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The cost-effectiveness of nonoperative management versus laparoscopic appendectomy for the treatment of acute, uncomplicated appendicitis in children☆

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A B S T R A C T

Background: Several studies have demonstrated the safety and short-term success of nonoperative management in children with acute, uncomplicated appendicitis. Nonoperative management spares the patients and their family the upfront cost and discomfort of surgery, but also risks recurrent appendicitis.
Methods: Using decision-tree software, we evaluated the cost-effectiveness of nonoperative management versus routine laparoscopic appendectomy. Model variables were abstracted from a review of the literature, Healthcare Cost and Utilization Project, and Medicare Physician Fee schedule. Model uncertainty was assessed using both one-way and probabilistic sensitivity analyses. We used a $100,000 per quality adjusted life year (QALY) threshold for cost-effectiveness.
Results: Operative management cost $11,119 and yielded 23.56 quality-adjusted life months (QALMs). Nonoperative management cost $2277 less than operative management, but yielded 0.03 fewer QALMs. The incremental cost-to-effectiveness ratio of routine laparoscopic appendectomy was $910,800 per QALY gained. This greatly exceeds the $100,000/QALY threshold and was not cost-effective. One-way sensitivity analysis found that operative management would become cost-effective if the 1-year recurrence rate of acute appendicitis exceeded 39.8%. Probabilistic sensitivity analysis indicated that nonoperative management was cost-effective in 92% of simulations.
Conclusions: Based on our model, nonoperative management is more cost-effective than routine laparoscopic appendectomy for children with acute, uncomplicated appendicitis.
Level of evidence: Cost-Effectiveness Study: Level II

There is a growing interest in the nonoperative management (NOM) of children with acute, uncomplicated appendicitis, with many pediatric surgeons now adopting NOM in their clinical practice [1]. Recent clinical trials have reported promising short-term outcomes for patients managed nonoperatively, including success rates as high as 93% at 30 days and 75% at 1 year [2–9]. However, the long-term clinical efficacy of NOM has yet to be fully characterized.

NOM presents an attractive alternative to laparoscopic appendectomy for several reasons. First, children treated with NOM may be spared the discomfort, emotional stress, and risk of serious complications associated with surgery, all which may negatively affect their quality of life [5]. Second, given the inherent costs of the operating room, routine use of NOM may result in a significant cost-savings, both to families and to the healthcare system as a whole. However, NOM is not without its own potential downsides. Since NOM does not remove the source of the disease (i.e., the appendix), children treated with NOM remain at risk for treatment failure, disease recurrence, and a lower quality of life because of persistent symptoms or anxiety. Moreover, the need for rescue appendectomy in cases of treatment failure – not to mention the use of interval appendectomy in asymptomatic patients – leads to additional hospitalization and negates the advantage of a shorter recovery period that would otherwise be associated with NOM. It is unclear whether these potential disadvantages of NOM ultimately offset any upfront cost-savings or improvements in quality of life.

The purpose of this study was to use a decision analysis framework to weigh the complex trade-offs between NOM and routine laparoscopic appendectomy and to explore the potential cost-effectiveness of NOM

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in children. We hypothesized that nonoperative management would be cost-effective compared to routine laparoscopic appendectomy for acute, uncomplicated appendicitis in children.

1. Methods

1.1. Reference case

In decision analysis, reference cases provide a framework for comparison and allow for specific model variables to be taken from outside sources, including literature review. The reference case for our analysis was an otherwise healthy child older than 5 and younger than 18 years diagnosed with acute, uncomplicated appendicitis by either ultrasound or abdominal computed tomography (CT) scan in the United States. We defined uncomplicated appendicitis as having less than 48 h of abdominal pain, a white blood cell count <18,000 cells/μL, and no clinical or radiographic findings suggestive of phlegmon, abscess, or appendicolith.

1.2. Decision model

Using decision analysis software (TreeAge Pro, Williamstown, MA), we constructed a computer model that compared initial NOM with a variable rate of elective interval appendectomy at 1 year to routine laparoscopic appendectomy (Fig. 1). The treatment strategy that generated the most utility, measured in quality-adjusted life months (QALMs) or quality-adjusted life years (QALYs), without exceeding an incremental cost effectiveness ratio (ICER) of $100,000/QALY was considered to be the most cost-effective. We selected $100,000/QALY as a threshold for cost-effectiveness because it is a commonly used value in current healthcare cost-effectiveness analyses, though it may not represent the amount the United States or its individuals are willing to spend on a year of good health [10]. As the current standard of care, routine laparoscopic appendectomy was used as the reference group for all comparisons of costs and health effects.

