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Published by Elsevier Inc.

0003-4975/$36.00
https://doi.org/10.1016/j.athoracsur.2023.01.017

RICHARD E. CLARK MEMORIAL PAPER FOR GENERAL THORACIC SURGERY

The Impact of Age and Need for Emergent Surgery in Paraesophageal Hernia Repair Outcomes

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ABSTRACT

BACKGROUND Observation of paraesophageal hernias (PEHs) may lead to emergent surgery for hernia-related complications. This study evaluated urgent or emergent repair outcomes to quantify the possible sequelae of failed conservative PEH management.

METHODS The impact of operative status (elective vs urgent or emergent) on perioperative mortality or major morbidity for patients who underwent hiatal hernia repair for a PEH diagnosis from 2012 to 2021 in the Society of Thoracic Surgery General Thoracic Surgery Database was evaluated with multivariable logistic regression models.

RESULTS Overall, 2082 (10.9%) of 19,122 patients with PEHs underwent urgent or emergent repair. Patients undergoing nonelective surgery were significantly older than patients undergoing elective surgery (median age, 73 years [interquartile range, 63-82 years] vs 66 years [interquartile range, 58-74 years]) and had a lower preoperative performance score (*P* < .001). Nonelective surgical procedures were more likely to be performed through the chest or by laparotomy rather than by laparoscopy (20% vs 11.4%; *P* < .001), and they were associated with longer hospitalizations (4 days vs 2 days; *P* < .001), higher operative mortality (4.5% vs 0.6%; *P* < .001), and higher major morbidity (27% vs 5.5%; *P* < .001). Nonelective surgery was a significant independent predictor of major morbidity in multivariable analysis (odds ratio, 2.06; *P* < .001). Patients more than the age of 80 years had higher operative mortality (4.3% vs 0.6%; *P* < 0.001) and major morbidity (19% vs 6.1%; *P* < .001) than younger patients overall, and these older patients more often had nonelective surgery (26% vs 8.6%; *P* < .001)

CONCLUSIONS The operative morbidity of PEH repair is significantly increased when surgery is nonelective, particularly for older patients. These results can inform the potential consequences of choosing watchful waiting vs elective PEH repair.

(Ann Thorac Surg 2023;■:■-■)

Hiatal hernia is a common condition, and the incidence increases with age.[1,2] Most hiatal hernias are the sliding type that may be asymptomatic or associated with gastroesophageal reflux disease; however approximately 5% to 15% of hiatal hernias have a paraesophageal hernia (PEH) component where the stomach or other organs herniate into the mediastinum.[3] The most serious presentation of a PEH is incarceration or strangulation, a life-threatening condition where the only management option is urgent surgery.[4-6] Historically, most patients

The Supplemental Figures can be viewed in the online version of this article [https://doi.org/10.1016/j.athoracsur.2023.01.017] on http://www.annalsthoracicsurgery.org.

Accepted for publication Jan 14, 2023.

Presented at the Fifty-ninth Annual Meeting of The Society of Thoracic Surgeons, San Diego, CA, Jan 21-23, 2023. Richard E. Clark Memorial Paper for General Thoracic Surgery.

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with known PEH, regardless of severity of symptoms, underwent elective surgery because urgent surgery was cited to have a mortality of up to 50%.[5,7] However, with the increasing use of diagnostic imaging, the incidence of asymptomatic or minimally symptomatic PEH has risen accordingly. This has led to the common clinical dilemma of deciding which patients are safe with a watchful waiting approach vs which patients may benefit from elective surgery.[8,9]

Elective PEH repair for elderly patients may be deferred or never even considered because of the perceived potential risk for these patients. However, watchful waiting has the inherent risk that patients can either present with the need for urgent surgery, which is also known to be riskier than elective surgery, or die before making it to emergency surgery.[10-15] Although the natural history of hiatal hernia is not well described, a study that examined the prevalence of hiatal hernia in a cohort of 3200 patients aged 53 to 94 years who had computed tomographic scans performed as part of an atherosclerosis study found that the hiatal hernias almost doubled in size in 75 patients who were followed up for 10 years.[1]

Despite the higher deployment of watchful waiting in the elderly population, the independent impact of age on outcomes after hiatal hernia repair has not been well delineated. This study aimed to use a multicenter surgical database and provide quantitative evidence that informs clinicians and patients on PEH management in elderly patients. Our hypothesis was that the impact of age on outcomes is much more significant when surgery is performed urgently rather than electively, and our purpose was to document objectively the consequences of what can happen if a conservative strategy fails. A secondary goal was to compare outcomes between patients who are extremely elderly (aged ≥80 years) vs younger patients.

