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A population-based analysis of emergent versus elective paraesophageal hernia repair using the Nationwide Inpatient Sample

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Abstract

Background—As the life expectancy in the United States continues to increase, more elderly, sometimes frail patients present with sub-acute surgical conditions such as a symptomatic paraesophageal hernia (PEH). While the outcomes of PEH repair have improved largely due to the proliferation of laparoscopic surgery, there is still a defined rate of morbidity and mortality. We sought to characterize the outcomes of both elective and emergent PEH repair using a large population-based data set.

Methods—The Nationwide Inpatient Sample was queried for primary ICD-9 codes associated with PEH repair (years 2006–2008). Outcomes were in-hospital mortality and the occurrence of a pre-identified complication. Multivariate analysis was performed to determine the risk factors for complications and mortality following both elective and emergent PEH repair.

Results—A total of 8,462 records in the data, representing 41,723 patients in the US undergoing PEH repair in the study interval, were identified. Of these procedures, 74.2 % was elective and 42.4 % was laparoscopic. The overall complication and mortality rates were 20.8 and 1.1 %, respectively. Emergent repair was associated with a higher rate of morbidity (33.4 vs. 16.5 %, $p > 0.001$) and mortality (3.2 vs. 0.37 %, $p > 0.001$) than elective repair.

Emergent repair patients were more likely to be male, were older, and more likely to be minority. Logistic modeling revealed that younger age, elective case status, and a laparoscopic approach were independently associated with a lower probability of complications and mortality.

Conclusions—Patients undergoing emergent PEH repair in the United States tend to be older, more likely a racial minority, and less likely to undergo laparoscopic repair. Elective repair, younger age, and a laparoscopic approach are associated with improved outcomes. Considering all of the above, we recommend that patients consider elective repair with a surgeon experienced in the laparoscopic approach, especially when symptoms related to the hernia are present.

Keywords

Clinical papers; Trials; Research G–I; Hernia

As the life expectancy in the United States continues to increase, more and more elderly, sometimes frail patients present with sub-acute surgical conditions such as a symptomatic paraesophageal hernia (PEH). While the outcomes of PEH repair have improved dramatically in recent years largely due to the proliferation of laparoscopic surgery, there is still a defined rate of morbidity and mortality, especially in elderly patients [1]. Some influential studies published by Skinner and Belsey [2] and Hill [3] more than 40 years ago led many surgeons to prophylactically repair all paraesophageal hernias in order to prevent the life threatening complications of obstruction and strangulation. This approach has been challenged in recent years. In fact, it has been suggested that asymptomatic or minimally symptomatic paraesophageal hernias (symptoms that do not affect the quality of life of the patient, such as belching and heartburn) can be managed non-operatively. In a pooled analysis of 5 studies, Stylopoulos et al. [4] estimated that the probability of a paraesophageal hernia patient developing acute symptoms requiring emergency surgery was 1.16 % per year. What is not clear from existing data is whether the severity of paraesophageal hernia-

related symptoms relates to the risk of progression to emergency surgery. It seems likely that a patient with moderate or severe symptoms (significant dysphagia, vomiting, epigastric and chest pain, early satiety) is more apt to require an emergency operation than an asymptomatic patient.

Patients who present for emergency paraesophageal hernia surgery due to acute complications may have had a known paraesophageal hernia (asymptomatic and intentionally not treated), an unknown and asymptomatic paraesophageal hernia, may have elected or been counseled not to undergo surgery despite ongoing symptoms (fear of surgery or high operative risk), or may have suffered from symptoms not linked or attributed to the hernia (patient not seeking medical attention, provider not knowing symptoms likely related to hernia). Contemporary data related to the risk of morbidity and mortality following elective and emergent paraesophageal hernia repair can be helpful for patients and surgeons for whom the decision to operate or observe a paraesophageal hernia is difficult. We sought to characterize the outcomes of both elective and emergent PEH repair using a large population-based data set. We hypothesized that emergent surgery would be associated with higher morbidity and mortality rates, and that patients who chose to undergo elective repair were different from those undergoing emergent surgery (elective likely younger and with fewer medical conditions).

