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Supervisors
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Disclosure

None
Published theoretical minimum attenuation of blood required to identify nearly all acute and chronic PE are of 93HU and 211HU respectively (Wittram, 2007); hence a **minimum of 211HU**

- Takes into account the attenuation of acute and chronic thrombus to be 33HU and 87HU
- To detect 99.75% of all thrombi, attenuation of thrombi can be equal to the mean +3 standard deviations
- Need attenuation of the PA to be at least one more than highest possible attenuation of a thrombus either acute or chronic
- Prior research suggest up to 10.8% of all CT PAs maybe suboptimal/indeterminate due to multiple causes, with motion artifact and **bolus enhancement** being the most frequent cited causes for indeterminism (Jones et al, 2005)

**TARGET:** No more than 10.8% CT PAs have less than 211 HU enhancement of main pulmonary outflow tract (MPOT)
METHODS

TIME AND SEARCH

• Institutional Research Ethics Board Approval was obtained at McMaster University, HIPAA compliant

• All CT pulmonary angiographic studies were identified on PACS over a 20 day period from December 1, 2015 to December 20, 2015

• The following study title searches were completed for each of the hospitals
  • “CT ANGIO PULMONARY” for Hamilton General cases
  • “CT CHEST PULM EMBOLUS” for Henderson Hospital cases
  • “CT-PULMONARY EMBOLUS” for St. Joes cases
**METHODS**

**VARIABLES COLLECTED**

- Patient Demographics (id, age, gender)

- Main pulmonary outflow tract (MPOT) enhancement. The details of scan and the average HU for each patient were recorded in an excel database. A circular region of interest was measured in the largest axial image of the main pulmonary artery with a diameter of approximately 50% of the vessel.

- Result of the study: + or - for PE.

- Variables affecting the studies that did not meet 211HU of MPOT such as motion artifact, body habitus, opacification of distal vessels, timing of contrast
## PATIENT DEMOGRAPHICS
### HOSPITAL COMPARISON

<table>
<thead>
<tr>
<th></th>
<th>HGH</th>
<th>JHCC</th>
<th>SJH</th>
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<tbody>
<tr>
<td><strong>Average Patient Age (Years)</strong> &lt;br&gt; $p=0.87411$</td>
<td>63</td>
<td>62</td>
<td>61</td>
</tr>
<tr>
<td><strong># Male Patients</strong></td>
<td>26 M</td>
<td>33 M</td>
<td>18 M</td>
</tr>
<tr>
<td><strong>% Female Patients</strong></td>
<td>38/64= 59.4%</td>
<td>31/65= 47.7%</td>
<td>24/42= 57.1%</td>
</tr>
<tr>
<td><strong>Total number of patients scanned over 20 day period</strong></td>
<td>64</td>
<td>65</td>
<td>42</td>
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</table>
• SJ H had almost 1/3rd less studies compared to HGH and J HCC (20 day period)

• Why? - population difference? No statistical difference in age. J HCC more cancer patients, however HGH does not. Incidental due to data sampling or patient presentation to the ER during that timeframe.

• SJ H has standardized order for PE studies, a specific stamp on the req with the Wells Score (for ER studies only, inpatient studies had standard requisition with open box to fill in information)

• Impact of implementation of the Simplified Wells Criteria on referrals for pulmonary embolism; Michelle Ong, Vincent Leung, Julian Dobranowski, Ehsan Haider, St Joseph’s Healthcare, Hamilton, Ontario (http://www.car.ca/uploads/education%20lifelong%20learning/audit%20templates/2014_ap001_audit.presentation.pdf)
AUDIT RESULTS FROM 2014 PROJECT

- 21.7% reduction in the number of studies with enforced use of an algorithm based on the simplified Wells Score

- Higher percentage of positive PE studies after implementation of the algorithm (21.7% vs 13.2%) – but not statistically significant (p = 0.12)

- **Change #1**: Consider implementation of standardized use of simplified Wells score on the requisitions and need for d-dimer on a score <1 at HGH and J HCC ER requisitions
## Positive Studies