PATIENTS AND METHODS

DATA SOURCE AND PATIENT SELECTION. The General Thoracic Surgery Database is a subset of a large, national data set managed by The Society of Thoracic Surgeons. It compiles more than 700,000 general thoracic procedure records from more than 1000 participating surgeons. General Thoracic Surgery Database versions 2.2, 2.3, and 2.41 were queried for patients who underwent PEH repair as a primary elective, urgent, or emergent treatment for the diagnosis of hiatal hernia from 2012 to 2021 (Figure). Diagnosis and procedure codes were used to identify the cohort, which included patients from 319 sites.

BASELINE CHARACTERISTICS AND OBSERVED OUTCOMES. Demographics and surgical data of the cohort were collected. The primary outcome studied was the composite of mortality and major morbidity, where major morbidity was defined as a postoperative length of stay greater than 7 days. The definition of major

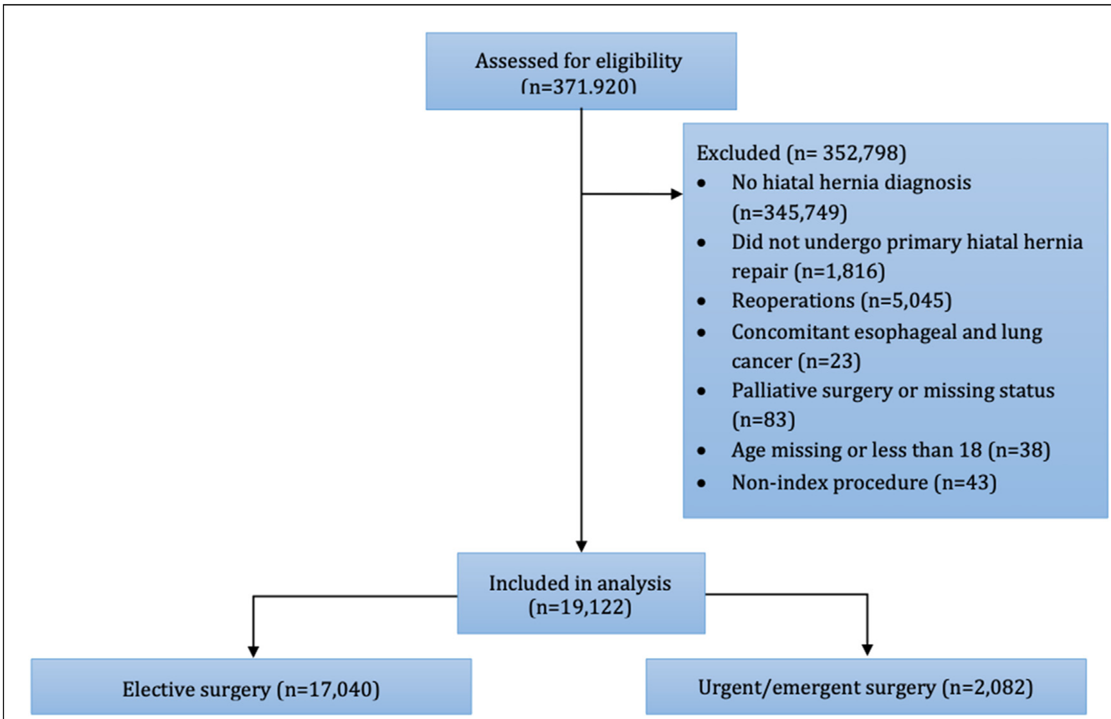

FIGURE Study flowchart.

morbidity was formulated from expert opinion and consensus from the Society of Thoracic Surgeons General Thoracic Access and Publications committee that hospital length of stay >7 days likely represented a major deviation from a normal postoperative course. Secondary outcomes included operative mortality, defined by mortality within 30 days, or during hospitalization even if after 30 days, or discharge to hospice, as well as specific complications within 30 days.

