# Critical Review Form
## Therapy

Suspected Appendicitis in Children: US and CT—A Prospective Randomized Study, *Radiology* 2002; 233:633-638

**Objective:** **"To evaluate the accuracy of ultrasonography (US) and of abdominal computed tomography (CT) performed in addition to US in the diagnosis of childhood appendicitis". (p. 634)**

**Methods:** **Pediatric patients presenting to Astrid Lindgren Children's Hospital from December 1999 to September 2000 were recruited. The initial physical exam was conducted by a pediatric surgeon or surgical resident who estimated the likelihood (0% to 100%) of appendicitis. Randomization occurred thereafter to either US only or US plus abdominal CT.**

**US was performed by 1 to 12 attending pediatric Radiologists or 1of 9 senior Radiology residents using a 7MHz linear array transducer and graded compression. US -appendicitis was defined as a "blind-ending, non-compressible tubular structure with a maximal diameter greater than 6mm, with or without an appendicolith, and no peristaltic activity". (p. 634)**

**The CT study was always performed after the US and used intravenous non-ionic contrast medium. The interpreter had access to the results of the US study. CT-appendicitis was defined by "visualization of an appendix larger than 6mm in maximal diameter, with contrast enhancement in the thickened appendiceal wall and/or pericecal inflammatory changes, or on the visualization of an abscess, with or without an appendicolith". (p. 634)**

| Guide | | Comments |
|---|---|---|
| **I.** | **Are the results valid?** | |
| **A.** | **Did experimental and control groups begin the study with a similar prognosis (answer the questions posed below)?** | |
| 1. | Were patients randomized? | Yes, randomized after surgeon evaluation. |
| 2. | Was randomization concealed (blinded)? | No. Furthermore, the method of randomization is not described. |

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| 3. | Were patients analyzed in the groups to which they were randomized? | Yes. "Four patients, including one patient with an appendiceal abscess, and all of whom were originally assigned to undergo US only, had false-negative US findings. However, additional CT, which was performed in all four of these patients but not included in the study analysis, was positive for appendicitis". (p. 636) |
| 4. | Were patients in the treatment and control groups similar with respect to known prognostic factors? | Unknown since the investigators do not compare the groups for known appendicitis prognostic factors. |
| **B.** | **Did experimental and control groups retain a similar prognosis after the study started (answer the questions posed below)?** | |
| 1. | Were patients aware of group allocation? | Yes. |
| 2. | Were clinicians aware of group allocation? | Yes. |
| 3. | Were outcome assessors aware of group allocation? | Yes. |
| 4. | Was follow-up complete? | "The follow-up questionnaire was completed by 327 (94%) of the 348 patients who were treated non-surgically". (p. 636) |
| **II.** | **What are the results (answer the questions posed below)?** | |
| 1. | How large was the treatment effect? | • 95% of CT's were performed within 3 hours after the US<br>• 600 subjects were enrolled and 244 had appendicitis (prevalence =244/600 = 40.7%).<br>• 252 subjects underwent laparotomy and 348 did not. 244 underwent appendectomy, 8 cases of appendicitis were treated with antibiotics alone.<br>• 283 subjects were randomized to the US group and 317 to the US and CT group (Fig 1, p. 634)<br>• The following test characteristics were described: |

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| | Appendicitis | | |
|---|---|---|---|
| US | + | - | sen 80% (77% - 83%) |
| + | 196 | 20 | spec 94% (92% - 96%) |
| - | 48 | 336 | LR+ 14.3 (9.9 – 21.2) |
| | | | LR- 0.21 (0.18 – 9.25) |

| | Appendicitis | | |
|---|---|---|---|
| CT | + | - | sen 97% (94% - 99%) |
| + | 131 | 12 | spec 93% (91% - 95%) |
| - | 4 | 170 | LR+ 14.7 (10 - 19) |
| | | | LR- 0.03 (0.01 – 0.07) |

| | Appendicitis | | |
|---|---|---|---|
| USplusCT | + | - | sen 99% (95% - 100%) |
| + | 133 | 20 | spec 89% (87% - 90%) |
| - | 2 | 162 | LR+ 9.0 (7.2 – 9.8) |
| | | | LR- 0.02 (0.005 – 0.05) |