Materials and methods

A retrospective analysis was performed using the Nationwide Inpatient Sample (NIS) database for the years 2006–2008. The NIS is the largest all-payer inpatient care database in the United States, containing data on more than seven million hospital stays from approximately 1,000 hospitals participating in the Healthcare Cost and Utilization Project (HCUP) and maintained by the Agency for Healthcare Research and Quality (AHRQ). This represents an approximately 20 % stratified sample of US hospitals in 42 states. The large sample size is ideal for developing national and regional estimates and enables analyses on rare conditions, uncommon treatments, and special populations [5]. As the database is de-identified, the study was exempt from the institutional review board approval process.

Patients were identified according to the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) diagnosis, and procedure codes. Emergency paraesophageal hernia repairs were coded as emergent and had one of three ICD-9 diagnosis codes (diaphragmatic hernia [553.3], diaphragmatic hernia with obstruction [552.3] and diaphragmatic hernia with gangrene [551.3]), and a relevant procedure code (Table 1) consistent with PEH repair. Elective PEH repairs were coded as elective and had a diagnosis code of diaphragmatic hernia (553.3) and a relevant procedure code. In the elective hernia repair group, there are likely some patients undergoing repair of a diaphragm hernia for gastroesophageal reflux disease (GERD) who cannot be separated from the study population due to the nature of the administrative data.

Study variables extracted from the dataset for analysis included age, gender, race, operative intervention (laparoscopic versus open and procedure type), AHRQ pre-operative comorbidities (alcohol abuse, deficiency anemia, chronic pulmonary diseases, depression,

diabetes, liver disease, fluid/electrolyte disorders, obesity, renal failure, chronic peptic ulcer disease, and weight loss), and in-hospital morbidity and mortality. The AHRQ comorbidities are selected using a comorbidity software program that searches through the database for pre-determined ICD-9 codes specific to that comorbidity. For example, “deficiency anemia” includes ICD-9 codes for iron-deficiency, vitamin B12-deficiency, folate-deficiency, and protein-deficiency anemia, as well as anemia of chronic disease. “Renal failure” includes codes for chronic kidney disease and end-stage renal failure. It should be noted that “weight loss” was somewhat of a misnomer, in that only one of nine preselected ICD-9 codes reflects weight loss. The other eight codes include various forms of chronic malnutrition, such as Kwashiorkor, nutritional marasmus, and protein-calorie malnutrition. Adverse outcomes (e.g., wound infection/dehiscence, hemorrhage/hematoma, intraoperative laceration or injury to other organs, sepsis, shock, cardiopulmonary complications, venous thromboembolism, and reoperation) were selected based on likely association with time to surgery as noted in other similar studies utilizing the NIS [6].

Continuous data were reported as mean values, while categorical variables were reported as percentages. Bivariate analysis of categorical data was performed using χ^2 tests, and for continuous data, two-tailed *t* tests were used. Multivariate analysis was performed using multiple logistic regression models, adjusting for age, sex, elective versus emergent status, race, pre-treatment comorbidities, and operative approach, to identify risk factors for postoperative morbidity and mortality. When race data were missing, these discharges were categorized separately as race “other/missing”. A complete case method was not utilized. A p value < 0.05 was considered to be statistically significant. Statistical analysis was conducted using SAS 9.2 (SAS Institute, Cary, NC). All analyses were adjusted for the complex survey design of NIS, using the SurveyFreq and SurveyLogistic procedures for the analyses.

