Does this child have appendicitis? A systematic review of clinical prediction rules for children with acute abdominal pain

Kulik DM, Uleryk EM, Maguire JL

CRD summary
This review concluded that none of the six clinical prediction rules for children with suspected appendicitis met the performance standards of the time. The Paediatric Appendicitis Score and Alvarado rule were best validated, and a third rule was promising, but needed validation. These conclusions reflect the evidence and are likely to be reliable.

Authors' objectives
To systematically identify the clinical prediction rules for children with suspected appendicitis, and to compare their quality and performance.

Searching
MEDLINE and EMBASE were searched, without language restrictions, for published articles from January 1950 to January 2012 (search terms were reported). References were searched; conference proceedings were excluded.

Study selection
Prospective or retrospective studies that derived, validated, or assessed the impact of clinical prediction rules were included. Each rule had to include three or more predictive variables from the history, physical examination, or simple diagnostic tests. Eligible studies had to be of children (birth to 18 years old) with suspected appendicitis of less than one week duration.

The included studies derived or validated six clinical prediction rules (Alvarado, Kharbanda, Lintula, modified Lindberg, Paediatric Appendicitis Score – PAS, and van den Broek). Study cohorts were from the USA, the UK, Canada, Finland, the Netherlands, Spain, or Italy. Two studies were multicentre. None of the studies reported the clinical impact of the prediction rule, five reported a derivation, and seven described validations. One study was conducted on a hospital ward, the others were in emergency departments. The most common predictors were migratory right iliac fossa pain, nausea or vomiting, right lower quadrant tenderness, rebound tenderness, and temperature (>38°C). Diagnosis was confirmed by pathology and follow-up, in most studies; some used pathology alone.

Two reviewers independently selected studies for inclusion and discrepancies were resolved by consensus.

Assessment of study quality
Quality was assessed using a 17-item checklist derived from the literature (references provided). Each item was scored as present (1) or absent (0) by two independent reviewers.

Data extraction
The data were extracted from each publication to construct a 2x2 table to calculate the sensitivity, specificity, predictive values and negative likelihood ratio, with their 95% confidence intervals, for the diagnosis of appendicitis.

These data were extracted by two independent reviewers, with disagreements resolved by discussion to reach a consensus.

Methods of synthesis
The results were not pooled due to variation in the included patients and the predictors, and poor reporting of the results. A narrative synthesis summarised the methodological quality and diagnostic performance of the included clinical decision rules.

Results of the review
Twelve studies were included in the review, with 4,201 participants. These studies met between 4 and 16 quality criteria; the worst items were the definition and reproducibility of predictors, blinding of outcome assessors, and...
reporting of the results. PAS validation studies had better methodological quality (9 to 16 quality items) than Alvarado validation studies (7 to 12 quality items).

**PAS:** In five studies, the sensitivity of the PAS varied between 0.82 and 1 (median 0.93). The negative likelihood ratio varied between zero and 0.27 (median 0.1). The predicted appendicitis frequency varied between 0.43 and 0.98 (median 0.52).

**Alvarado:** In five studies, the sensitivity of the Alvarado rule varied between 0.72 and 0.93 (median 0.88). The negative likelihood ratio varied between 0.09 and 0.34 (median 0.14). The predicted appendicitis frequency varied between 0.34 and 0.64 (median 0.6).

Relative to the actual appendicitis frequency (median 0.34 for PAS and 0.41 for Alvarado studies), the PAS on average over-diagnosed appendicitis by 35%, and the Alvarado over-diagnosed by 32%.

**Authors’ conclusions**
Six unique clinical prediction rules for children with suspected appendicitis were identified; the PAS and Alvarado rule were best validated, but neither met the performance standards of the time. One rule was promising, but had not been validated.

**CRD commentary**
This review addressed a clear question, with suitable inclusion criteria and an adequate search. The review process was clearly documented and likely to reduce the impact of reviewer error and bias throughout. The included studies were described and the quality assessment was reported and discussed. The decision to report a narrative synthesis appears to have been appropriate.

The clinical prediction rules overestimated the appendicitis frequency across studies on average, but the amount of overestimation varied widely, with some studies reporting little or none. The authors appropriately noted that – among other uncertainties – the degree of over-diagnosis using clinical judgement alone was unclear.

The authors’ conclusions about methodological weaknesses and variation in diagnostic performance in the included studies, seem to be reliable.

**Implications of the review for practice and research**
**Practice:** The authors recommended further research before a clinical prediction rule for children with suspected appendicitis could be used in routine practice. Existing rules might be useful to encourage shared decision making between physicians and parents.

**Research:** The authors recommended that future derivation and validation studies should use consistent inclusion criteria, such as all patients from birth to 18 years old, who presented with abdominal pain, suggestive of appendicitis, of less than one week in duration. Patients should be assessed throughout the year.

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