



Age-Dependent Costs and Complications in Pediatric Umbilical Hernia Repair

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Objectives To characterize regional variation in the age of patients undergoing umbilical hernia repair to determine costs and subsequent care.

Study design We performed a cross-sectional descriptive study using a large convenience sample of US employer-based insurance claims from July 2012 to December 2015. We identified children younger than 18 years of age undergoing uncomplicated (not strangulated, incarcerated, or gangrenous) umbilical hernia repair as an isolated procedure (*International Classification of Diseases, Ninth Revision* procedure codes 53.41, 53.42, 53.43, or 53.49, *International Classification of Diseases, Tenth Revision* procedure code 0WQF0ZZ, or Current Procedural Terminology procedure codes 49580 or 49585).

Results In all, 5212 children met criteria for inclusion. Children younger than age 2 years accounted for 9.7% of repairs, with significant variation by census region (6% to 14%, $P < .001$). Total payments for surgery varied by age; children younger than 2 years averaged \$8219 and payments for older children were \$6137. Postoperative admissions occurred at a rate of 73.1 per 1000 for children younger than age 2 years and 7.43 for older children; emergency department visits were 41.5 per 1000 for children younger than age 2 years vs 15.9 for older children ($P < .001$).

Conclusions Umbilical hernias continue to be repaired at early ages with large regional variation. Umbilical hernia repair younger than age 2 years is associated with greater costs and greater frequency of postoperative hospitalization and emergency department visits. (*J Pediatr* 2020;226:236-9).

Umbilical hernias are present in approximately 20% of newborns. Although up to 90% of umbilical hernias close spontaneously by age 4 years,¹⁻³ umbilical hernia repair is among the most common operations performed in children.⁴ Until very recently, no formal guidelines existed for the optimal age for umbilical hernia repair,⁵ and the existing literature is outdated and sparse.⁶ Despite the paucity of evidence-based guidelines, surgical societies and many US children's hospitals have published recommendations for age of repair on their Web sites, generally suggesting repair of uncomplicated umbilical hernias between 3 and 5 years. We are aware of no published practice recommendations advising repair before the age of 2 years.⁶

We have previously demonstrated significant geographic variability in the median age of umbilical hernia repair across 3 states with comprehensive all-payer databases. In that study, 14% of Wisconsin pediatric umbilical hernia repairs were performed in children younger than age 2 years compared with rates of 8% and 5% for Florida and New York respectively.⁷ Variation in the age of repair also has been demonstrated in a study of freestanding children's hospitals in the Pediatric Health Information Systems database, showing that 30% of children (hospital range 6.9%-54.3%, $P < .001$) have repair at younger than 3 years of age.⁸ The consequences of repair at younger ages have not been fully elucidated, but a recent study of 7 states between 2010 and 2014 found that children younger than 4 years of age had greater rates of hernia recurrence and unplanned related hospital visits.⁹

A new guideline from the Choosing Wisely campaign and the American Academy of Pediatrics recommends that repair of asymptomatic umbilical hernias occur after age 4 or 5 years,⁵ and data on the effects of early repair have the potential to inform interventions to change practice behavior toward guideline-concordance. Because many umbilical hernia repairs continue to be performed by community general surgeons and in communities without freestanding children's hospitals,⁷ our objective was to determine whether variation is reflected in broader national trends. We also evaluated 2 types of postoperative healthcare use by age—emergency department visits and readmissions within 30 days—as well as total healthcare costs in the 30 days postrepair to further examine the clinical implications of repair at young ages.

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Methods

Study Population

This study was exempt from review by the institutional review board at the University of Wisconsin–Madison. We used the Truven Health MarketScan Research Databases (Ann Arbor, Michigan), a national database of employer-based insurance claims, covering July 2012 to December 2015. Patients were included if they were younger than 18 years old at the time of an uncomplicated umbilical hernia repair (*International Classification of Diseases, Ninth Revision* procedure code 53.41, 53.42, 53.43, or 53.49, *International Classification of Diseases, Tenth Revision* procedure code 0WQF0ZZ, or Current Procedural Terminology procedure code 49580 or 49585) and if they had uninterrupted insurance coverage for the period 90 days before the procedure and 30 days after. Patients younger than 90 days old were included if they had uninterrupted coverage from birth.

Patients were excluded for any diagnosis code associated with an incarcerated or strangulated hernia (*International Classification of Diseases, Ninth Revision* diagnosis codes 551.1 or 552.1, *International Classification of Diseases, Tenth Revision* diagnosis codes K42.0 or K42.1, or Current Procedural Terminology procedure codes 49582 or 49587), or if they had another surgical procedure on the day of their hernia repair, as some umbilical hernia repairs may be performed incidentally to other operations. Cases also were excluded if they occurred during a patient's newborn admission, as such procedures were likely miscoded repairs of other umbilical defects, such as gastroschisis or omphalocele. All diagnosis codes associated with postoperative admissions and emergency department visits were reviewed by a pediatric surgeon and categorized as being likely, possibly, or not associated with surgical procedures ([Appendix](#); available at www.jpeds.com).