Results

A total of 8,462 records in the data, representing 41,723 patients in the United States undergoing PEH repair in the study interval, were identified. Of these procedures, 74.2 % was elective and 42.4 % was performed laparoscopically. The overall complication and mortality rates were 20.8 % and 1.1 %, respectively. Emergent repair was associated with a significantly higher rate of morbidity (33.4 vs. 16.5 %, $p < 0.0001$) and mortality (3.2 vs. 0.37 %, $p < 0.0001$) than elective repair. Race was categorized as other/missing in 28 % of discharges.

In general, patients undergoing elective surgery were younger, more likely to be female, and less likely to be Caucasian. Patients undergoing elective repair were more likely to have a laparoscopic repair (Table 2). Among the AHRQ pre-treatment comorbidities, patients undergoing emergent surgery had a significantly higher rate of alcohol abuse, deficiency anemia, electrolyte disorders, renal failure, and weight loss/malnutrition (Table 3).

On multivariate analysis of complications, younger age, elective repair, female gender, and laparoscopy were independently associated with lower odds of complications (Table 4). Race was not independently associated with a risk for complications. For each additional

year of age, the odds of having a complication increase by 1.2 % ($p < 0.0001$). The presence of chronic lung disease (OR 1.3, 95 % CI 1.1–1.5, p = 0.0005), fluid/electrolyte disorders (OR 2.6, 95 % CI 2.2–3.1, $p < 0.0001$), and malnutrition (OR 2.8, 95 % CI 2.1–3.6, $p < 0.0001$) were independent risk factors for complications.

On multivariate analysis for mortality, younger age, elective repair, and laparoscopic approach were independently associated with a lower risk of death (Table 5). For each additional year of age, the risk of mortality increases 6.1 %. Fluid/electrolyte disorders (OR 2.1, 95 % CI 1.3–3.5, $p = 0.004$), renal failure (OR 2.1, 95 % CI 1.1–4.1, $p = 0.04$), and malnutrition (OR 3.1, 95 % CI 1.8–5.1, $p < 0.0001$) were independently associated with risk of mortality.

Discussion

Through this analysis, we have demonstrated that the majority of PEH repairs performed in the United States during the study interval were elective. Compared to patients undergoing emergent repair, the patients undergoing elective repair tended to be younger and were more often Caucasian and female. The morbidity and mortality rates were higher in emergent cases. Multivariate analysis reveals that younger patients undergoing elective and laparoscopic repair had the best outcomes.

Our findings are similar to those of previous authors who have examined this issue using a variety of data sources. Polomsky et al. [7] looked at emergent and elective admissions for intrathoracic stomach (diagnosis ICD-9-CM 552.3 and 553.3) in New York State from 2002 to 2006. In their cohort, more than half of all admissions were emergent (53 %). Of note, the majority of emergent admissions (66 %) were discharged before any surgical intervention. Similar to our study, these authors found that emergently admitted patients were older and more likely to be African-American. Emergent admissions were associated with a higher mortality, longer length of stay, and higher hospital costs. Among the emergent admissions that underwent surgery, mortality, length of stay, and costs were found to be significantly elevated as well. Based on their data, the authors recommend that early elective repair of intrathoracic stomach be considered. In our study, we chose to evaluate only patients undergoing surgery for PEH. Based on the findings of Polomsky et al., we likely missed a significant number of patients admitted emergently for a PEH who did not undergo surgery during the index admission. What cannot be determined from either the Polomsky study or the NIS database is how many patients who were admitted emergently for PEH and discharged without surgery were readmitted at a later date for PEH repair—either emergently or electively. Considering the high rates of morbidity and mortality associated with emergent surgery for intrathoracic stomach, we would agree that early elective repair of PEH and intrathoracic stomach would be a prudent strategy.

