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Cost modeling for management strategies of uncomplicated gastroschisis

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ABSTRACT

Introduction: Compared to operative fascial closure, nonoperative flap and/or skin-closure repair for gastroschisis has several potential advantages: avoidance of anesthesia, decreased pain, and improved cosmesis. Disadvantages include a higher risk of hernia. We hypothesized that routine nonoperative closure results in cost savings *versus* conventional management in uncomplicated gastroschisis.

Methods: A decision tree was constructed to compare three different strategies for the management of uncomplicated gastroschisis: nonoperative closure, primary closure, and routine silo. Model variables were abstracted from a literature review and the Medicare Physician Fee schedule. Uncertainty surrounding model parameters was assessed via one-way and probabilistic sensitivity analyses.

Results: According to our model, the nonoperative strategy for uncomplicated gastroschisis was the least costly, with an expected cost of $198,085 per patient. Primary closure cost $208,763 per patient. Routine silo placement was the most costly, $239,038 per patient. One-way sensitivity analysis suggested the cost of primary closure would be less costly than nonoperative management if the initial success rate of nonoperative management was less than 35.4% or if the initial success rate of primary operative closure was greater than 87.8%. Probabilistic sensitivity analysis found that nonoperative management was the least costly strategy among 97.4% of 10,000 Monte Carlo simulations.

Conclusions: A nonoperative strategy for uncomplicated gastroschisis with routine attempted flap and/or skin closure repair is less costly than strategies using routine primary closure and routine silo placement. Given the expected cost savings and other potential advantages of the nonoperative strategy (including avoidance of general anesthesia), more studies examining outcomes of the flap and/or skin closure are indicated.

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Introduction

Gastroschisis is the most common congenital abdominal wall defect, characterized by the herniation of intestines through an opening in the abdominal wall. Gastroschisis continues to increase in prevalence, affecting an estimated 4.9 per 10,000 births.[1] Treatment is prolonged and costly. The length of neonatal stay for gastroschisis averages more than 1 mo, and hospital costs can exceed $100,000.[2-5]

Significant debate exists over the optimal surgical management strategy of gastroschisis.[6] Originally, patients underwent attempted primary closure, and silo placement was only performed when initial closure failed. Later, the development of a preformed silo resulted in many institutions adopting a strategy of routine silo placement with the purported benefit of decreasing potential complications of high intra-abdominal pressures associated with attempts at primary closure.[7,8] The results for routine silo placement have been mixed with some concerns that this strategy may lead to longer lengths of stay and higher hospital costs.[7,9,10] Recently, many centers have initiated a nonoperative strategy involving umbilical flap or skin closure at the bedside (reserving an operating room team and general anesthesia only for complex cases).[11,12] The benefits of nonoperative strategies (using "umbilical flap," "sutureless," "ward reduction," and "plastic" techniques) include avoidance of general anesthesia, theoretically reduced intra-abdominal pressures and pain (because the fascia is not closed), and reported excellent cosmetic results.[12-23] The main disadvantage of the nonoperative strategy is that most patients are left with a fascial defect, a proportion of which will require delayed repair.[14-17,20,21]

Decision analysis techniques offer a useful framework for comparing treatment strategies with complex tradeoffs.[24-26] Using computer-generated decision tree software, we aimed to compare the expected treatment costs of different management strategies for uncomplicated gastroschisis. We hypothesized a nonoperative strategy with attempted flap and/or skin closure would be the least costly management of uncomplicated gastroschisis.

Methods

Reference case

We began by defining the reference case: a hypothetical patient with uncomplicated gastroschisis. We elected to exclude complicated gastroschisis because surgical management strategies for these patients may be influenced by the patient's condition (e.g., intestinal atresia and/or necrosis, liver herniation). Furthermore, complicated gastroschisis occurs in only a minority of patients (<15%).[27] Finally, patients with complicated gastroschisis are often outliers with respect to length of stay and hospital costs that would be difficult to account for in a decision model.[27]

Decision model

We constructed a decision tree using decision analysis software (TreeAge Pro, Williamstown, MA). Our tree compared three management strategies: (1) nonoperative, (2) primary closure, and (3) and routine silo. Figure 1 schematically illustrates the treatment strategies and potential outcomes.

Nonoperative strategy

The probability of initial success of the nonoperative strategy (*P1*) was defined as the likelihood of achieving bedside umbilical flap or skin closure without the need for general anesthesia or an operating room team within the first day of life. For the purposes of the decision tree model, patients who have initial failure of the nonoperative strategy undergo silo placement and have a probability of either delayed operative repair with general anesthesia and an operating room team (*P2*) or nonoperative flap and/or skin closure.

Primary closure strategy

The probability of initial success of the primary closure strategy (*P3*) was defined as the probability of fascial closure with an attempt at primary operative closure. Patients who have initial failure of the primary closure strategy undergo silo placement and delayed operative repair.

Routine silo strategy

In this strategy, we assume that all patients (*P4* = 100%) in this strategy undergo routine silo placement with delayed operative repair.

A mean number of silo days for each scenario requiring delayed closure were extrapolated from the literature. The length of stay for each scenario was extrapolated from a combination of literature review and estimated increases in length of stay for each day of delay in closure (estimated 2 day longer length of neonatal stay for each additional day of silo utilization).[9,28]

The probability of a hernia (fascial defect) being present, and the probability of the hernia requiring repair were extrapolated from the literature for both nonoperative skin and/or flap closure (*P5*) and operative fascial closure (*P6*). We assumed that patients would require two-surgeon follow-up consultations if a hernia was present at the time of discharge and an additional follow-up consultation if the hernia did not resolve and required surgical repair.

The primary closure strategy was used as the reference group for all comparison of costs.

Literature review

A PubMed search using the keyword "gastroschisis" was performed. All abstracts that contained information about outcomes, cost, and length of stay were reviewed for relevant model variables.

Model variables: clinical events

Probabilities of initial management success and/or failure, need for operative closure, mean silo days for delayed closure,