Cleveland Clinic Children's

QI: Pediatric Appendicitis Ultrasound across a Quaternary Health System

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PURPOSE

- Pediatric patients with right lower quadrant pain routinely were evaluated by CT across our quaternary Health System as our current **ultrasound (US)** was believed to be ineffective as a screening tool.
- Concern over increased radiation dose led to an initiative to improve **right lower quadrant (RLQ)** US.

GOALS:

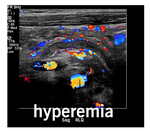
- To improve technical skill of the sonographers and to increase confidence in the reporting of pediatric ultrasound.

METHODS

- In an effort to improve the diagnostic accuracy of pediatric right lower quadrant ultrasound across the quarternary health system for the diagnosis of appendicitis, we first provided didactic and technical education to the ultrasound technologists.
- A leading radiologist and his lead ultrasound technologist, from Nationwide Children's Hospital, were invited to provide hands on instruction. A didactic lecture and live demonstration of ultrasound methods was provided to all ultrasound technologists across the enterprise.[1] Attendance was mandatory. Pediatric surgeons and pediatric Emergency Department (ED) staff were encouraged to attend.
- Further education was provided to pediatric radiology and ED staff including our goals of decreased CT use and how to read/interpret the new structured reporting.
- An updated technique was sent to sonographers requiring at least 20 minutes of scan time.
- A new structured report was created using the Nationwide Children's Hospital scale **(Figure 1)**. All radiologists were advised to use the new macro which automatically launched at the start of dictation.
- Ultrasound cases were reviewed at the end of the month and discrepancies between CT and/or surgical outcome with ultrasound report were sent to the lead sonographers for review. Discrepancies were reviewed with the interpreting radiologist.
- Methods for clustered proportions were used to compare the new structured report to the old template with respect to the proportion of cases requiring a follow up CT. The sensitivity and specificity of the structured report versus old template were estimated after correcting for verification bias. Pathology results were used as the reference standard when possible; CT results were used otherwise.

RESULTS

- 804 ultrasounds (793 patients) performed October 2017 - December 2018.
- Patient's mean age at the time of US was 10.6 years (standard deviation: 4.3 years, range: 0 – 18 years).
- The proportion of ultrasounds being read with the new structured report steadily increased over time **(Table 1)**.
- The proportion of ultrasounds requiring a follow up CT was significantly lower when the new structured report was used (141/656 = 21%) compared to when the old template was used (46/148 = 31%)(p=0.021).
- Of the 804 ultrasounds, 247 had a reference standard result (100 surgery, 147 CT).
- Patients who were positive on US were much more likely to have a reference standard result (98/103=95%) compared to patients who were negative or indeterminate on US (149/701=21%).
- Sensitivity and specificity were 44% and 97% with the old template and 78% and 83% with the new template **(Table 1).**



CONCLUSIONS

- As a quaternary health system with multiple hospitals and sonographers, we faced the challenge of uniform improvement across the enterprise.[2]
- Challenges included training the sonographers, particularly with a limited pediatric population, and obtaining the commitment of the radiologists, to use the designated structured report and provide definitive reports, to thereby increase the confidence of our clinicians.
- The use of structured reporting increased and the use of CT following RLQ US decreased.

LIMITATIONS:

- Selection bias as only cases with higher clinical concern or US features concerning for appendicitis went on to CT or surgery. Additionally, there is a paucity of surgical/pathologic correlation and limited number of CT's.
- The assessment of the accuracy of US results is subject to imperfect gold standard bias (CT is an imperfect reference standard).

Figure 1: Structured Report

EXAMINATION: **RIGHT LOWER QUADRANT ULTRASOUND (APPENDIX)**

HISTORY:

TECHNIQUE: Ultrasonographic images of the RIGHT lower abdominal quadrant were performed with graded compression. Doppler imaging was done in areas of interest. Images were obtained and stored in a permanent archive.

COMPARISON:

RESULT:

Appendix: *(pick list)*
__ The appendix is identified in its entirety.
__ The appendix is partially visualized.
__ Not visualized.

Size: AP width … cm *(pick list)*
__ Non-enlarged (normal: less than 0.7 cm)
__ Enlarged (normal: less than 0.7 cm).

Appendicolith: __ yes / __ no

Hyperemia: __ yes / __ no / __ not assessed

Mesentery/peritoneum:
Fluid: __ none / __ focal fluid collection *(describe)* _____
Fat: __ normal / __ echogenic

Lymph Nodes *(pick list)*
__ Pathologically enlarged lymph nodes (normal: less than 0.7 cm).
__ Pathologically enlarged lymph nodes, size … cm (normal: less than 0.7 cm).

Additional Findings:

IMPRESSION: According to Nationwide Children's appendicitis grading system *(pick list)*
__ Grade 1: Normal appendix without secondary features of appendicitis.
__ Grade 2: The appendix is not visualized/depicted in its entirety. There are no sonographic signs to suggest appendicitis.
__ Grade 3: The appendix is not visualized/depicted in its entirety. Secondary signs of appendicitis were identified.
__ Grade 4: Findings of acute appendicitis.

The above findings should be interpreted in the context of the patient's clinical presentation and laboratory values.

Quaternary Health System

Cleveland Clinic

- Main campus
- Fairview
- Hillcrest
- Avon
- Marymount
- Euclid
- Lutheran
- South Pointe
- Twinsburg

Table 1: Assessment of accuracy of US results with new structured report and old template

	# ultrasounds total	# ultrasounds with reference standard (surgery or CT)	Sensitivity	Specificity
Old template	148	50	44% (8/18)	97% (29/32)
New Structured Report	656	197	78% (71/91)	83% (88/106)

REFERENCES

1. Reduction of CT for the Diagnosis of Appendicitis. Speech presentation. Adler, Brent. Nationwide Children's Hospital, 2017.
2. Diagnostic imaging for acute appendicitis: interfacility differences in practice patterns. Michailidou, Maria. *Pediatric Surgery Int* (2015) 31: 355-361.
3. US examination of the appendix in children with suspected appendicitis: the additional value of secondary signs. Wiersma F, Toorenvliet BR, Bloem JL, Allema JH, Holscher HC. *Eur Radiol.* 2009 Feb;19(2):455-61.

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