- Provided these LR's one can compute post-test probabilities to ascertain how useful a positive or negative result might be. Starting from a pre-test probability of appendicitis of 41% and using free online statistical calculators a positive or negative result on each study would change post-test probability as follows:

| **Pretest Prob** | | **Posttest Prob** |
|---|---|---|
| 41% | (+ US with $LR^+$ 14.3) $\longrightarrow$ | 91% |
| 41% | (+CT with $LR^+$ 14.7) $\longrightarrow$ | 91% |
| 41% | (-US with $LR^-$ 0.21) $\longrightarrow$ | 13% |
| 41% | (-CT with $LR^-$ 0.03) $\longrightarrow$ | 2% |

- An appendicolith was identified in 27% of US and 58% of CT patients who had appendicitis.
- Among the 317 who underwent both US and CT the results were discordant in 50 (16%). Among these discordant findings CT was correct in 39 and US in 11.
- 52/244 (21%) had perforation.
- Two patients assigned to US-only had CT performed. The CT results were not included in this intention-to-treat analysis.

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| | | • Surgeons estimated appendicitis risk as > 75% in 173/600 (28.8%) and 119/173 (68.8%) had a final diagnosis of appendicitis. In 78/173(45.1%) physical signs were convincing enough that surgeons would have gone to OR if imaging were unavailable and 20/78 (25.6%) would have been a negative laparotomy.<br>• Among the 130 patients stratified as low-risk (<50% probability of appendicitis), 25 had appendicitis diagnosed by US or CT (19.2%). |
| 2. | How precise was the estimate of the treatment effect? | No CI's were reported, but they can be independently computed by readers (see above). Both the positive-LR and negative-LR Confidence Intervals are sufficiently narrow to incorporate into clinical practice. |
| **III.** | **How can I apply the results to patient care (answer the questions posed below)?** | |
| 1. | Were the study patients similar to my patient? | No. Surgeons conducted the physical exam and Radiologists (experienced pediatric-specialist Radiologists) performed and interpreted the ultrasounds. |
| 2. | Were all clinically important outcomes considered? | No. There is no assessment of surgeon confidence in sonography or CT findings correlated with physical exam. Also, there is no assessment of patient satisfaction with either imaging modality, pain entailed, or diagnostic delays or long-term cancer risk trade-off priorities. |
| 3. | Are the likely treatment benefits worth the potential harm and costs? | The current research supports the use of CT or US to rule-in the diagnosis of appendicitis when examined by a surgeon and imaged by experienced pediatric radiologist. Unfortunately, this data does not support the use of sonography alone ($LR^- = 0.21$) to exclude the diagnosis of appendicitis. |

**Limitations:**

1) **Hybrid diagnostic therapeutic-trial but unfortunately does not reference or follow the STARD or CONSORT guidelines.**
2) **Insufficient detail on the randomization process or results. How was randomization performed? Were these any significant prognostic differences between the two groups (age, illness, severity, co-morbidity, etc)?**
3) **CT interpreter was not blinded to US result. Pragmatic design, but subject to ascertainment bias.**
4) **No LR's or CI reported.**
5) **Limited external validity for EP's who may lack a surgeon or radiologist-sonographer 24/7.**

**Bottom Line:**

**In a pediatric hospital children evaluated by a Pediatric-Surgeon with suspected appendicitis can have the diagnosis confirmed with either Radiologist-performed compression sonography or intravenous contrast CT, but only CT can sufficiently rule out the diagnosis. One reasonable strategy in this setting would be US as first-line imaging study followed by CT if sonography negative but clinical impression remains high for appendicitis. To ensure external validity (i.e. reproducibility) this technology and diagnostic algorithm would need to be tested prospectively in pediatric and non-pediatric EDs staffed by EM physicians performing the initial evaluation and perhaps US testing.**