Interval Appendectomy: Finding the Breaking Point for Cost-Effectiveness

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BACKGROUND: Patients with phlegmonous appendicitis can be managed nonoperatively, yet debate continues about the need for interval appendectomy (IA), given the low risk of recurrence or neoplasm. We sought to determine for which patient age interval appendectomy is cost-effective.

METHODS: Using TreeAge software, a cost-effectiveness model was developed. Two strategies were compared, IA and no interval appendectomy (NIA). Interval appendectomy patients were modeled with probability of benign pathology, cancer or inflammatory bowel disease, and possible operative complications. Patients with NIA were modeled with the probability of recurrence. The probability of malignancy or inflammatory bowel disease developing, or death occurring during a lifetime, was modeled. Base case scenarios at 18, 35, and 50 years old were completed using a Monte Carlo microsimulation. Probabilistic sensitivity analysis was completed using 2-dimensional sample as a Monte Carlo microsimulation to account for variability for patients 18 to 60 years old. Probabilities of complications developing, pathologic diagnosis requiring additional management, and state utility were extracted from published data. Costs were collected from the Centers for Medicare and Medicaid Services and utility was quality-adjusted life years (QALY).

RESULTS: For an 18-year-old patient, IA costs \$9,417.22 with a gain of 16.59 QALYs compared with NIA, which costs \$11,613.57 with a gain of 16.52 QALYs. For a 35-year-old, IA costs \$8,989.16 with 9.1 QALYs gained. No interval appendectomy costs \$6,614.61 and 9.09 QALYs gained. For the 35-year-old patient, the interval cost-effectiveness ratio comparing NIA with IA is \$237,455/QALY. As patient age increases, the interval cost-effectiveness ratio increases. Using a willingness-to-pay threshold of \$50,000/QALY, IA remains cost-effective until the patient is 33 years old.

CONCLUSIONS: Interval appendectomy should be considered in patients younger than 34 years of age. (J Am Coll Surg 2016;223:632−643. © 2016 by the American College of Surgeons. Published by Elsevier Inc. All rights reserved.)

Patients with acute, uncomplicated appendicitis typically undergo appendectomy with low complication rates, early postoperative discharge, and low cost.[1,2] Patients with complicated appendicitis who have a phlegmon or abscess and receive immediate surgery might require larger colonic resection and have higher complication risk and longer hospital stay.[3] Therefore, these patients can be treated with antibiotics with image-guided drainage, as needed, without surgery in the acute setting.[1,4-19] This initial nonoperative management is safe; however, it is unclear if these patients need interval appendectomy (IA) after recovery from the acute illness.[6,7,10]

Proponents for IA cite the importance of eliminating the risk of recurrent appendicitis, as well as excluding other diagnoses, such as cancer, inflammatory bowel disease, or other rare pathology of the appendix, which would alter their subsequent treatment.[20-27]

Interval appendectomy is not, however, without risks, including deep and superficial surgical site infection, perioperative MI, pneumonia, ileus, and stroke. These risks vary with age and comorbidities and must be balanced with the modest risk of recurrent appendicitis and low

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risk of cancer and inflammatory bowel disease, which also vary with age.[5,6,8,10,15,28-32] No interval appendectomy (NIA) eliminates the cost of appendectomy and any complications associated with the procedure.

Currently, there is no cost-benefit analysis to inform providers in the decision to proceed with IA after resolution of the acute episode. In addition, no patient-centered analysis exists to dictate the decision of IA or NIA. To assume that NIA would be more cost-effective than IA due to the absence of surgical costs would be an oversimplification because of the risk of recurrent appendicitis and missed diagnoses that could potentially present in a more-advanced stage, requiring more costly treatment and yield poorer patient outcomes and, therefore, decreased utility. We performed a cost-utility analysis to evaluate the lifetime cost and utility accumulated for each possible pathologic diagnosis related to phlegmonous appendicitis and stratified by patient age.

METHODS

Model

A decision tree was generated to determine the cost and the utility of treatment in patients after resolution of phlegmonous appendicitis IA or NIA. After the decision node, patients have their subsequent outcomes modeled by probabilities derived from previously published data.

For example, the hypothetical patient treated with IA has their probability of benign pathology and probability of identifying other pathology modeled. Thereafter, the risk of perioperative major and minor complications is modeled (Fig. 1).

The 3 outcomes after diagnosis of benign pathology are no complication, major complication, or minor complication. At this stage in the model, patients enter into a Markov model with initial state of alive, which is then modeled, with probability of death vs living over the patients' lifetime (Table 1).

In patients without benign pathology after IA, the probability of other diagnoses is modeled (patients younger than 50 years, 0.15% or patients 50 years and older, 1.1%).[8,38] Those diagnosed with inflammatory bowel disease (IBD) have risk of no complication, major complication, and minor complication modeled, as well as Markov modeling for risk of death during the patient's lifetime (Table 2). The probability of appendiceal cancer and carcinoid are modeled along with the likelihood of
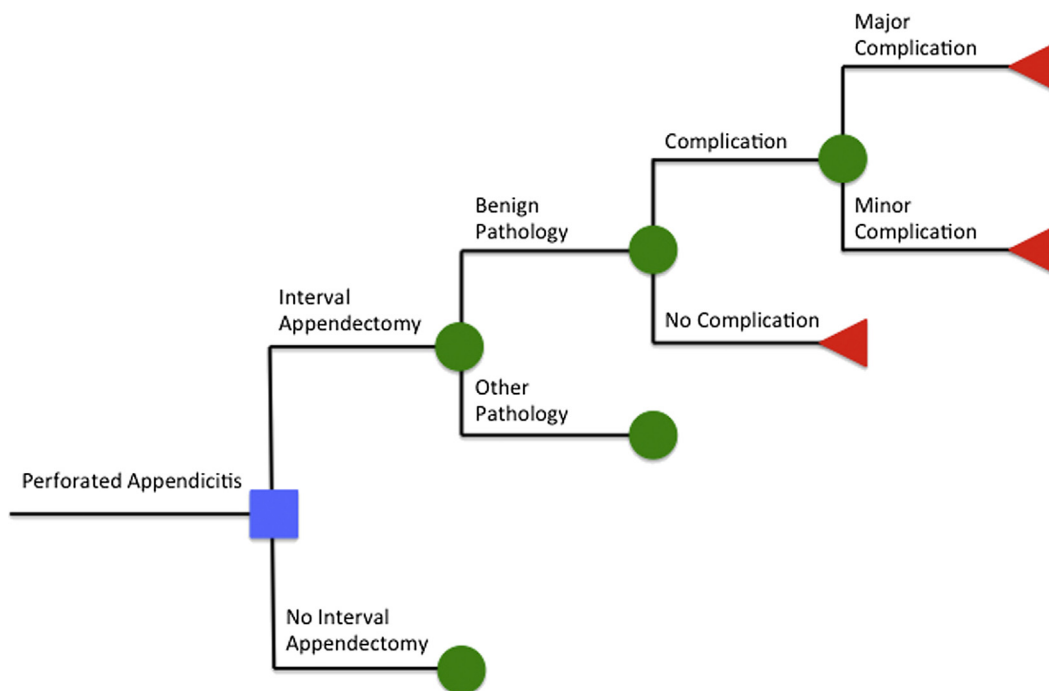

Figure 1. Initial decision node schema in patients with interval appendectomy.