IMPACT OF AGE AND SURGICAL PRIORITY ON SURGICAL OUTCOMES. The impact of age and surgical priority on surgical outcomes was estimated with multivariable logistic regression. The main outcome modeled was the composite of mortality or postoperative length of stay greater than 7 days, which as described earlier was considered on the basis of expert consensus to indicate that major morbidity leading to a complicated postoperative recovery had occurred. The primary exposure was the interaction of age and status, elective vs urgent or emergent surgery. Multivariable hierarchical logistic regression models were created on the main outcome, by using the primary variables investigated by the study (age and operative status), as well as other patient characteristics (body mass index, performance status as measured by the Eastern Cooperative Oncology Group score, American Society of Anesthesiologists classification), specific comorbid conditions (history of cardiopulmonary disease, history of vascular disease, current dialysis treatment), and operative factors (intraoperative transfusion, operative approach) known to be associated with morbidity and mortality after major surgery.

STATISTICAL ANALYSIS. All analyses were performed with R statistical software version 4.1.2 (R Foundation for Statistical Computing). To compare patients' preoperative characteristics, operative characteristics, and unadjusted outcomes by age group or surgery status, we presented counts and percentages for categoric variables and median and interquartile range (IQR; 25th and 75th percentiles) for continuous variables. Categoric variable proportions were compared using the χ^2 test, the Fisher exact test, or the Cochran-Mantel-Haenszel test as appropriate. Continuous variables were compared using the *t* test, analysis of variance, or the Wilcoxon rank-sum test as appropriate, depending on normality of data.

TABLE 1 Preoperative Characteristics of the Entire Cohort and Categorized by Elective vs Urgent or Emergent Procedures

Variable	Elective[a] (n = 17,040)	Urgent or Emergent[a] (n = 2082)	P Value[b]
Age group			<.001
<80 y	15,226 (89)	1438 (69)	
≥80 y	1814 (11)	644 (31)	
Age, y	66 (58, 74)	73 (63, 82)	<.001
BMI group			<.001
Underweight	121 (0.7)	53 (2.6)	
Normal weight	2951 (17)	594 (29)	
Overweight	6308 (37)	727 (35)	
Obese	6787 (40)	610 (30)	
Gender			<.001
Female	12,348 (72)	1389 (67)	
Male	4691 (28)	693 (33)	
Race			
White	15,317 (92)	1878 (91)	
Black	902 (5.4)	115 (5.6)	
Asian	252 (1.5)	16 (0.8)	
Hispanic	660 (4.1)	77 (3.9)	
Other	570 (3.4)	62 (3)	
History of cardiopulmonary disease	10,560 (62)	1463 (70)	<.001
History of vascular disease	1723 (10)	280 (13)	<.001
Diabetes	2026 (12)	285 (14)	.017
Current dialysis treatment	38 (0.2)	15 (0.7)	<.001
Preoperative chemotherapy	191 (1.1)	37 (1.8)	.009
Preoperative thoracic radiation	241 (1.4)	44 (2.1)	.013
Cigarette smoking			<.001
Current smoker	941 (5.5)	138 (6.7)	
Never smoked	10,088 (59)	1350 (66)	
Past smoker	5968 (35)	569 (28)	
ASA classification			<.001
I	95 (0.6)	5 (0.2)	
II	6347 (37)	359 (17)	
III	10,036 (59)	1359 (65)	
IV	549 (3.2)	341 (16)	
V or VI	5 (<0.1)	15 (0.7)	
ECOG score			<.001
0	6006 (35)	328 (16)	
1	9969 (59)	708 (34)	
2	709 (4.2)	367 (18)	
3	199 (1.2)	429 (21)	

[a]Values are n (%), except age, which is median (interquartile range); [b]Wilcoxon rank-sum test, Pearson χ^2-squared test, Fisher exact test. ASA, American Society of Anesthesiologists; BMI, body mass index; ECOG, Eastern Cooperative Oncology Group.

