# Improving Care for Patients with Suspected Appendicitis through Efficient Imaging

QUALITY IMPROVMENT PROJECT- ACUTE APPENDICITIS

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# Introduction

- Appendicitis occurs in 1 in 1,000 people, commonly in patients between 10 - 30 years of age.
- The most feared complication is rupture or perforation of the appendix, thereby spilling its infected contents into the abdomen, a potentially life-threatening condition.

# Introduction

- As a Practice Quality Improvement (PQI) project, we intend to retrospectively analyze the existing data in our electronic medical record and Radiology PACS system to identify specific time points in care for patients with diagnosed or suspected appendicitis that obtained a CT scan from June 2013 through December 2013.

# Study Design

- **Description of population:**
  - Age: All ages
  - Sex: Men and women
  - Number of Subjects: 119
- **Method of Data Collection:**
  - Retrospective analysis of data in Radiology PACS and correlation with the pathology in Sunrise and Centricity.
- **Approximate duration of time over which the study will be conducted:**
  - This study is based on a retrospective review of the Radiology database at our institution, between June 2013 and December of 2013.

# Major endpoint

- Our **major endpoint** was to gain better insight into the timeline of CT in our system, both obtaining the CT and also time for interpretation. We chose to specifically analyze cases of suspected/diagnosed appendicitis on CT as this is an acute process, thereby avoiding contamination of our results with CT obtained for a chronic process. We had some hypotheses, particularly that there was likely delay in obtaining/interpreting "After Hours" cases when compared to "Normal Work Hours." By analyzing the timeline with specific time points, **we hoped to identify areas for possible improvement.**

# Major Endpoint

- **The timepoints we analyzed included:**
  - CT Order Entry Time to CT Performed Time
  - CT Order Entry Time to Prelim Report Time
  - CT Performed Time to Prelim Report Time
  - CT Order Entry Time to Communication Time
  - CT Performed Time to Communication Time
  - CT Order Entry Time to Final Report Time
  - CT Performed Time to Final Report Time
  - Prelim Report Time to Final Report Time

- **The data was also subdivided and compared using multiple variables:**
  - The data was analyzed based on degree on confidence of the CT report, separated into "High Suspicion" and "Low Suspicion."
  - The data was analyzed based on time of day, separated into "Normal Work Hours" and "After Hours."
  - The data was analyzed based on "Pediatric" or "Adult" patient. (Only 3 Pediatric cases were present in the data, severely limiting conclusions).

# Minor Endpoints

- An attempt was made to evaluate the number of scans that received oral contrast and the subset of those patients in which contrast had reached the cecum by the time of scanning. Unfortunately, the low number of these cases did not reach statistical significance.
- A minor endpoint was the presence or absence of perforation at Imaging and at Surgery. The Radiology Report findings and the Surgical findings (presuming surgery was performed) were accessed and recorded. We correlated the imaging findings with the surgical findings to assess our accuracy in detecting perforation.
- A minor endpoint was the presence of documentation of communication of the critical result of diagnosed/suspected appendicitis. Documentation of communication of findings was reviewed and recorded.

# Major Findings

- On average, in our system, cases of appendicitis take 2 hours to be CT scanned once ordered and another hour until a preliminary read is submitted and the clinical team is called. This results in approximately 3 hour turnaround time for order to working diagnosis.
- Once ordered, a CT is performed more quickly during the daytime (1.5 hrs vs 2.0 hrs).
- Regardless of time of day, it takes approximately 1 hr to have a prelim report after the scan is performed.
- Preliminary reads are finalized more quickly during the daytime (35 min vs 50 min)
- Results of studies that were less confident of diagnosis of appendicitis took longer to communicate findings to the clinical team.
- Positive predictive value (PPV) of appendicitis on CT was 94.7%.
- While specificity for perforation was high (95.4%), sensitivity was relatively low (60.0% overall).
- Documentation of communicated diagnosed/suspected appendicitis occurred 79.8% of the time.
- Very few patients that were ultimately diagnosed with/suspected of having appendicitis received oral contrast.

