Original Article

Trends in the management and outcomes of esophageal perforations among racial-ethnic groups

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Background: Esophageal perforation (EP) is a life-threatening emergency requiring emergent surgical intervention. Little is known about potential racial-ethnic disparities among patients with EP.

Methods: Hospitalizations of adult (≥18 years old) patients admitted with a diagnosis of EP were identified in the 2000–2017 National Inpatient Sample (NIS). Multivariable Cox proportional hazards regression was used to estimate the association between race-ethnicity and inpatient mortality. Inpatient complications were assessed using multivariable logistic regression.

Results: There were an estimated 36,531 EP hospitalizations from 2000–2017. One quarter of hospitalizations were racial or ethnic minorities. Non-Hispanic (NH) White patients were, on average, older (median age 58 vs. 41 and 47 years, respectively, P<0.0001). The rate of EP admissions, per 1,000,000 the United States (US) adults, significantly increased among all groups over time. In-hospital mortality decreased for both NH White and NH Black patients (10.2% to 4.6% and 8.3% to 4.9%, respectively, P<0.0001) but increased for Hispanic patients and patients of other races (2.9% to 4.7% and 3.4% to 6.9%, P<0.0001). NH Black patients were more likely to have sepsis during their hospital course [odds ratio (OR) =1.34; 95% confidence interval (CI): 1.08 to 1.66], and patients of other races (OR =1.44; 95% CI: 1.01 to 2.07) were more likely to have pneumonia. Similar rates of surgical intervention were seen among all racial-ethic groups. After adjustment, inpatient mortality did not differ among racial-ethnic groups.

Conclusions: Rates of EP admissions have increased for all racial-ethnic groups since 2000. Despite similar incidences of inpatient mortality across groups, NH Black and other race patients were more likely to experience postoperative complications, suggesting potential racial-ethnic disparities in quality or access to care.

Keywords: Esophageal perforations (EPs); racial-ethnic groups; disparities

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Introduction

Esophageal perforation (EP) is a life-threatening disease that requires emergent surgical intervention. EP can occur in the cervical, intrathoracic, or abdominal compartment due to an iatrogenic or spontaneous cause. Leakage of esophageal and/or gastric contents into the mediastinum or abdomen can cause a necrotizing inflammatory process that leads to complications including sepsis, pneumonia, empyema, mediastinitis, and/or death (1). Treatment consists of broad-spectrum antibiotics and depending on

the etiology of perforation and extent of contamination, surgical drainage and debridement with primary repair, esophagostomy, esophagectomy, endoscopic management with stent placement, or a combination of these interventions. Despite decades of experience with surgical therapy and improvements in antibiotics, anesthesia, critical care, and percutaneous interventions, EP still confers a high rate of mortality ranging from 15–40% (2-6).

In the United States (US), racial and ethnic disparities in the treatment of esophageal cancer have been widely documented (7-9). Racial-ethnic disparities are also prevalent in traumas, such as traumatic brain injuries, gunshot wounds, and motor vehicle accidents, despite the highly protocolized nature of trauma management plans (10,11). However, little is known about potential disparities in access to treatment and outcomes among patients presenting with EP—a surgical emergency as well. Therefore, the purpose of this analysis was to assess trends in the management and outcomes of EPs specifically among racial and ethnic groups. We hypothesized that racial-ethnic disparities exist in both EP treatment and outcomes. Due to the rarity of EP, single center retrospective reviews will be limited by a small sample size. As such, we used the National Inpatient Sample (NIS), the largest publicly available all-payer database in the US, to determine the association between race-ethnicity and outcomes in patients with a diagnosis of EP. We present this article in accordance with the STROBE reporting checklist (available at https://jtd.amegroups.com/article/view/10.21037/jtd-23-1004/rc).

Highlight box

Key findings

- Non-Hispanic (NH) Black and NH other race patients were more likely to experience postoperative and inpatient complications from esophageal perforations (EPs).

What is known and what is new?