Poulose et al. [8] reviewed the 2005 NIS to evaluate perioperative mortality in patients >80 years old undergoing PEH repair. In octogenarians, non-elective repair was found to be associated with a 6–7 fold increase in the risk of mortality (2.5 % mortality elective vs. 16 % non-elective). These authors concluded that earlier elective repair of paraesophageal hernia may reduce mortality. Fullum et al. [9] utilized the NIS (1998–2005) to compare patients

undergoing surgery for “uncomplicated” (553.3) and “complicated” (552.3) paraesophageal hernia repair. They found that a laparoscopic approach was associated with decreased length of stay for all patients. In uncomplicated patients, laparoscopy was associated with a decreased risk of death. Age >60 and non-White ethnicity were associated with a higher risk of death for all patients.

Bhayani et al. [7] used the American College of Surgeons National Surgical Quality Improvement Program database (NSQIP) to evaluate the relationship between timing of surgery in patients presenting acutely with obstructed PEH and outcomes [10]. They determined that surgery on the first hospital day did not result in meaningful improvements in morbidity or mortality compared to interval surgery (surgery after the first hospital day), but that sepsis and length of stay were less for the early group. The mortality rate for patients presenting with obstruction related to PEH (not gangrene) was 5.4 % in those undergoing early surgery vs. 4 % in those undergoing interval repair.

Nguyen et al. [11] reviewed the outcomes of laparoscopic compared to open paraesophageal hernias using the University Health Consortium (UHC) database from 2007 to 2010. The UHC is an alliance of 97 academic medical centers representing 90 % of the nation's non-profit academic medical centers (during the years of the study). These authors determined that at academic medical centers, laparoscopic surgery is highly utilized for PEH repair (76 % of 2,726 procedures). For elective procedures, utilization of laparoscopic repair was 81 % (higher than we observed in the NIS) and was associated with a shorter hospital stay, less requirement for intensive care unit care and lower overall complications, 30-day readmissions, and costs. In-hospital mortality for patients presenting with obstruction or gangrene was 1.5 % for laparoscopy and 6 % for open repair. The fact that the utilization of laparoscopy for both emergent and elective PEH repairs appears to be higher in the UHC (a group of academic medical centers) than in the NIS (a stratified sample based on ownership/control, bed size, teaching status, urban/rural location, and US region that includes both academic and public hospitals) suggests that the surgical expertise to approach these complicated paraesophageal hernias laparoscopically is more prevalent at academic medical centers.

Given the superior outcomes associated with the laparoscopic approach, paraesophageal hernia repairs should be performed electively at a center with experience and expertise in the laparoscopic approach to repair.

Sihvo et al. [12] have published perhaps the only truly population-based study of patients with large paraesophageal hernia and intrathoracic stomach. Assessing the population of Finland, the authors identified an overall 2.7 % operative mortality rate. Nonoperative management of symptomatic hospitalized patients had a mortality rate of 16.4 %. They estimated that routine elective surgical intervention rather than watchful waiting could have prevented 13 % of deaths. The authors recommended elective repair of paraesophageal hernia, at least in symptomatic patients.

Stylopoulus et al. [4] reported that the annual probability of an asymptomatic patient developing acute symptoms requiring emergency surgery was 1.16 % per year, and that the

lifetime risk was 18 % for patients older than 65 years. These probabilities were based on a pooled analysis of five case series studies where the time interval of known diagnosis of a hernia prior to repair was documented. A mathematical Markov analysis predicted that watchful waiting was the optimal strategy in 83 % of patients and elective laparoscopic hernia repair in 17 %. The authors based their analysis on an estimated operative mortality of emergency surgery of 5.4 % based on the 1997 NIS, an operative mortality of emergency surgery of 17 % from a pooled analysis of six case series studies reporting emergent repair published in 1986 [13], and 1.38 % mortality for elective surgery based on the literature review of 21 studies. The authors concluded that “watchful waiting” was the preferred approach in the management of patients with asymptomatic or minimally symptomatic paraesophageal hernias.