# Discussion of Results and Recommendations

- **On night versus day timeline:**
  - The only statistically significantly differences between daytime-working-hours CT's and nighttime-afterhours CT's were in the average time gap between CT order time and CT performed time, CT order time and communication time and CT order time and final report time, where nighttime scans demonstrated longer times in all three categories. It is important to note that the latter two categories are dependent to the average time gap between CT order time and CT performed time, suggesting that this is the weak link in the time point data series. **Thus, attention should be paid to improving nighttime CT tech workflow and/or hiring more nightshift technologists to improve patient care quality and turnaround time.**

# Discussion of Results and Recommendations

- **On turnaround time for prelim report:**
  - Regardless of time of day, it takes approximately 1 hr to have a prelim report after the scan is performed. Our results confirm that resident coverage of the ER overnight matches turnaround time during normal working hours. This was not entirely expected, but confirms that our current system loses little in efficiency when fewer residents/faculty cover overnight. Our results found no major issue to address in regards to interpretation turnaround time overnight.

# Discussion of Results and Recommendations

- **On presence or absence of perforation:**
  - Specificity and NPV for perforation was high at 95.4% and 83.3 %, respectively. Out of the 18 patients called perforated on CT who stayed in the hospital, 15 were found to be perforated in the operating room (O.R.). This results in a PPV of 83.3%. However, 10 patients who were called as NOT perforated on CT were found to be perforated in the operating room. This results in a sensitivity of only 60.0% for perforation. This figure drops even further during the nighttime, when sensitivity for perforation is only 50.0%. **These findings suggest that radiologists, particularly on-call/nighttime residents, are under-calling perforation. Better education, especially residents, on the CT signs of perforation may lead to improved patient care quality.**

# Discussion of Results and Recommendations

- **On documentation of communication:**
  - As acute appendicitis is a surgical emergency, the department of radiology **should strive to increase the documentation of communication in all CT scans suspected of having appendicitis** from 79.8% to 100.0%.

# Discussion of Results and Recommendations

- **On high suspicion versus low suspicion:**
  - There was an statistically significantly longer average time gap between CT performed time and communication time between the high and low CT suspicion for appendicitis scans . This seems logical, since in low suspicion scans, the radiologist read often favored less acute pathology and it would follow that the radiologist probably felt less rushed to dictate the study and communicate results. Also, there was a lower percentage of scans with low CT suspicion for appendicitis that has documentation of communication. However, 6 of 27 (22%) patients with low suspicion scans still had appendicitis at surgery. **Thus, educating radiologists to treat exams with any level of suspicion for the appendicitis the same as exams with unequivocal evidence of appendicitis could lead to improved communication and patient care quality.**

# Criticisms

- A criticism of our work is selection bias. We only included patients that had imaging suggesting/consistent with appendicitis. We have limited ability to "mine data" using our current resources. This results in us not being able to assess sensitivity, specificity and negative predictive value for the diagnosis of appendicitis. The strength of our results is positive predictive value. Out of 95 patients suspected of having appendicitis on CT who were taken to surgery, 90 had appendicitis for a positive predictive value (PPV) of 94.7%.

- One criticism is that time from imaging to surgery was not obtained. This time gap could very well be the cause of increased incidence of perforation at night, maybe not undercalling at the time of imaging. Presumably there is less OR activity with less staff overnight. Waiting to operate in the morning could obviously increase the chance of finding perforation at surgery. This is speculative as it is not known if there is a difference how quickly suspected appendicitis goes to surgery based on time of day. An institution PQI project for future exploration could include time gap between imaging diagnosis and operating time.

# Criticisms

- Another criticism regards skewed data based on absence of reading faculty during the night. The time it takes to finalize a preliminary report is longer at night. This includes the 3-4 hour period from 4 am to 7-8 am, after the overnight ER faculty stops reading and when the morning faculty finalizes the remaining preliminary reports generated during that timeframe. It is unclear how many cases fell into this category, but it is easy to see that this additional time, even if only for a few cases, could significantly impact the average time to finalize the preliminary reports at night. The consistent preliminary interpretation turnaround suggests this is a minor issue at best.

- There is only a 14 minute difference between CT performed to prelim report time based on high or low suspicion, with high suspicion being faster (1:03 vs 1:17). HOWEVER, there is 56 min lag for communication of low suspicion studies compared to high suspicion. Likely a confounder is limited resources in contacting clinicians at the same time keeping up with the workload. We have to triage our time, and using "critical" finding via the help desk vs. "routine" is likely a confounder of longer communication times.

# Possibilities for future projects based on these results:

- Evaluation of benefit of oral contrast. Does it help? It adds time (48 min on average based on these results), but does it provide additional benefit?
- Separate the overnight cases into "During ER Faculty Night Coverage" and "After ER Faculty Night Coverage." This could more accurate reflect what happens during these very different workflow times.
- Institution PQI project to include time gap between imaging diagnosis and operating time.