### % Studies Diagnostic

<table>
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<tr>
<th></th>
<th>HGH</th>
<th>JHCC</th>
<th>SJH</th>
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<tbody>
<tr>
<td>Positive for PE</td>
<td>17</td>
<td>21</td>
<td>5</td>
</tr>
<tr>
<td>Negative for PE</td>
<td>47</td>
<td>43</td>
<td>37</td>
</tr>
<tr>
<td>% Total</td>
<td>36%</td>
<td>49%</td>
<td>14%</td>
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## MAIN PULMONARY OUTFLOW TRACT

### HOUNSFIELD UNITS DISTRIBUTION

<table>
<thead>
<tr>
<th></th>
<th>HGH</th>
<th>JHCC</th>
<th>SJH</th>
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<tbody>
<tr>
<td><strong>Range (delta)</strong></td>
<td>143 - 638</td>
<td>157 - 606</td>
<td>102 - 833</td>
</tr>
<tr>
<td><strong>Average HU</strong></td>
<td>400</td>
<td>309.5</td>
<td>374.5</td>
</tr>
<tr>
<td><strong>How many studies below 211 HU</strong></td>
<td><strong>1</strong></td>
<td><strong>8</strong></td>
<td><strong>4</strong></td>
</tr>
<tr>
<td><strong>% studies (target &lt;10.8%)</strong></td>
<td><strong>1.5%</strong></td>
<td><strong>12.3%</strong></td>
<td><strong>9.5%</strong></td>
</tr>
</tbody>
</table>
- 8 patients at J HCC below criteria (50% of the studies were positive for PE)
  - 30 y M - 157HU, breathing, 22g iv rac, suboptimal opacification due to body habitus, however Saddle embolus
  - 57 y M - 170HU, breathing, suboptimal opacification with venous opacification and body habitus
  - 66 y M - 193HU, motion in distal vessels, power picc, positive for subsegmental PE
  - 56 y M - 208 HU, 18g forearm, breathing
  - 70 y M - 178HU, breathing, suboptimal opacification distally
  - 41 y M - 190 HU, suboptimal opacification distally
  - 58 y M - 182 HU, suboptimal opacification distally, body habitus
  - 67 y M - 195 HU, suboptimal distal opacification
- Omnipaque 300 was used (30ml -> 10ml(small-ave patient)/20ml(ave-large patient) 30c:70s blend ->25ml flush)
- **Change #2:**
  - Better instructions for breath hold, encourage minimal inspiration (decreased draw of unopacified blood from ivc)
  - Can not change body habitus, consider increase in kVP/mAs (to 135/140) for large patients similar to protocols at HGH/SJH
  - Lower concentration of contrast used at J HCC (Omni 300 vs 350 at other sites), improve distal opacification by increasing the initial bolus from 30ml to 40ml, followed by the blend
• 4 patients at **SHJ** below criteria (Omnipaque 350, 30-40ml ->30ml 30c/70s ->20ml flush)
  • 35 y F - 149 HU, 18g iv distal forearm, delayed scan, contrast already in aorta
  • 41 y M - 206 HU, distal vessels not well opacified
  • 50 y M - 102 HU, delayed scan, contrast mainly in pulmonary veins and LV
  • 38 y M - 123 HU, contrast in right circulation, 20g iv in forearm, repeated twice, however large body habitus
• 1 patient at **HGH** below criteria (Omnipaque 350 - 90ml)
  • 62 y F - 149 HU, delayed scan, contrast already in aorta and large body habitus
• **No change needed, target met**
SUMMARY OF CHANGES

• Change #1:
  • Consider implementation of standardized use of simplified Wells score on the requisitions and need for d-dimer on a score <1 at HGH and J HCC
  • Goal: decrease ordering low risk studies and cost to the healthcare system

• Change #2 to meet target at J HCC:
  • Better instructions for breath hold, encourage minimal inspiration (decreased draw of unopacified blood from ivc)
  • Can not change body habitus, consider increase in kVP/mAs (to 135/140) for large patients similar to protocols at HGH/SJ H
  • Lower concentration of contrast used at J HCC, improve distal opacification by increasing the initial bolus from 30ml to 40ml, followed by the blend
REFERENCES

• Wittram C. How I do it: CT pulmonary angiography. AJR 2007; 188:1255–1261
