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Cost analysis of nonoperative management of acute appendicitis in children

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ABSTRACT

Purpose: The purpose of this study was to determine if nonoperative management of acute appendicitis in children is more cost effective than appendectomy.
Methods: A retrospective review of children (6–17 years) with acute appendicitis treated nonoperatively (NOM) from May 2012 to May 2015 was compared to similar patients treated with laparoscopic appendectomy (OM) (IRB#107535). Inclusion criteria included symptoms ≤48 h, localized peritonitis, and ultrasound confirmation of acute appendicitis. Variables analyzed included failure rates, complications, length of stay (LOS), and cost analysis.
Results: 26 NOM patients (30% female, mean age 12) and 26 OM patients (73% female, mean age 11) had similar median initial LOS (24.5 h (NOM) vs 16.5 h (OM), $p = 0.076$). Median total LOS was significantly longer in the NOM group (34.5 h (NOM) vs 17.5 (OM), $p = 0.01$). Median cost of appendectomy was $1416.14 (range $781.24–$2729.97). 9/26 (35%) NOM patients underwent appendectomy for recurrent appendicitis. 4/26 (15%) OM patients were readmitted (postoperative abscess (n = 2), *Clostridium difficile* colitis (n = 1), postoperative nausea/vomiting (n = 1)). Median initial hospital admission costs were significantly higher in the OM group ($3502.70 (OM) vs $1870.37 (NOM), $p = 0.004$)). However, median total hospital costs were similar for both groups ($3708.68 (OM) vs $2698.99 (NOM), $p = 0.065$)).
Conclusion: Although initial costs were significantly less in children with acute appendicitis managed nonoperatively, total costs were similar for both groups. The high failure rate of nonoperative management in this series contributed to the total increased cost in the NOM group.
Level of evidence: 3b

Acute appendicitis is the most common emergency in children [1]. The lifetime risk of developing appendicitis is 7%–8% [2]. In Canada, an average of 5972 children were diagnosed with appendicitis annually between 2004 and 2010 [3]. For more than a century, appendectomy has been the gold standard for the treatment of acute appendicitis [4]. However, recent studies have suggested that nonoperative management of acute appendicitis with antibiotics is effective, thus challenging the surgical dogma [5–7].

Appendectomy itself is associated with risks of complications and a large financial burden [8,9]. The risks associated with appendectomy include wound infection, intraabdominal abscess, and ileus. The overall complication rates are 11.1% for open appendectomy and 8.7% for laparoscopic appendectomy [8]. Although a nonoperative approach may avoid these risks, reduce complication rates, minimize time away from normal activities and avoid the physical trauma and mental stress associated with surgery, this would not be a viable alternative unless it is equally effective at curing acute appendicitis. The average cost of appendectomy in Ontario in 2011 was $4327 (±$1684) according to the 2014 Ontario Case Costing Initiative [9]. If we assume that this figure is representative of Canada as a whole, then treating appendicitis in children costs approximately $25 million per year. Therefore, there may also be a significant cost savings to our health care system if surgery is avoided in the majority of cases.

The existing literature relating to the efficacy of nonoperative treatment of uncomplicated acute appendicitis is predominantly from the adult patient population and a few small pediatric studies, including one from our institution [5–7,10–17]. With increasing evidence supporting nonoperative management of acute appendicitis, it is important to determine the cost efficacy of this approach in children. The purpose of this study was to determine if nonoperative management of acute appendicitis in children is more cost effective than laparoscopic appendectomy.

1. Methods

We performed a retrospective review of children with acute appendicitis, aged 6–17 years, who were treated at Children's Hospital at London Health Sciences Centre (LHSC) from May 2012 to May 2015.

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There were two treatment groups: operative management (OM) and nonoperative management (NOM). All appendectomies were performed laparoscopically. Inclusion criteria included clinical diagnosis of acute appendicitis, symptoms less than 48 h, localized peritonitis, and ultrasound confirmation of acute appendicitis. Exclusion criteria included symptoms >48 h as well as clinical and/or radiographic evidence of perforated appendicitis. Operative patients received 1 preop dose of IV Ceftriaxone and Flagyl. Nonoperative patients received IV Ceftriaxone and Flagyl while in hospital and were discharged home with a 7 day course of Amoxicillin/Clavulin. Variables analyzed included: demographic data, treatment type (operative or nonoperative), length of stay (measured as the number of hours the patient stayed in the hospital), failure rates, complications, operative costs and total hospital costs.

1.1. Statistical analysis

Deidentified data were analyzed in the Statistics Package for the Social Sciences (SPSS). Prior to conducting any hypothesis testing, we explored whether both groups were normally distributed. Visual inspection using histograms and computation of the Shapiro–Wilk test indicated that both groups were not normally distributed ($p < 0.05$). As such, we decided to test for differences using the Mann–Whitney U test to determine if there was a difference in the length of stay (initial and total) between groups as well as the total cost to treat acute appendicitis operatively and nonoperatively.

Continuous data were presented as median (Mdn) unless otherwise stated. Statistical significance was defined as a p-value less than 0.05.