A generalized linear mixed model was fit to the data by using a binomial distribution and a logit link function. The model included fixed effects for status, history of cardiopulmonary disease, history of vascular disease, current dialysis treatment, American Society of Anesthesiologists classification, Eastern Cooperative Oncology Group score, intraoperative packed red blood cells, primary approach, body mass index, surgery volume group, age in decades, decades higher than 70 years, and a random intercept for participant or site. Predictors were chosen on the basis of clinical knowledge and preexisting literature. All predictors were retained in the model, and no specific model building was used. The model was fit using adaptive Gaussian Hermite approximation of the likelihood with 10 integration points (nAGQ [number of points per axis for evaluating the adaptive Gauss-Hermite quadrature approximation to the log-likelihood] = 10). A forest plot

TABLE 2 Operative Details and Postoperative Events of the Entire Cohort and Categorized by Elective vs Urgent or Emergent Procedures

Variable	Elective[a] (n = 17,040)	Urgent or Emergent[a] (n = 2082)	*P* Value[b]
Operative time, min)	211 (165, 269)	238 (177, 306)	<.001
Intraoperative packed red blood cells	101 (0.6)	98 (4.7)	<.001
Primary approach			<.001
Chest	1117 (6.6)	188 (9.0)	
Laparoscopy	15,107 (89)	1664 (80)	
Laparotomy	816 (4.8)	230 (11)	
Mesh	6042 (35)	832 (40)	<.001
Postoperative LOS, d	2.00 (1.00, 3.00)	4.00 (3.00, 7.00)	<.001
Operative mortality	105 (0.6)	94 (4.5)	<.001
Composite outcome, operative mortality, and postoperative LOS >7 d	906 (5.5)	528 (27)	<.001
Morbidity or mortality	909 (5.4)	350 (17)	<.001
Initial visit to ICU	2209 (13)	867 (42)	<.001
Initial ICU visit days	2.00 (1.00, 3.00)	2.00 (1.00, 4.00)	<.001
Readmission within 30 d of discharge	1050 (6.4)	247 (13)	<.001
Readmission related to operative procedure	591 (3.7)	121 (6.3)	<.001
Postoperative events occurred	2942 (17)	733 (35)	<.001
Adult respiratory distress syndrome	21 (0.1)	9 (0.4)	.004
Myocardial infarction	25 (0.1)	12 (0.6)	<.001
Pulmonary embolus	113 (0.7)	30 (1.4)	<.001
Pneumonia	167 (1.0)	79 (3.8)	<.001
Respiratory failure	225 (1.3)	107 (5.1)	<.001
Renal failure - RIFLE criteria	33 (0.2)	16 (0.8)	<.001
Return to operating room	489 (2.9)	141 (6.8)	<.001
Tracheostomy	41 (0.2)	40 (1.9)	<.001
Initial ventilation support >48 h	34 (0.2)	61 (2.9)	<.001
Surgical site infection	121 (0.7)	34 (1.6)	<.001
Urinary tract infection	222 (1.3)	88 (4.2)	<.001
Atrial arrhythmia requiring treatment	489 (2.9)	136 (6.5)	<.001
Postoperative pleural effusion requiring drainage	270 (1.6)	116 (5.6)	<.001
Postoperative packed red blood cells	243 (1.4)	162 (7.8)	<.001
Ileus	168 (1.0)	54 (2.6)	<.001
DVT requiring treatment	88 (0.5)	37 (1.8)	<.001
New central neurologic event	31 (0.2)	11 (0.5)	.004

[a]Values are median (interquartile range) or n (%); [b]Wilcoxon rank-sum test, Pearson χ^2-squared test, Fisher exact test. DVT, deep venous thrombosis; ICU, intensive care unit; LOS, length of stay; RIFLE, risk, injury, and failure; and loss, and end-stage kidney disease.

was created to visualize the results of the multivariable logistic regression model. The plot included the estimated effect (expressed as an odds ratio [OR]) and 95% CI for each predictor variable.