In the NOM treatment arm, all patients ended up in one of six disease states: 1) early treatment failure, 2) late treatment failure, 3) recurrent appendicitis within 1 year, 4) elective interval appendectomy within 1 year, 5) recurrent appendicitis after 1 year, and 6) successful NOM without recurrence. Early treatment failure was defined as the need for rescue appendectomy prior to discharge. Late treatment failure was defined as the need for readmission and rescue appendectomy within 30 days of discharge. Any rescue appendectomy performed after 30 days following discharge was considered recurrent appendicitis. Recurrent appendicitis was further subdivided into uncomplicated disease, complicated disease with phlegmon, and complicated disease requiring drainage by interventional radiology. Appendectomies that were performed in asymptomatic patients because of parent/patient preference were considered to be elective interval appendectomies. In our model, all treatment failures and cases of recurrent appendicitis underwent laparoscopic appendectomy.

We used a societal perspective for our model, which considers costs and benefits to the patient and healthcare system as a whole rather than to any single party (e.g., an insurance carrier). When selecting index values, we intentionally biased the model toward the current standard of care, routine laparoscopic appendectomy. All costs and utilities were discounted at 3% per year, based on the usual standard for cost-effectiveness analyses [11].

1.3. Model variables: probabilities

The probabilities associated with each health state in our model were abstracted from a review of the literature. We queried PubMed and Google Scholar for relevant articles using the keywords “appendicitis,” “non-operative,” “uncomplicated,” “antibiotics,” “pediatric,” and “children.” All clinical trials and retrospective studies applicable to our reference case were included. Index values were chosen based on data from prospective clinical trials in combination with expert opinion. The source of each index value and the appropriate ranges from the literature are listed in Table 1.

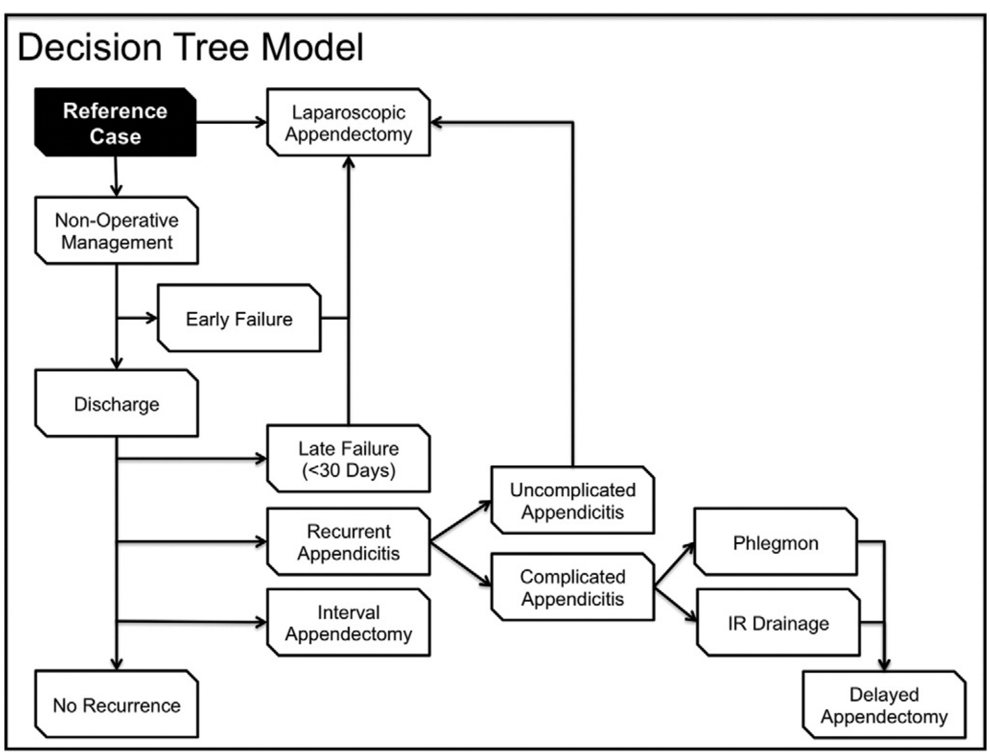

Fig. 1. Study decision tree model. IR, interventional radiology.