JOURNAL OF SURGICAL RESEARCH • OCTOBER 2017 (218) 277–284

Available online at www.sciencedirect.com

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journal homepage: www.JournalofSurgicalResearch.com

Differences in rural and urban outcomes: a national inspection of emergency general surgery patients

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ARTICLE INFO

Article history:
Received 8 March 2017
Received in revised form 20 May 2017
Accepted 15 June 2017
Available online xxx

Keywords:
Emergency general surgery
Outcomes
Rural
Disparities

ABSTRACT

Background: About 19% of the United States population lives in rural areas and is served by only 10% of the physician workforce. If this misdistribution represents a shortage of available surgeons, it is possible that outcomes for rural patients may suffer. The objective of this study was to explore differences in outcomes for emergency general surgery (EGS) conditions between rural and urban hospitals using a nationally representative sample.

Methods: Data from the 2007-2011 National Inpatient Sample were queried for adult patients (≥18 years) with a primary diagnosis consistent with an EGS condition, as defined by the American Association for the Surgery of Trauma. Urban and rural patients were matched on patient-level factors using coarsened exact matching. Differences in outcomes including mortality, morbidity, length of stay (LOS), and total cost of hospital care were assessed using multivariable regression models. Analogous counterfactual models were used to further examine hypothetical outcomes, assuming that all patients had been treated at urban centers.

Results: A total of 3,749,265 patients were admitted with an EGS condition during the study period. Of 3259 hospitals analyzed, 40.2% ($n = 1310$) were rural; they treated 14.6% of patients. Relative to urban centers, EGS patients treated at rural centers had higher odds of in-hospital mortality (odds ratio [OR]: 1.24; 95% confidence interval [CI]: 1.21-1.28) and lower odds of major complications (OR: 0.98; 95% CI: 0.96-0.99). Rural patients had 0.51 d (95% CI: 0.50-0.53) shorter LOS and $744 (95% CI: 712-774) higher cost of hospitalization compared to urban patients. In counterfactual models overall odds of death decreased by 0.05%, whereas the overall odds of complications increased by 0.02%. Overall difference in LOS and total costs were comparable with absolute differences of 0.08 d and $98, respectively.

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0022-4804/$ – see front matter

http://dx.doi.org/10.1016/j.jss.2017.06.034

Conclusions: Despite the statistically significant difference in mortality and cost of care at rural *versus* urban hospitals, the magnitude of absolute differences is sufficiently small to indicate limited clinical importance. Large urban centers are designed to manage complex cases, but our results suggest that for cases appropriate to treat in rural hospitals, equivalent outcomes are found. These findings will inform future work on rural outcomes and provide impetus for regionalization of care for complex EGS presentations.

Introduction

Emergency general surgery (EGS) conditions account for more than two million hospital admissions in the United States each year.[1] Patients undergoing EGS are more likely to have higher mortality and complication rates when compared with similar elective operations.[2] Certain hospital-level factors such as bed size, EGS patient volume, and teaching status are associated with difference in outcomes among EGS patients,[3,4] but the association of hospital location has not been completely elucidated.

Rural locales are implicitly associated with diminished access to specialized health care and poor outcomes. Rural areas account for 19% of the population of the United States[5] but are served by only 10% of its physician population.[6] The continuous decrease in the number of surgeons willing to serve in rural regions has been a cause of debate.[7,8] Rural patients have less exposure to health care subspecialties[7] and have to travel long distances to receive therapeutic interventions.[9]

In 2010, rural areas accounted for 12% of the 35 million hospitalizations across the United States.[10] Several reports suggest that the practice of rural surgeons is often different to that of their urban counterparts.[11] However, the impact of rural location on EGS outcomes has largely remained understudied. In this context, the objective of this study was to evaluate differences in mortality, morbidity, length of stay (LOS), and cost of care between patients presenting at urban and rural hospitals with an EGS condition, in a nationally representative cohort.

Methods

Five years (2007-2011) of data from the National Inpatient Sample (NIS) were queried for adult patients (≥18 years) with a primary diagnosis of EGS, as defined by the American Association for Surgery of Trauma (AAST).[1] Diagnostic categories included in the AAST definition of EGS are resuscitation, general abdominal conditions, intestinal obstruction, upper gastrointestinal tract, hepatic-pancreatic-biliary, colorectal, hernias, soft tissue, vascular and cardiothoracic, and others. The NIS is the largest all payer database of US patients. It is a 20% weighted sample of 95% of the US inpatient population. Information available in the database includes patient- (age, sex, race, insurance status, zip code, length of hospitalization, discharge status, and so forth) and hospital-level (geographic location, patient volume, bed size, teaching status etc.) characteristics and up to 25 International Classification of Disease, ninth edition, Clinical Modification (ICD-9-CM) diagnosis and 15 procedure codes. The NIS is, however, an administrative database and lack granular clinical information, such as severity or duration of presenting symptoms, vital signs, laboratory tests, and medication data.

Patients transferred from one acute care hospital to another, were excluded from the cohort, as transferred patients are known to have higher mortality rates[12] and might affect outcomes at urban and rural hospital differently. Patients meeting the inclusion criteria were divided into two groups: those managed at rural *versus* urban hospitals. Rural and urban health care facilities are distinguished using Core-Based Statistical Area codes from census data from 2000 in the NIS.[13,14] Hospitals in areas labeled as metropolitans are designated as urban, whereas hospitals in micropolitans and noncenter areas were designated as rural.[14] This is the standard method of assignment of urban or rural status in the NIS. Secondary ICD-9-CM diagnosis codes were used to identify complications, including pneumonia, pulmonary emboli, myocardial infarction, cardiac arrest, acute respiratory distress syndrome, and sepsis and septic shock. Similar assessment was conducted to identify AAST-defined EGS diagnostic groups and receipt of operative intervention. Charlson Comorbidity Index (CCI) was calculated using the ICD-Programs for Injury Categorization program in Stata and was used to adjust for pre-existing cormorbid conditions.[15] Annual EGS patient volumes were also calculated for each hospital based on the number of included EGS admissions, and hospitals were divided in quartiles. Missing observations, if present, were recoded as missing/unknown to protect the integrity of the data set.

Patient demographics considered for analysis included age, gender, race, insurance status (private *versus* public *versus* uninsured), and socioeconomic status (income quartiles). Hospital-level factors included in the analysis comprised hospital region (US census regions), teaching status, bed size, and EGS volume. Patients' clinical factors accounted for in the analysis were comorbidities (CCI), operative intervention, and disease severity (all patient-refined Diagnosis-Related Group risk of mortality). In-hospital mortality, LOS, cost of inpatient care, and complications were the outcomes of interest.

Coarsened Exact Matching (CEM) was used to match patients presenting to rural hospitals to those presenting to urban hospitals in a 1:many ratio, to make the outcomes in both group more comparable. CEM involves temporarily coarsening continuous data into predefined set-width bins, matching of categorical and binned-continuous variables of interest, and then running analysis on the uncoarsened, matched data following the matching procedures.[16] This technique has been previously used to match data in large