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Early appendectomy reduces costs in children with perforated appendicitis



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ABSTRACT

Background: Perforated appendicitis can be managed with early appendectomy, or nonoperative management followed by interval appendectomy. We aimed to identify the strategy with the lowest health care utilization and cost.

Methods: We retrospectively reviewed the medical records of all children ≤ 18 years old with perforated appendicitis admitted to a single institution between January 2009 and March 2016. After excluding immunosuppressed patients and transfers from outside hospitals, we grouped the remaining patients by early or interval appendectomy. Cost accounting data were obtained from our institutional database. The primary outcome was total hospital cost over 2 y from initial admission for appendicitis. Other outcomes analyzed included initial admission costs, number of admissions, emergency room and clinic visits, percutaneous procedures, cross-sectional and overall imaging studies, and length of stay.

Results: A total of 203 children with perforated appendicitis were identified. After exclusion of immunosuppressed patients and outside hospital transfers, 94 patients were included in the study. Thirty-nine underwent early appendectomy and 55 initial nonoperative management; of these, 54 underwent elective interval appendectomy. Five of 55 patients (9%) failed initial nonoperative management and required earlier-than-planned appendectomy. Total cost over 2 y was significantly lower with early appendectomy than initial nonoperative management ($\$19,300 \pm 14,300$ versus $\$26,000 \pm 17,500$; $P = 0.05$). Early appendectomy resulted in fewer hospital admissions, clinic visits, invasive procedures, and imaging studies.

Conclusions: Early appendectomy results in lower hospital costs and less health care utilization compared with initial nonoperative management with elective interval appendectomy. A prospective study will shed more light on this question and can assess the role of nonoperative management without interval appendectomy in children with perforated appendicitis.

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Introduction

Appendicitis is the most common surgical urgency in children, with perforation rates as high as 20%-74% at presentation.¹⁻⁴ Management is generally by one of two strategies: early appendectomy (within 24 h of admission) or nonoperative therapy, usually followed by elective interval appendectomy at least 6-8 wk after discharge from the hospital. Nonoperative therapy consists of intravenous antibiotics, withholding and then carefully advancing diet, and percutaneous drainage procedures as indicated.^{5,6} There has been significant debate over which of these strategies is superior, and the two are still considered to have equipoise.

Recent prospective studies highlight this conflicting evidence. A 2011 randomized trial associated early appendectomy with shorter length of stay (LOS), lower health care cost, less time away from work or school, fewer adverse events, recurrent abscesses, small bowel obstructions, and readmissions compared with nonoperative therapy and interval appendectomy in patients with perforated appendicitis.^{7,8} However, this study cited a 34% failure rate of initial nonoperative therapy resulting in earlier-than-planned urgent appendectomy. On the other hand, a 2010 pilot randomized controlled trial showed no difference in outcomes between early and interval appendectomy, except for apparent longer operative times with early appendectomy than interval appendectomy. This study was limited by a smaller sample size (40 patients) and a study population consisting only of patients with an abscess on admission.⁹

Given these conflicting data, our goal was to retrospectively assess outcomes of both management strategies at our institution. Specifically, we sought to determine the failure rate of nonoperative initial therapy and to compare outcomes of early *versus* interval appendectomy. Based on anecdotal evidence and pre-existing literature, we hypothesized that the failure rate of nonoperative initial management of perforated appendicitis would be low, and early appendectomy would result in lower cost and less health care utilization than interval appendectomy.

Methods

After IRB approval (HUM00095746), the medical records of all children ≤ 18 years old with perforated appendicitis admitted to our institution between January 2009 and March 2016 were reviewed. Patients were included if their admission history and physical noted perforated appendicitis or suspected perforated appendicitis during the admission diagnosis. They were excluded if they were immunosuppressed or if they were transferred from an outside hospital after initiation of care, as the various studies and different treatments provided by outside facilities vary greatly and are not captured by our institution's cost accounting database. Patients were then grouped into two management strategies, early appendectomy or initial nonoperative management, based on the plan dictated in the admission history and physical.

Data were collected on demographics, surgical pathology, diagnostic studies, complications, and therapeutic

procedures. Cost accounting data were collected from our institution's cost accounting database. Total cost and direct cost were recorded for the initial admission. In addition, subsequent complications and procedures, total cost, direct cost, and total hospital charges were recorded for a 2-year period, starting from the time of the initial admission for appendicitis. Direct cost includes hospital expenditures related directly to the care of the individual patient including labor, supplies, pharmacy, procedures, and the hospital stay itself, whereas total cost also includes indirect costs (hospital overhead expenditures distributed between patients). Total charges, on the other hand, represent fees billed to patients or insurance providers but do not represent payments received. Given that prior studies have identified costs as the preferred metric of health care financial burden,^{10,11} 2-year total hospital cost was our primary outcome. Other outcomes evaluated included number of admissions, emergency room and clinic visits, percutaneous procedures, cross-sectional and overall imaging studies, and LOS.

Statistical analysis was performed using SPSS, version 22.0 (IBM Corp, Armonk, NY). Categorical variables were compared using Chi-square analysis or Fisher's exact test. Continuous variables were compared using t-test. To further evaluate the effect of management strategy on cost as opposed to potentially confounding group characteristics such as abscess at the time of admission, multivariable generalized linear modeling using gamma function with log link was used, as this method has been reported to account for the inherent skewness of cost data with less bias than lognormal conversion.¹² Statistical significance was defined as $P < 0.05$.

Results

We identified 203 children who were treated for clinically diagnosed perforated appendicitis at our institution. After exclusion of 4 patients who were immunosuppressed and 105 who were transferred from outside facilities, 94 children were included in the study (Fig). This study population was 60% male with a mean age of 9.4 ± 4.3 y. Ninety-three patients underwent appendectomy (early or interval); of these, 86 (93%) had confirmed perforated appendicitis on pathology. Of the 7 patients who were not perforated on pathology, 4 underwent early operation and 3 interval appendectomy. Twenty-three patients (25%) experienced a complication (new/recurrent abscess [21], more invasive operation [3], small bowel obstruction [2], recurrent appendicitis [1]).

Figure summarizes the breakdown of study groups. Of the 55 patients initially managed nonoperatively, only five required appendectomy before the planned elective interval appendectomy, representing a 9% failure rate. One patient did not undergo subsequent appendectomy despite two recorded follow-up visits with plans for elective interval appendectomy. The reason why he did not undergo the procedure could not be discerned from the medical record.

Demographic, complication, and health care utilization data are summarized in Table 1. There was no difference in the rates of pathology proven perforation between groups, though more patients presented with an abscess on imaging

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