Data on the insurance payments for umbilical hernia repair procedures and follow-up care were calculated by adding the payments for the outpatient surgical procedure to the total payments for all inpatient and outpatient care in the 30 days following the procedure, including emergency department and primary care visits. Payments were defined as gross payments from insurance, after discounts were applied, including the share paid by patients and other payers through deductibles, copayments, and coordination of benefits.¹⁰ Payment data were adjusted for inflation using 2015 dollars.

Statistical Analyses

We performed descriptive analyses of patient characteristics, including age and region, and compared postoperative costs and outcomes by age. χ^2 and Wilcoxon rank-sum tests of statistical significance were applied as appropriate using Stata 15 (StataCorp, College Station, Texas). For these analyses, $P < .05$ was considered statistically significant.

Results

We identified 7732 children who underwent an umbilical hernia repair between July 2012 and December 2015. A total of 5212 of these (67.4%) underwent single-procedure, uncomplicated umbilical hernia repair and were included in the analysis ([Figure](#)).

The median age of repair was 5 years, and the age of repair for umbilical hernias varied widely ([Table I](#)). Nationally, 9.7% of umbilical hernias were performed in children younger than 2 years old and 17.9% were performed in children aged 2-3 years, meaning 27.6% of repairs occurred at ages younger than advised by current guidelines. Repair at younger than the age of 2 years varied significantly by census region, from a high of 14% in the West to a low of 6% in the Northeast ($P < .001$).

When stratified between very young children (younger than age 2 years) for whom we are not aware of any published evidence for hernia repair and children for whom there are some hospitals that have advised repair (age 2 and older),⁶ we found that total insurance payments for umbilical hernia repairs were 34% greater in children younger than age 2 years. Wilcoxon rank-sum tests indicate that surgical payments were 29% greater (\$7775 vs \$6036 for older children, $P = .01$) and postsurgical payments 378% greater (\$540 vs \$143, $P < .001$).

Postoperative admissions and emergency department visits were also more likely for children younger than age 2 years. Overall, children younger than age 2 years were admitted on the day of surgery at a rate of 115 per 1000 procedures, had a subsequent hospital admission within 30 days in 12 of 1000 procedures, and had an emergency department visit within 30 days at a rate of 57 per 1000 procedures

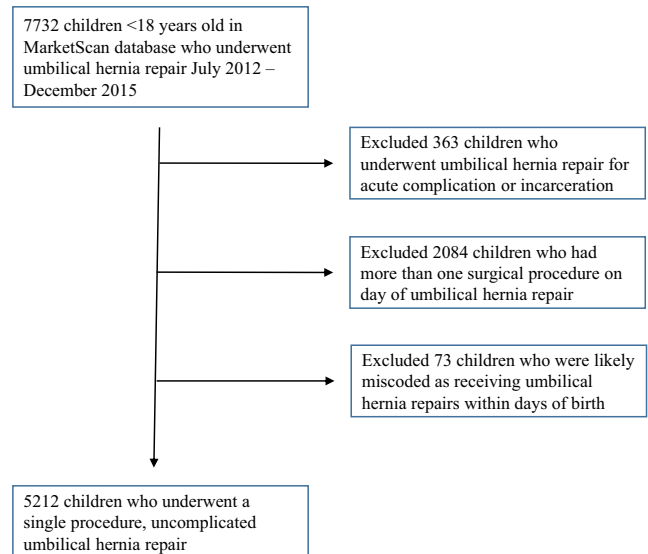


Figure. Umbilical hernia cases in MarketScan database, July 2012 to December 2015.

Table I. Regional variation in age of repair ($\chi^2 = 62.21, P < .001$)

Age ranges, y	Northeast % (n)	Midwest % (n)	South % (n)	West % (n)	Total % (n)
0-<2	6.2 (49)	12.0 (148)	7.9 (180)	14.3 (116)	9.7 (493)
≥2-<4	15.1 (120)	18.6 (230)	18.6 (422)	17.1 (139)	17.9 (911)
≥4-<6	35.0 (278)	34.3 (424)	35.5 (807)	30.1 (245)	33.4 (1754)
≥6-<18	43.8 (348)	35.1 (433)	38.0 (862)	36.5 (297)	38.1 (1940)
Total	100.0 (795)	100.0 (1235)	100.0 (2271)	100.0 (797)	100.0 (5098)

(Table II). When admission or visit diagnoses were limited only to those judged likely to be directly associated with surgery or surgical complications (Appendix), the rate of admissions for surgery on the day of the procedure was 10-fold greater in children younger than age 2 years relative to older children (73.1 vs 7.4, $P < .001$). Surgical complications related to same-day admissions varied by age. For children younger than age 2 years, the most common codes judged likely to be associated with surgical complications were acute kidney failure (11%), acute postoperative pain (11%), acute respiratory failure (8%), and constipation (8%). For children aged 2-3 years, the most common complications were constipation (57%) or acute postoperative pain (42%), and for children aged 4 years and older, they were acute postoperative pain (21%) and postoperative fever (7%). Similarly, the rate of emergency department visits related to diagnoses directly associated with surgery or surgical complications was almost 3-fold greater for children younger than age 2 years (41.5 vs 15.9, $P < .001$). Common postsurgical codes associated with emergency department visits for children younger than age 2 years were postsurgical infection (19%) and dehydration (19%), and for children aged 2-3 years they were constipation (21%) and acute postoperative hemorrhage (21%). The most common postsurgical complication codes for children age 4 years and older were acute postoperative pain (15%) and constipation (15%).