2. Results

There were 113 OM cases and 26 NOM cases identified based on inclusion criteria. Out of the 113 OM cases, 26 were randomly chosen using a computer generated randomization program. The remaining 84 OM cases were excluded in order to make the number of cases equal in each group. This resulted in 26 NOM cases: 30% female with mean age 12 years, and 26 OM cases: 73% female with mean age 11 years (Table 1). Of these cases, cost data were available for the 2013–2014 and 2014–2015 fiscal years. Thus, cost data were available for 16 out of 26 OM cases and 10 out of 26 NOM cases (Table 1).

2.1. Length of stay (LOS)

Initial LOS was similar for the OM group ($Mdn = 16.5$ h) and the NOM group ($Mdn = 24.5$ h), $U = 241$, $z = -1.777$, $p = .076$ (Fig. 1). On the other hand, the total LOS (including all subsequent admissions) was statistically significantly higher in NOM group ($Mdn = 34.5$ h) than in OM group ($Mdn = 17.5$ h), $U = 198$, $z = -2.56$, $p = .01$ (Fig. 1).

Table 1
Demographic data and complications.

	Operative group (OM) (n = 26)	Non operative group (NOM) (n = 26)
Age (mean)	11	12
Gender (M:F)	7:19	18:08
Available cost data (n)	16	10
Fecalith present on initial ultrasound	5	3
Complications		
Recurrent appendicitis requiring urgent appendectomy	N/A	9
Interval appendectomy	N/A	3
Clostridium difficile colitis	1	0
Intraabdominal abscess	2	0
Postoperative nausea/vomiting	1	0

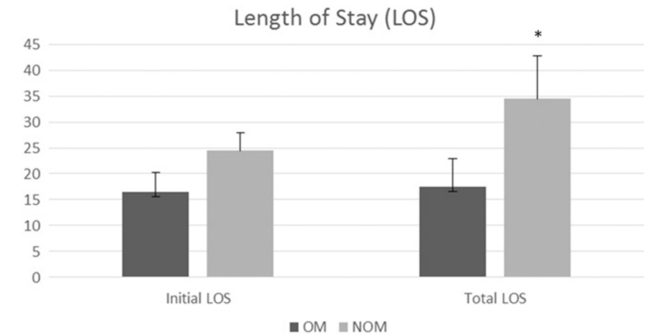

Fig. 1. Comparison of LOS between OM and NOM groups. Initial LOS was similar for OM and NOM (P = .076). Total LOS in the NOM group was significantly longer than OM (*p = .01).

2.2. Cost data

The median initial cost of hospital admission was significantly higher for the OM group ($3502.70 (OM) vs $1870.37 (NOM), $U = 19$, $z = -3.21$, $p = 0.004$) (Fig. 2). However, after accounting for all subsequent admissions, the median total hospital cost was similar between both groups ($3708.68 (OM) vs $2698.99 $U = 100$, $z = -1.265$, $p = 0.065$) (Fig. 2). The median cost of appendectomy was $1416.14 with a range from $781.24 to $2729.97.

2.3. Failure rate

Failure rate was defined as the number of children in the NOM group who had to be readmitted to hospital as a consequence of recurrent appendicitis and/or interval appendectomy. Our NOM group consisted of 26 children, of which 9 were readmitted to hospital. Therefore, the NOM group accounted for an approximate failure rate of 35%. Of the 9 children with recurrent appendicitis, 3 patients developed recurrent appendicitis within 2 weeks of initial admission, 3 patients recurred between 7 weeks and 7 months, and 3 patients re-presented after more than 1 year. Of those that developed recurrent appendicitis, 3 out of 9 had a fecalith on ultrasound and 6 out of 9 had been treated with Ciprofloxacin and Flagyl, rather than Ceftriaxone and Flagyl. Only 5 out of 9 children had appendicitis proven on pathology, while 4 had a normal appendix. None of these patients had perforated appendicitis. Interestingly, 8 out of 9 patients who failed NOM had repeat ultrasounds that showed appendicitis. Only one NOM patient underwent appendectomy without a repeat ultrasound and pathology revealed a normal appendix.

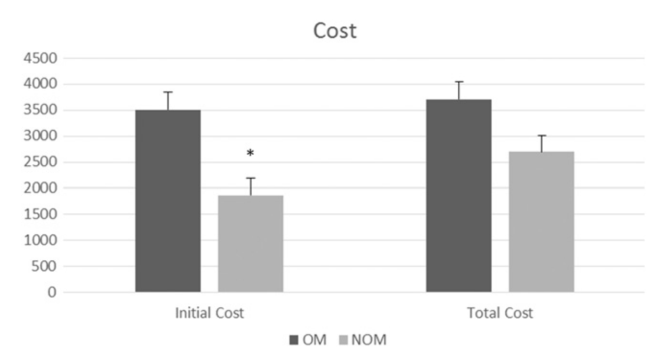

Fig. 2. Comparison of initial and total cost of OM and NOM. The initial cost of NOM was significantly less than OM (*p = .04). Total cost was similar between OM and NOM (p = .065).