RESULTS

BASELINE CHARACTERISTICS OF THE PATIENT COHORT. Of the 19,122 patients who met the inclusion criteria, 17,040 (89.1%) had elective PEH repairs, and 2082 (10.9%) had urgent or emergent repairs. Table 1 shows patients' characteristics stratified by the priority of surgery and demonstrates that the urgent or emergent group was more comorbid. The urgent or emergent group was older in general (median age, 73 years [IQR, 63, 81 years] vs 66 years [IQR, 58, 74 years]; $P < .001$) and specifically much more likely to be more than aged 80 years (31% vs 11%; $P < .001$). The relationship of age and surgical urgency was further assessed by evaluating the incidence of urgent or emergent surgery across categories of age (Supplemental Figure 1). The rates of urgent or emergent surgery in patients in the age ranges of 80 to 89 years and ≥90 years noticeably increased to 23.6% (522 of 2210) for patients aged 80 to 89 years and 49.2% (122 of 248) for patients aged ≥90 years, compared with the 8.6% (1438 of 16,664) rate of urgent or emergent surgery in the patients aged less than 80 years.

PERIOPERATIVE OUTCOMES: UNIVARIATE ANALYSES OF THE ENTIRE COHORT. Several differences in outcomes between elective and urgent or emergent patient groups were noted (Table 2). Regarding operative data, the urgent or emergent group had longer operative times (238 minutes [IQR, 177, 306 minutes] vs 211 minutes [IQR, 165, 269 minutes]; $P < .001$) and a higher rate of intraoperative blood transfusions (4.7% vs 0.6%; $P <$ 001), and they were more likely to have procedures performed through the chest or by laparotomy rather than by laparoscopy (20% vs 11.4%; $P < .001$).

The urgent or emergent group had higher operative mortality (4.5% vs 0.6%) and higher major morbidity (27% vs 5.5%; $P < .001$), and this group was associated with longer hospitalizations (4 days [IQR, 3-7 days] vs 2 days [IQR, 1-3 days]; $P < .001$). Multiple individual postoperative outcomes were also worse for the urgent or emergent group, all of which were statistically significant with $P < .001$ (Table 2).

PERIOPERATIVE OUTCOMES: UNIVARIATE ANALYSES OF THE ENTIRE COHORT STRATIFIED BY AGE. Patients aged ≥80 years had significantly higher operative mortality (4.3% [105/2,458] vs 0.6% [94/16,664]; $P < .001$), higher overall major morbidity (19% [452/2458] vs 6.1% [982/16,664]; $P < .001$), and longer length of stay (4 days [IQR, 2-6 days] vs 2 days [IQR, 1-4 days]; $P < .001$) compared with younger patients. Subgroup analysis stratifying patients into groups on the basis of age <80 years or ≥80 years, as well as by surgical priority, showed that urgent or emergent surgery was associated with significantly more morbidity for elderly patients (Table 3, Supplemental Figure 2). In patients aged ≥80 years, urgent or emergent surgery was associated with significantly higher operative mortality (10% vs 2.3%; $P < .001$), as well as major morbidity (38% vs 13%;

TABLE 3 Operative Details and Postoperative Events of the Entire Cohort Split Into Age <80 Years and ≥80 Years and Categorized by Elective vs Urgent or Emergent Procedures