Discussion

Despite widespread acceptance of delayed repair of umbilical hernias to allow time for spontaneous closure, children continue to undergo uncomplicated umbilical hernia repairs

at ages when spontaneous closure remains probable. Although umbilical hernia repair is a technically straightforward operation, there remains a risk of surgical and anesthetic complications.

In this analysis, children younger than age 2 years—a group for whom we are aware of no published evidence for repair but who continue to have repairs—were more likely than older children to have a postoperative admission or emergency department visit following an umbilical hernia repair, both for all causes and for diagnoses associated with surgery. Increased healthcare use within 30 days of elective surgery supports waiting until older ages for elective umbilical hernia repair, both because of the greater risk of complications particularly in very young children (<2 years), and the possibility that the hernia could spontaneously close even in children aged 2-3 years. Also, the long-term risks of anesthesia in young children are unknown, and recent reports from the Food and Drug Administration and in the pediatric anesthesia literature suggest that general anesthesia, and particularly multiple anesthetics, should be avoided when possible in children younger than 3 years.^{11,12}

The increased complexity of umbilical hernia repair in very young patients is also supported by cost data showing that even in uncomplicated, single-procedure umbilical hernia repair, both the insurance payments for surgery and the payments for postsurgical care are increased in children younger than age 2 years. These data corroborate the findings of a single-institution retrospective trial that demonstrated increased postoperative complications in children younger than 4 years of age¹³ and those of a population study of seven states showing increased rates of hospital revisits in children younger than 4 years of age.⁹ These data predate a published guideline⁵ that advises waiting until children are at least

Table II. Surgery-associated admission and ED visit rates by age, per 1000 procedures

Age ranges, y	Admit rate day of surgery, per 1000 procedures (no. admits/no. surgeries)	Admit rate 1-30 days after surgery, per 1000 procedures (no. admits/no. surgeries)	ED visit rate 0-30 days after surgery, per 1000 procedures (no. visits/no. surgeries)
0-<2	73.1 (37/506)*	4.0 (2/506)	41.5 (21/506)*
≥2-<4	7.5 (7/933)*	3.2 (3/933)	15.0 (14/933)*
≥4-<18	7.4 (28/3773)*	2.4 (9/3773)	16.2 (61/3773)*
χ^2	133.8	0.5	15.6
P value	<.001	.77	<.001

ED, emergency department.

*Indicates significance at $P < .05$ level.

4 years of age to repair asymptomatic umbilical hernias, so we stratified our analysis based on an age—younger than 2 years—for which we were unable to find any supporting literature or published hospital practice for umbilical hernia repair. Including patients aged 2-3 years to align with the new guideline, almost one-third of patients in this dataset had repairs at an age younger than the new guideline advises, with regional variation of 21%-32% having repairs younger than age 4 years. Waiting to repair these hernias until children are older may reduce complication risks to patients, especially those younger than 2 years of age, and reduce unnecessary operations in children younger than 4 years. This could be a benefit to patients, insurers, hospitals, and society at large.

This study is limited by the nature of the dataset. Limitations common to claims-based administrative data include lack of clinical detail, anatomy, type of facility, and outpatient mortality. Because MarketScan is a data set comprising data from private payers, our results may not generalize to the publicly insured pediatric population, which recent literature suggests is at increased risk of unplanned returns to the hospital.¹⁴ Although the total number of covered lives is consistently very large, in the years studied in this analysis, MarketScan contained data on between 7 and 15 million children within a given year. In addition, regional variation in sampling makes comparisons between smaller geographic areas such as state or metropolitan areas unreliable. The dataset does not provide patient or physician-level factors of interest, such as socioeconomic class or surgeon subspecialty. Nor does it provide detailed clinical information such as hospital type, where differential reimbursement rates between community and pediatric hospitals, or hospitals and free-standing surgical centers, could affect the cost data. The database does not characterize the size of the hernia, presence of redundant skin or a proboscis, or relative indications for repair such as pain or skin irritation. Analysis of more comprehensive data sources suggests that hernia factors such as these may play a role in the age at which umbilical hernia repair is performed,^{7,8,15} although recently released guidelines based on the available literature advise that even large hernias or those with a skin proboscis can close spontaneously and should not be repaired early.⁶ This database does not allow for measurement of recurrence, an outcome that has been found to be related to the age of repair.⁹ Study of recurrence would be possible using a database allowing tracking of children over many years. Nonetheless, for purposes of regional comparison and cost and complication data, MarketScan represents the best-available data for outpatient surgical procedures that are performed in a wide variety of settings by both general and pediatric surgeons,

from community hospitals and free-standing surgical centers to tertiary pediatric hospitals. ■

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