Successful nonoperative management of uncomplicated appendicitis: predictors and outcomes

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ABSTRACT

Background: Our objective was to identify predictors of successful nonoperative manage-ment (NOM) of uncomplicated appendicitis. We hypothesized that the absence of diabetes, absence of an appendicolith, short duration of symptoms, absence of systemic inflam-mation, and low modified Alvarado score would predict successful NOM.

Methods: We performed a retrospective cohort analysis of 81 consecutive patients who underwent NOM of uncomplicated appendicitis. Successful NOM was defined as resolution of appendicitis with antibiotics alone and no recurrent appendicitis within 180 days. Pa-tients with successful NOM ($n = 36$) were compared with patients who failed NOM ($n = 45$). Multivariable logistic regression was used to identify predictors of successful NOM, expressed as odds ratios (ORs) with 95% confidence intervals. Model strength was assessed by calculating area under the receiver operating characteristic curve (AUC).

Results: Patient age (35 years), the American Society of Anesthesiologists class (2.0), and Charlson comorbidity index (0.0) were similar between groups. Independent predictors of successful NOM were duration of symptoms prior to admission >25 hours: OR 4.17 (1.42-12.24), maximum temperature within 6 hours of admission <37.3°C: OR 8.07 (1.79-36.38), modified Alvarado score <4: OR 9.06 (1.26-64.93), and appendiceal diameter <13 mm: OR 17.55 (1.30-237.28); model AUC: 0.81 (0.72-0.90).

Conclusions: Patients with a longer duration of symptoms prior to admission were more likely to have successful NOM. Other independent predictors of successful NOM included lower temperature, lower modified Alvarado score, and smaller appendiceal diameter. These findings provide a framework for clinical decision-making and large-scale derivation and validation of a model to predict successful NOM of uncomplicated appendicitis.

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Introduction

Nonoperative management (NOM) with antibiotic therapy alone has emerged as an alternative to appendectomy for the treatment of acute uncomplicated appendicitis, and is often preferred by patients.[1-4] However, NOM may fail due to persistent inflammation, appendiceal perforation, or recurrent appendicitis.[1,5,6] Complications associated with these events may be equal to or worse than complications associated with appendectomy.[6] In the recently published Jerusalem guidelines, Di Saverio et al.[7] did not find adequate evidence to recommend routine NOM of appendicitis, and both strategies remain viable options for most patients.

Rather than seeking to establish the superiority of operative *versus* NOM of appendicitis, a more effective approach may be used to determine which strategy is best for each individual patient. Several studies have identified risk factors for failing NOM of uncomplicated appendicitis. Shindoh et al.[8] demonstrated that high serum C-reactive protein levels and the presence of an appendicolith are associated with failed NOM, Vons et al.[9] also found that appendicoliths were associated with complicated appendicitis, and Tsai et al.[10] recently described diabetes as a risk factor for requiring appendectomy after NOM of uncomplicated appendicitis. However, the relative importance of other potential risk factors remains unclear, and multivariable clinical prediction models have not been reported.

The aims of this study were to identify conditions present on admission that are independent predictors of successful NOM and to provide a framework for derivation and validation of clinical prediction models. We hypothesized that the absence of comorbid diabetes, absence of an appendicolith, short duration of symptoms, absence of systemic inflammation, and low modified Alvarado score would predict successful NOM.

Methods

We performed a retrospective cohort analysis of 81 consecutive patients who underwent NOM of acute uncomplicated appendicitis at our university hospital during a 4-year period ending July 1, 2016. The Institutional Review Board approval was obtained. We searched our institutional database for all adults (age ≥ 18 years) with acute appendicitis. Pregnant women, patients with complicated appendicitis (i.e., perforation or abscess), patients who did not have computed tomography (CT) scan evidence of appendicitis, patients with a prior episode of appendicitis, and patients with incomplete documentation of history and physical examination findings were excluded. Successful NOM was defined as the resolution with antibiotics alone and no recurrent appendicitis within the 180-day follow-up period. One hundred eighty days was selected as the end point of the study based on the evidence that within 2 years of NOM, the incidence of late failures occurring between 6 months and 2 years is approximately 3%, and 6-month follow-up allowed for inclusion of a greater number of patients in the study population by extending the

end date of the study period.[1] During the study period, there were 667 patients presenting with acute uncomplicated appendicitis, and 81 patients underwent NOM. Patients with successful NOM (n = 36) were compared with patients who failed NOM (n = 45). Derivation of the study population is illustrated in Figure.

Conditions present on admission that were significantly different between groups were assessed for the capacity to predict successful NOM. Continuous variables were transformed to binary variables by determining the optimal cutoff value on Youden's index,[11] that is, the single value with optimal sensitivity and specificity for predicting successful NOM was calculated by coordinating points on the receiver operating characteristic curve. These optimal cutoff values were converted to ranges (e.g., duration of symptoms prior to admission was converted to duration of symptoms prior to admission >25 hours). Both continuous and binary variables were individually assessed for the capacity to predict successful NOM on univariate logistic regression. Variables that were statistically significant on univariate regression were entered into one of two multivariable models: one model for continuous variables, and one model for binary variables. Model strength was assessed by calculating the area under the receiver operating characteristic curve with 95% confidence intervals (CIs).

Patient demographics, comorbidities, clinical presentation, timing of admission, systemic inflammatory response syndrome criteria,[12] the modified Alvarado score,[13-15] CT findings,[16] procedural management, pathology findings, complications, and outcomes within 180 days were obtained from our institutional data repository and review of the electronic medical record. Admissions occurring between 6 PM and 6 AM were considered nighttime admissions. This study used the modified Alvarado score[13-15] that includes eight parameters, assigning one or two points to each: pain migrating to the right lower quadrant (+1), anorexia (+1), nausea or vomiting (+1), right lower quadrant tenderness (+2), rebound tenderness (+1), temperature > 37.5°C (+1), white blood cell
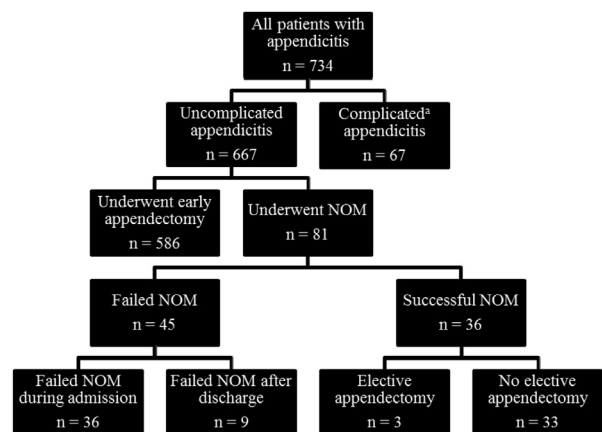
Figure — Derivation of the study population. [a]Perforation or abscess.