Variable	Elective[a] (n = 15,226)	Urgent or Emergent[a] (n = 1438)	P Value[b]	Elective[a] (n = 1814)	Urgent or Emergent[a] (n = 644)	P Value[b]	CMH P Value
Operative time, min	210 (164, 267)	243 (177, 308)	<.001	218 (170, 277)	229 (177, 298)	.008	
Intraoperative packed red blood cells	72 (0.5)	62 (4.3)	<.001	29 (1.6)	36 (5.6)	<.001	
Primary approach							<.001
Chest	1033 (6.8)	160 (11)		84 (4.6)	28 (4.3)		
Laparoscopy	13,473 (88)	1122 (78)		1634 (90)	542 (84)		
Laparotomy	720 (4.7)	156 (11)		96 (5.3)	74 (11)		
Mesh	5317 (35)	571 (40)	<.001	725 (40)	261 (41)	.8	
Postoperative LOS	2.00 (1.00, 3.00)	4.00 (2.00, 7.00)	<.001	3.0 (2.0, 5.0)	6.0 (3.0, 9.0)	<.001	
Operative mortality	64 (0.4)	30 (2.1)	<.001	41 (2.3)	64 (10.0)	<.001	
Composite outcome, operative mortality and postoperative LOS >7 d[3]	685 (4.6)	297 (22)	<.001	221 (13)	231 (38)	<.001	
Morbidity or mortality	738 (4.9)	198 (14)	<.001	171 (9.5)	152 (24)	<.001	
Initial visit to ICU	1804 (12)	527 (37)	<.001	405 (22)	340 (53)	<.001	
Initial ICU visit days	2.00 (1.00, 3.00)	2.00 (1.00, 4.00)	<.001	2.0 (1.0, 3.0)	2.0 (2.0, 4.0)	<.001	
Readmission within 30 d of discharge	875 (6.0)	157 (11)	<.001	175 (10)	90 (15)	<.001	
Readmission related to operative procedure	499 (3.5)	83 (6.1)	<.001	92 (5.5)	38 (6.7)	.3	
Postoperative events occurred	2414 (16)	436 (30)	<.001	528 (29)	297 (46)	<.001	
Adult respiratory distress syndrome	18 (0.1	6 (0.4)	.014	3 (0.2)	3 (0.5)	.2	
Myocardial infarct	18 (0.1	7 (0.5)	.004	7 (0.4)	5 (0.8)	.3	
Pulmonary embolus	105 (0.7	21 (1.5)	.001	8 (0.4)	9 (1.4)	.022	
Pneumonia	128 (0.8)	40 (2.8)	<.001	39 (2.2)	39 (6.1)	<.001	
Respiratory failure	175 (1.2)	57 (4.0)	<.001	50 (2.8)	50 (7.8)	<.001	
Renal failure - RIFLE criteria	23 (0.2)	10 (0.7)	<.001	10 (0.6)	6 (0.9)	.4	
Return to operating room	404 (2.7)	86 (6.0)	<.001	85 (4.7)	55 (8.5)	<.001	
Tracheostomy	37 (0.2)	24 (1.7)	<.001	4 (0.2)	16 (2.5)	<.001	
Initial ventilation support >48 h	28 (0.2)	39 (2.7)	<.001	6 (0.3)	22 (3.4)	<.001	
Surgical site infection	111 (0.7)	22 (1.5)	.001	10 (0.6)	12 (1.9)	.002	
Urinary tract infection	170 (1.1)	47 (3.3)	<.001	52 (2.9)	41 (6.4)	<.001	
Atrial arrhythmia requiring treatment	347 (2.3)	64 (4.5)	<.001	142 (7.8)	72 (11)	.010	
Postoperative pleural effusion requiring drainage[c]	199 (1.3)	65 (4.5)	<.001	71 (3.9)	51 (7.9)	<.001	
Postoperative packed red blood cells	183 (1.2)	85 (5.9)	<.001	60 (3.3)	77 (12)	<.001	
Ileus	139 (0.9)	30 (2.1)	<.001	29 (1.6)	24 (3.7)	.001	
DVT requiring treatment	78 (0.5)	23 (1.6)	<.001	10 (0.6)	14 (2.2)	<.001	
New central neurologic event[3]	18 (0.1)	8 (0.6)	.001	13 (0.7)	3 (0.5)	.8	

[a]Values are median (interquartile range) or n (%); [b]Wilcoxon rank-sum test; Pearson χ^2–squared test; Fisher exact test; [c]Significant 2-way analysis of variance interaction; significant logistic regression interaction. CMH, Cochran-Mantel-Haenszel test; DVT, deep venous thrombosis; ICU, intensive care unit; LOS, length of stay; RIFLE, risk, injury, and failure; and loss, and end-stage kidney disease.

$P < .001$), compared with elective surgery (Table 3). The rates of mortality (2.1% vs 0.4%; $P < .001$) and major morbidity (22% vs 4.6%; $P < .001$) were also significantly higher for urgent or emergent surgery in younger patients, although qualitatively both variables were noticeably lower in these younger patients compared with the older patients.