Unfortunately, race data were missing in 28 % of PEH surgery discharges in this study. This does weaken our race related conclusions, and in fact might lead to bias regarding these conclusions if the missing race data are not missing at random. A recent study evaluating the 2003–2007 NIS in lower extremity revascularization or lower extremity amputation determined that 25 % of all discharges were missing data on race. The majority of the missing data (80 %) were from states that do not report this information [14]. In these cases, missingness is clustered by state and unrelated to the intrinsic characteristics of the patient. The other 20 % of missing data were missing for unknown reasons and potentially not missing randomly. We found that racial minorities were less likely to undergo elective PEH repair in our analysis. Given the limitations noted above, if this were true this could be a reflection of decreased access to surgeons comfortable with the management of large paraesophageal hernias, decreased utilization of medical services by minorities, or other factors. A recent publication utilizing the NIS demonstrated that in bariatric surgery, non-Hispanic blacks demonstrate higher in-hospital mortality than their racial counterparts [15]. What could not be determined from this analysis was if this disparity was due to susceptibility to obesity-related mortality or to the suboptimal delivery of healthcare in the perioperative setting. In patients with lower extremity ischemia, the NIS was used to determine that black patients have greater odds of undergoing amputation than White patients, even after correcting for an array of confounding parameters [16]. Contrary to current beliefs that the disparity is mainly secondary to differences in access, this study found that the disparity was magnified in settings where resources were greatest. The authors conclude that whether the explanation lies primarily in patient-specific, physician-specific, or institutional-specific factors, it remains to be determined and is critical to better understanding our health care system and maintaining approaches that are consistently fair and equitable. If in fact minorities are less likely to undergo elective repair of PEH as suggested by our analysis, this is a concern that requires further evaluation.

There are several additional limitations to the current study. The NIS database underestimates the 30-day complication and mortality rates for all procedures, as death and adverse events occurring after discharge are not captured in this dataset. These databases are also limited by the clinical information available in the patients chart and by coding inconsistencies [17]. We were not able to determine how symptomatic a PEH was at the time of repair from these data. Furthermore, given the lack of specific ICD-9 diagnostic codes for paraesophageal hernias, we may be comparing elective GERD surgery with hiatal

hernia repair to emergent paraesophageal hernia repair in some cases. These limitations aside, large databases do provide data on thousands of patients and reflect the outcomes of surgical care provided in the community as a whole rather than at specialized centers in the United States.

In summary, patients undergoing emergent PEH repair in the United States tend to be older and less likely to undergo laparoscopic repair. Elective repair, younger age, and a laparoscopic approach are associated with improved outcomes following surgery. Considering all of the above, we recommend that patients consider elective repair of paraesophageal hernias with a surgeon experienced in the laparoscopic approach when clinically indicated.

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Table 1

ICD-9 procedure and diagnosis codes and frequency

ICD-9-CM diagnosis code	
553.3	Diaphragmatic hernia
552.3	Diaphragm hernia with obstruction
551.3	Diaphragm hernia with gangrene

ICD-9-CM procedure codes		
Code	**Description**	**Percent**
44.64	Gastropexy	0.618
44.65	Esophagogastroplasty	0.767
44.66	Other procedures for creation of esophagogastric sphincteric competence excluding laparoscopy	12.856
44.67	Laparoscopic procedures for creating esophagogastric sphincteric competence	40.067
53.7	Repair of diaphragmatic hernia, abdominal approach	34.977
53.71	Laparoscopic repair of diaphragmatic hernia, abdominal approach	2.318
53.72	Other and open repair of diaphragmatic hernia, with abdominal approach	1.381
53.8	Repair of diaphragmatic hernia, thoracic approach	6.528
53.83	Laparoscopic repair of diaphragmatic hernia, thoracic approach	0.093
53.84	Other and open repair of diaphragmatic hernia, with thoracic approach	0.395

Table 2

Emergent versus elective PEH repair

	Age	Sex (% female)	Race (% Caucasian)	Laparoscopic (%)
Elective	61.3	69.7	88.5	47.7
Emergent	65.5	64.4	84.0	26.9
p value	<0.0001	<0.0001	0.016	<0.0001

