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

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Abstract

Objectives: To systematically identify clinical prediction rules (CPRs) for children with suspected appendicitis and compare their methodological quality and performance.

Study Design and Setting: Included studies involved children aged 0−18 years with suspected appendicitis identified through MEDLINE and EMBASE from 1950 to 2012. The quality was assessed using 17 previously published items. The performance was evaluated using the sensitivity, negative likelihood ratio, and predicted frequency of appendicitis diagnosis that would result if the rule was used.

Results: Twelve studies fulfilled the inclusion criteria describing the derivation or validation of six unique CPRs involving 4,201 children with suspected appendicitis. Migratory pain, nausea or vomiting, and right lower quadrant tenderness were common predictors to all rules. Methodological quality varied widely. The most poorly addressed quality items were the predictor and outcome assessor blinding, predictor description, and reproducibility of predictor assessment. The most well-validated CPRs were the Pediatric Appendicitis Score (PAS) and MANTRELS (**M**igration, **A**norexia, **N**ausea/vomiting, **T**enderness in the right lower quadrant, **R**ebound pain, **E**levation in temperature, **L**eukocytosis, **S**hift to the left)/Alvarado Score. Overall, the PAS validation studies outperformed the Alvarado validation studies.

Conclusion: The PAS and Alvarado scores were the most well validated but neither met the current performance benchmarks. A high quality, well validated, and consistently high-performing CPR was not identified. Further research is needed before a CPR for children with suspected appendicitis can be used in routine practice.

Keywords: Appendicitis; Review; Clinical prediction rule; Child; Models; Multivariate analysis

1. Introduction

Acute appendicitis is the most common reason for abdominal surgery in children, with between 60,000 and 80,000 cases diagnosed annually in North America [1,2]. The lifetime risk for acute appendicitis ranges from 7% to 9% [3], with a peak incidence of 86 of 100,000/year in the second decade of life [4]. Morbidity in children is high, with an overall frequency of appendix perforation of 12.5−30% [5−7]. Despite its high incidence and potentially serious consequences, the diagnosis of appendicitis in children remains challenging, in which clinical signs and symptoms can be nonspecific and unreliable and there may be limited availability or concern for using costly and potentially harmful diagnostic tests such as computerized tomography.

Classical clinical signs and symptoms of appendicitis [8] are often lacking on the initial presentation of children with acute abdominal pain. Furthermore, young children often have difficulty in describing their pain, and many nonsurgical conditions such as gastroenteritis and mesenteric adenitis may mimic appendicitis. Additionally, one-third of the children with acute appendicitis present with atypical findings, such as irritability, periumbilical pain, and diarrhea [9]. To overcome the diagnostic uncertainly laboratory evaluation, ultrasonography and computed tomography (CT) are often performed in the emergency department (ED) in children who present with acute abdominal pain.

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What is new?

- The accurate diagnosis of acute appendicitis in children is important to avoid severe outcomes and minimize unnecessary investigations and surgery.
- A high quality and high-performing clinical prediction rule (CPR) could improve the diagnostic accuracy of clinical findings in children with suspected appendicitis.
- Of the six unique CPRs for children with suspected appendicitis, the Pediatric Appendicitis Score and Alvarado scores were the most well validated but neither met the current performance benchmarks. A high quality, well validated, and consistently high-performing CPR was not identified.
- Further research is needed before a CPR for children with suspected appendicitis can be used in routine practice.

However, such diagnostic evaluation is time consuming, resource intensive, and potentially harmful and may not be needed to routinely rule in or rule out appendicitis. A rapid, safe, and accurate method for diagnosing acute appendicitis in children is urgently needed.

Clinical prediction rules (CPRs) are potentially powerful evidence-based tools for reducing uncertainty and improving accuracy in medical decision making by standardizing the collection and interpretation of clinical data [10]. They also may minimize potentially harmful diagnostic tests such as ionizing radiation from CT, allergic reaction to contrast dye, and complications from diagnostic laparotomy. They have been defined as clinical decision-making tools that quantify the relative importance of three or more variables from history, physical examination, or simple tests to provide the probability of an outcome or suggest a single diagnostic or therapeutic course of action for an individual patient [10−12].

This study aims to systematically identify CPRs for children with acute abdominal pain and compare their methodological quality and performance for diagnosing acute appendicitis using a recently developed framework to evaluate CPRs for children [13].

2. Methods

2.1. Search strategy

For this systematic review, potentially relevant studies were identified through electronic searches of MEDLINE and EMBASE from January 1950 up to January 2012. Because there is no medical subject heading (MeSH) that specifies CPRs, a previously developed electronic search strategy was used [13,14]. To identify only studies concerning appendicitis, the MeSH term ‘‘appendicitis’’ was added to this search strategy (Appendix at www.jclinepi.com). The reference lists of identified CPR publications were searched manually to identify additional studies. The Cochrane Review Database was not searched as we sought to identify individual CPR publications and not reviews. Conference proceedings and other unpublished data were not included in this review. There was no language restriction.

2.2. Inclusion criteria

Only prospective or retrospective studies that derived, validated, or assessed the impact of CPRs were included. A CPR was defined as a clinical decision-making tool that [10,11,13−15]:

a) includes three or more *predictive variables* obtained from the history, physical examination, or simple diagnostic tests;
b) provides the probability of an *outcome* or suggests a diagnostic or therapeutic *course of action* for an individual patient; and
c) is not a decision analysis or practice guideline.

Only studies involving children (term birth−18 years) with suspected appendicitis (less than 1-week duration) were included. Studies involving both adults and children were included if a separate analysis was performed for children. Studies requiring the use of artificial neural networks or that assessed predictors with no obvious goal of creating a prediction rule were not included.

2.3. Selection of studies

Two reviewers (Drs D.M.K. and J.L.M.) independently assessed the inclusion of potentially relevant articles through a two-step process. First, the titles and abstracts from each article identified through the electronic search were assessed for inclusion. Second, the publications identified as relevant by title or abstract were reviewed manually. Discrepancy between the two reviewers was discussed and included by consensus.

3. Data abstraction and statistical analysis

3.1. Assessment of methodological quality

The quality of the included studies was assessed using a 17-item checklist from the published guidelines for use in the derivation or validation of CPRs for children (Table 1) [10−14,16,17]. Each item was noted to be present (1) or absent (0). The maximum number of quality items was 17. Two reviewers (Drs D.M.K. and J.L.M.) independently abstracted data from included articles using a standardized data collection form. Discrepancies between the reviewers were discussed and resolved by consensus. The