

Predictors of emergency ventral hernia repair: Targets to improve patient access and guide patient selection for elective repair

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Background. Emergency operations are associated with worse outcomes than elective operations. If not repaired electively, ventral hernias are at risk of strangulating and requiring emergency repair. We sought to identify patient- and hospital-level factors associated with emergency ventral hernia repair in a nationally representative, United States sample.

Methods. We abstracted data from the 2003–2011 Nationwide Inpatient Sample for adults (≥ 18 years) who underwent inpatient ventral hernia repair. Our primary outcome was emergency repair. We assessed differences in patient- and hospital-level factors as possible predictors of emergency repair using multivariable logistic regression. We examined secondary outcomes (mortality, total hospital cost, duration of stay) using multivariable logistic and generalized linear (family gamma; link log) regression.

Results. After weighting to the United States population, we included 453,161 adults (39.5% emergency). Independent predictors of emergency repair included payer status (uninsured: odds ratio 3.50, [3.10, 3.96]; Medicaid: 1.29 [1.20, 1.39] compared with private insurance), race/ethnicity (black: 1.77 [1.64, 1.92]; Hispanic: 1.44 [1.28, 1.61] compared with white), age (≥ 85 years: 2.23 [2.00, 2.47] compared with < 45 years), and comorbidities (Charlson Comorbidity Index ≥ 3 : 1.68 [1.56, 1.80] compared with 0). After risk-adjustment, emergency repair was associated with greater odds of in-hospital death, greater costs, and longer hospital stay.

Conclusion. Inpatient ventral hernia repairs are frequently performed emergently, with worse outcomes in this group. Independent predictors of emergency repair include factors that may limit access to and/or selection for an elective operation. These predictors provide targets for interventions to improve access to elective care and inform patient selection with the goal of improving patient outcomes. (Surgery 2016;■:■-■.)

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NATIONWIDE, >2 million patients undergo emergency operations each year, with an estimated annual net cost of \$28 billion.^{1,2} Compared with

elective operations, emergency operations are associated with excess morbidity and mortality, increased cost, and increased duration of hospital

Supported by the American College of Surgeons Resident Research Scholarship to L.L.W. This funding was used to support the salary of L.L.W. Not related to this work, A.H.H. is the PI of a contract (AD-1306-03980) with the Patient-Centered Outcomes Research Institute entitled *Patient-Centered Approaches to Collect Sexual Orientation/Gender Identity in the ED* and a Harvard Surgery Affinity Research Collaborative (ARC) Program Grant entitled *Mitigating Disparities Through Enhancing Surgeons' Ability To Provide Culturally Relevant Care*. A.H.H. also is the cofounder and an equity holder in Patient Doctor Technologies Inc, which owns and operates the website <http://www.doctella.com>.

Presented as an oral presentation at the 11th Annual Academic Surgical Conference in Jacksonville, FL, February 2–4, 2016.

Accepted for publication June 17, 2016.

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0039-6060/\$ - see front matter

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<http://dx.doi.org/10.1016/j.surg.2016.06.027>

stay.³⁻⁵ It has been suggested that improved access to elective care, including preventive care and screening, may allow for the “conversion” of emergency procedures to elective, with \$1 billion savings predicted over 10 years if as few as 10% of emergency operations were instead performed electively.⁵

Hernias are a prototypical example of an operative problem amenable to early detection and elective repair; diagnosis is clinical and often occurs independently by the patient. Whether a patient receives an elective repair may depend upon the decision to seek care, the ability to access care, and clinical decision-making by the surgeon.^{6,7} A better understanding of the factors associated with undergoing an emergency procedure has two main applications. First, predictors of emergency repair may be used to design interventions to improve timely access to elective repair for patients. Second, in the absence of clinical guidelines on the indication for and timing of elective ventral hernia repair, characterization of the patient groups at the greatest risk for emergency repair may assist surgeons with operative planning.

We performed an exploratory analysis in a nationally representative United States sample with the primary goal of identifying predictors of emergency ventral hernia repair. As a secondary aim, we sought to identify the excess burden of emergency procedures by comparing clinical outcomes (mortality, cases with an associated bowel procedure) and process of care (total index hospital costs, duration of hospital stay, cases performed laparoscopically) between patients undergoing elective versus emergency ventral hernia repairs.

METHODS

Data source. We abstracted data from the 2003–2011 Nationwide Inpatient Sample (NIS), the largest publicly available source of all-payer hospital discharge abstracts in the United States. The data set is a stratified sample of discharges from 20% of participating hospitals. The hospitals are sampled to represent 95% of the US population and can be weighted to calculate national population estimates. The NIS provides information on patient and hospital factors, including *International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM)* diagnosis codes, *ICD-9-CM* procedure codes, total hospital charges, duration of stay, and mortality.⁸

Study population. We used *ICD-9-CM* codes to specify patients undergoing inpatient ventral hernia repair in the inpatient setting only. We

included patients with both a primary diagnosis (*ICD-9-CM* 551.1, 551.20, 551.21, 551.29, 552.1, 552.20, 552.21, 552.29, 553.1, 553.20, 553.21, 553.29) and procedure code (*ICD-9-CM* 46.42, 53.41–53.43, 53.49, 53.51, 53.59, 53.61–53.63, 53.69) consistent with a ventral hernia repair. We excluded patients <18 years or those with a diagnosis of trauma (*ICD-9-CM* codes 800–959) during the same admission. Using a complete case analysis approach, we excluded all observations with missing data for key variables (Fig 1). The proportion missing was <5% for all study variables, except for cost-to-charge ratios (CCR—used to convert hospital charges to cost) (5.6%), admission type (11%), and race (21%), for which we performed sensitivity analysis.

Classification of end points. The primary outcome was undergoing an emergency operation. We defined this with the NIS variable “admission type,” which allowed us to categorize patients into emergency, urgent, and elective procedure groups. In all analyses, we considered emergency and urgent procedures together as the “emergency” group. Potential predictor variables were those available in the data set that represent patient- and hospital-level characteristics, including: age, sex, race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, other), zip code–based median household income quartile, primary payer for the hospitalization (private insurance, Medicare, Medicaid, self-pay, no charge, other), hospital region (Northeast, Midwest, South, West), bed size (small, medium, large), location (rural, urban), teaching status, and year.⁹

To estimate the burden of comorbid illness, we calculated a Charlson Comorbidity Index (CCI) score for each patient based upon reported *ICD-9-CM* codes associated with the index hospital admission.¹⁰ Although we wished to investigate body mass index (BMI) as a predictor, these data were not reliably recorded. In a sensitivity analysis, we assessed the Agency for Healthcare Research and Quality obesity comorbidity metric (obese, not obese).¹¹

Secondary outcomes included clinical end points (mortality, cases with an associated bowel procedure) and processes of care (total index hospital costs, duration of hospital stay, cases performed laparoscopically). In-hospital mortality was reported directly. We defined associated bowel procedure broadly to include any resection of the small or large intestine, as well as repair of a laceration, new anastomosis, revision of an anastomosis, or closure of a fistula (*ICD-9-CM* secondary procedure codes: 17.31–17.36, 17.39, 45.61–45.63,

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