PERIOPERATIVE OUTCOMES: MULTIVARIABLE ANALYSES. Multivariable analysis that considered surgical status as well as multiple other potential predictors demonstrated that nonelective surgery was a significant independent predictor of composite outcome of mortality or major morbidity (OR, 2.06; $P < .001$) (Table 4, Supplemental Figure 3). Increasing age greater than 70 years was also associated with an additional independent risk of the composite outcome (OR, 1.66 per 10-year increments; $P < .001$). Other predictors of worse outcomes included a history of cardiopulmonary disease (OR, 1.27; $P < 0.001$), vascular disease (OR, 1.25; $P = .014$), dialysis dependence (OR, 2.37; $P = .018$), and procedures through a chest or laparotomy approach (OR, 6.03; $P < .001$).

COMMENT

The common incidence of PEHs and its association with age mean that clinicians often must consider the risks and

TABLE 4 Multivariable Hierarchical Model Results Assessing Independent Predictors of Combined Outcome of Mortality or Major Morbidity (Where Major Morbidity Is Defined as Postoperative Length of Stay >7 Days)

Characteristic	Odds Ratio	95% CI	*P* Value
Status			<.001
Elective	...	...	
Urgent or emergent	2.06	1.74, 2.45	
History of cardiopulmonary disease			.002
No	...	...	
Yes	1.27	1.10, 1.48	
History of vascular disease			.012
No	...	...	
Yes	1.25	1.05, 1.49	
Current dialysis treatment			.019
No	...	...	
Yes	2.37	1.16, 4.84	
ASA classification			<.001
I or II	...	...	
	1.41	1.19, 1.67	
IV, V, or VI	3.34	2.62, 4.27	
ECOG score			<.001
0	...	...	
1	1.38	1.17, 1.62	
2	2.94	2.32, 3.73	
3	3.74	2.84, 4.93	
Intraoperative packed red blood cells			<.001
No	...	...	
Yes	2.21	1.52, 3.22	
Primary approach			<.001
Laparoscopy	...	...	
Laparotomy or chest	6.03	5.14, 7.07	
Body mass index			.001
Underweight	...	...	
Normal weight	0.55	0.34, 0.87	
Overweight	0.43	0.27, 0.69	
Obese	0.48	0.30, 0.76	
Bariatric	0.58	0.34, 0.99	
Age in decades	1.06	0.97, 1.15	.2
Decades >70 y	1.66	1.41, 1.96	<.001

ASA, American Society of Anesthesiologists; ECOG, Eastern Cooperative Oncology Group.

benefits of surgery vs observation in older patients. Our study showed that patients aged ≥80 years were much more likely to undergo urgent or emergent surgery than younger patients. Urgent surgical procedures were longer than elective procedures and were much more likely to require open approaches and blood transfusions. Our results also show that the operative morbidity and mortality of PEH repair are significantly increased when surgery is urgent, particularly in those patients aged ≥80 years. The independent importance of needing urgent surgery having significant association with operative morbidity and mortality was confirmed with multivariable logistic regression.

The findings from this diverse data set can be used when working up a patient for possible PEH repair. We found that patients who required urgent surgery were older, with more significant comorbid conditions, than elective surgery patients. This finding indirectly but strongly suggests that elective surgery is often deferred because the perceived increased risk of surgery. Our findings highlight what can happen if a conservative strategy of deferring surgery fails, and a high-risk patient develops a hernia-related complication where urgent surgery is the only available management option. The risk of major morbidity with urgent surgery was almost 5-fold higher than with elective surgery (27% vs 5.5%) in the overall cohort, including a more than 7-fold higher risk of mortality (4.5% vs 0.6%). The risks of both mortality (10%) and major morbidity (38%) were particularly striking in patients aged ≥80 years who required urgent surgery. These results suggest that despite higher risk on the basis of age and other baseline characteristics, elective surgery should be considered more heavily in the elderly population because the consequences of requiring urgent repair are particularly severe. Interestingly, our study's findings suggest that a conservative observation strategy of watch and wait is likely much safer in younger patients, with the operative mortality rate for urgent or emergent surgery in young patients at 2.1% still lower than the mortality rate for elective surgery for the elderly at 2.3%.