Table 3

Prevalence of medical condition by elective versus emergent status

Variable	Emergent	Elective	*p* value
Alcohol abuse	1.70 (0.29)	0.62 (0.11)	<0.0001
Deficiency anemia	15.37 (0.81)	10.03 (0.46)	<0.0001
Chronic lung disease	19.00 (0.86)	19.58 (0.56)	0.5638
Depression	8.53 (0.66)	10.20 (0.45)	0.0426
Diabetes	10.71 (0.65)	8.16 (0.35)	0.0002
Diabetes w/complications	0.78 (0.22)	0.49 (0.09)	0.1614
Liver disease	1.33 (0.24)	1.46 (0.16)	0.6455
Electrolyte disorder	33.02 (1.26)	7.36 (0.39)	<0.0001
Obesity	6.85 (0.57)	11.34 (0.54)	<0.0001
Renal failure	4.59 (0.46)	1.51 (0.16)	<0.0001
Peptic ulcer disease	0.41 (0.15)	0.09 (0.04)	0.0039
Weight loss/malnutrition	9.61 (0.70)	2.42 (0.22)	<0.0001
Died	3.17 (0.39)	0.37 (0.08)	<0.0001
Female	64.37 (1.13)	69.66 (0.64)	<0.0001

All results reported as % of patients with the comorbidity (standard error in parenthesis)

Table 4

Odds ratio for probability of complication with point estimates (pt. estimate) and 95 % confidence limits (95 % conf. limit)

Effect	Pt. estimate	95 % Conf. limit	*p* value
Age	1.012	1.008–1.016	<0.0001
Elective	0.679	0.592–0.779	<0.0001
Female	0.857	0.758–0.969	0.0137
Laparoscopic	0.451	0.399–0.511	<0.0001
Alcohol abuse	1.713	1.025–2.862	0.0400
Deficiency anemia	1.186	0.990–1.421	0.0645
Chronic lung disease	1.286	1.117–1.481	0.0005
Depression	0.972	0.792–1.193	0.7878
Diabetes	0.959	0.781–1.777	0.6895
Diabetes w/complications	0.960	0.462–1.997	0.9136
Liver disease	0.731	0.434–1.231	0.2391
Electrolyte disorder	2.613	2.231–3.061	<0.0001
Obesity	1.040	0.855–1.267	0.6933
Renal failure	1.298	0.932–1.807	0.1231
Peptic ulcer disease	0.657	0.208–2.072	0.4731
Weight loss/malnutrition	2.752	2.131–3.553	<0.0001
Race—Black vs. White	1.305	0.919–1.852	0.1371
Race—Hispanic vs. White	1.186	0.917–1.534	0.1933
Race—unknown/other vs. White	1.019	0.888–1.168	0.7928

Table 5

Odds ratio for probability of mortality with point estimates (pt. estimate) and 95 % confidence limits (95 % conf. limit)

Effect	Pt. estimate	95 % Conf. limit	*p* value
Age	1.061	1.039–1.084	<0.0001
Elective	0.310	0.176–0.544	<0.0001
Female	0.857	0.536–1.370	0.5185
Laparoscopic	0.365	0.196–0.679	0.0015
Alcohol abuse	0.951	0.122–7.434	0.9616
Deficiency anemia	0.882	0.500–1.555	0.6636
Chronic lung disease	1.488	0.888–2.495	0.1315
Depression	0.658	0.262–1.652	0.3724
Diabetes	0.826	0.401–1.700	0.6031
Diabetes w/complications	2.067	0.393–10.862	0.3909
Electrolyte disorder	2.092	1.260–3.474	0.0043
Obesity	0.659	0.194–2.237	0.5037
Renal failure	2.052	1.025–4.107	0.0424
Weight loss/malnutrition	3.052	1.830–5.092	<0.0001
Race—unknown/other vs. White	1.139	0.723–1.795	0.5742