Other studies investigating the optimal treatment of PEH have been limited by small cohorts and the lack of key clinical and perioperative details, which then limited the ability to consider the effects of age and surgical status on outcomes fully.[16-18] This study's strength of using a multiinstitutional data set focused specifically on thoracic surgical procedures provides richness and specificity for the analyses to isolate the impact of age on PEH repair outcomes. A study from 2005 to 2012 showed that the rate of nonelective PEH repair was 3.6%, whereas our study, investigating years 2012 to 2021, showed a much higher rate of nonelective repair at 10.9%.[16] This stark increase in urgent or emergent surgery could be a consequence of more nonoperative treatment pursued in the early 2000s secondary to a widely distributed study by Stylopoulos and colleagues[8] that used a Markov Monte Carlo decision analytic model and concluded that routine elective repair would benefit only less than 1 in 5 patients. A study published in 2017 documented a 2-fold increase in complications and a 3-fold increase in mortality with urgent PEH repair in a large, propensity-matched cohort.[19] Our contemporary study shows that even in this modern era with new and improving technology, the mortality of emergency surgery is still very high, at almost 5%, for PEH repair, which electively has a mortality rate of less than 0.5%. In addition, the general population today is living longer, and the elderly population is already shown to have on average 10 more years of symptoms or more severe symptoms than their younger counterparts before these patients are referred for surgery.[20]

STUDY LIMITATIONS. There are several limitations to our study, including the inherent limitation in performing retrospective, noncontrolled analyses using large data sets. One area that lacks granularity is that we do not have information on the rates of symptomatic vs asymptomatic PEH and the individual reasons for why known, symptomatic PEH may not have been surgically corrected in an elective setting. Therefore, the study's findings cannot be used to provide any data on whether patients who ultimately needed nonelective surgery could have had a less risky elective procedure. In addition, the study cannot be used to help predict in which patients with known large hiatal hernias would strategy of observation rather than elective repair fail. The General Thoracic Surgery Database includes only outcomes from specialized thoracic surgeons, so our results may not be generalizable, especially in places where specialized surgical care is limited and where outcomes from emergent surgery may be worse. In addition, we acknowledge that some patients may either not survive to surgery or may have had a different surgical procedure that was not captured by our criteria. Therefore, we are likely underestimating the true cost of a failed observation approach. Some patients who present acutely because of a hiatal hernia may have organ ischemia or perforation, which is a clinical condition that likely requires more extensive surgery, with gastric repair or resection with reconstruction or even diversion, and is also likely associated with more prolonged hospitalization and poorer outcomes. Our current study that selected patients who had only PEH repair can really be used to just quantify what happens if a patient requires nonelective surgery for an incarcerated hernia where all tissue is still viable. Finally, the elective and nonelective surgery cohorts of patients were not balanced in terms of preoperative characteristics. Unmeasured confounders that are not controlled for in the multivariable analysis could therefore have an impact on the measurement of the magnitude of how operative status affects outcomes. Nevertheless, this was a large and up-to-date series of patients with PEH, and the study used both age and surgical urgency in the stratification for our analyses, thereby providing a quantitative finding that could be used in clinical practice.

CONCLUSION. Considering an overall aging population, this study hoped to improve the PEH management process by allowing clinicians to understand better the importance of the compounded negative effect between age and surgical urgency. With PEH becoming a very common diagnosis as a result of the everyday use of diagnostic imaging, physicians will need to weigh the benefit of avoiding urgent repair by recommending elective repair to minimally symptomatic elderly patients against the risk of operative morbidity and mortality in both the elective and urgent settings. The purpose of this study was not to suggest that all hernias should be repaired electively regardless of a patient's specific clinical situation, but rather to provide data that surgeons, clinicians, and patients can all use when considering elective intervention for a hiatal hernia. The risks and consequences of volvulus, obstruction, bleeding, incarceration, and strangulation of watchful waiting in PEH management should continue to be reevaluated closely by primary care providers and surgeons alike to ensure optimal outcomes for the elderly population. The results of this study can be used by surgeons, other clinicians, and patients to understand best the increased risks of surgery if an elective procedure is deferred but then urgent or emergent surgery is ultimately required.

The data for this research were provided by the Society of Thoracic Surgeons National Database Access and Publications Research Program.

FUNDING SOURCES

The authors have no funding sources to disclose.

DISCLOSURES

The authors have no conflicts of interest to disclose.

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