- It is known that racial-ethnic disparities among management and outcomes of esophageal cancers and emergency general surgeries exist.
- This is a new study examining the racial-ethnic disparities in EPs.

What is the implications, and what should change now?

- There are potential racial-ethnic disparities in quality or access to EP care that warrants future research.

Methods

Study design and patient population

For this study, we utilized the Healthcare Cost and Utilization Project (HCUP) NIS. The NIS is the largest publicly available all-payer database in US and includes roughly 7 million hospitalizations (35 million weighted hospitalizations) from community hospitals in the US (12). It approximates a 20% stratified sample of all US discharges from community hospitals (rehabilitation and long-term acute hospitals are not included). Discharge weights, which are provided by HCUP, were used to obtain national estimates and account for complex sampling structure. Sampling strata include census division, location (urban *vs.* rural), teaching status, hospital control, and bed size.

All non-elective hospitalizations of adults (≥18 years old) with a primary diagnosis (DX1) of EP or a primary diagnosis of an esophageal condition (e.g., achalasia, esophageal neoplasm) with a secondary diagnosis (DX2-DX30) of EP between January 1, 2000 and December 31, 2017 were eligible for inclusion (Table S1). Since not all data sources provide information on race and ethnicity, hospitalizations missing this information were excluded from the analysis (n=1,574, 17.1% of unweighted records). For analytic purposes, Asian/Pacific Islander, Native American, and "other" race patients were combined into a single other race category.

All diagnoses and procedures were identified using ICD-9-CM (International Classification of Disease, 9th revision, Clinical Modification) (January 2000–September 2015) and ICD-10-CM (International Classification of Disease, 10th revision, Clinical Modification) (October 2015–December 2017) codes (Table S1). ICD-9-CM codes were identified using clinical review and previously published algorithms; ICD-10-CM code lists were generated by forward and backward mapping identified by ICD-9-CM codes using the Centers for Medicare and Medicaid Services (CMS) general equivalence mappings (GEMs). ICD-10-CM codes then underwent clinical review and unrelated codes were removed. Additionally, ICD-10-CM codes that mapped to multiple variables were clinically reviewed and assigned to meet only one definition.

The primary outcomes of interest were rates of EP admissions and management strategies over time, pneumonia, sepsis, and time to surgery from admission

(among patients who underwent a procedure). Secondary outcome of interest was inpatient mortality. Pneumonia and sepsis were captured using secondary diagnosis codes (Table S1). The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013).

Statistical analyses

Descriptive statistics were used to compare patient and hospital characteristics across patient race-ethnicity, which was categorized as non-Hispanic (NH) White, NH Black, Hispanic, and NH other. Poisson regression was used to estimate race and ethnicity-stratified rates, per 1,000,000 US adults, of EP. The estimated number of EP hospitalizations each year, stratified by race-ethnicity, were obtained from our HCUP NIS cohort. The number of US adults were estimated using data from the 2000 and 2010 US Census. Race and ethnicity-stratified counts for 2000 and 2010 were directly obtained from Census summary files [2000 Census Summary File 1 (SF1) and 2010 Census Summary File 1 (SF1)], and for the years 2001–2009 and 2011–2017, population estimates were predicted using the 2000 and 2010 available data and linear regression. Time was treated as a continuous, linear variable.

Multivariable Cox proportional hazards regression was used to estimate the association between race-ethnicity and inpatient mortality. Patients were followed from admission until death or discharge. Models adjusted for age (modeled as a restricted quadratic spline), gender, Charlson comorbidity index (CCI) score, underlying esophageal cancer, tobacco use, alcohol abuse, primary admission type, transfer status, injury type, undergoing any procedure (esophagostomy, esophagectomy, other esophageal repair, esophageal suture repair, esophageal stent, chest tube placement, mediastinal incision, lung decortication, gastrostomy, or other enterostomy), hospital region, teaching status/location, and bed size. Deyo *et al.* [1992] and Quan *et al.* [2005] algorithms were adapted to determine each patients CCI score; only codes which indicated present conditions were included (e.g., history of myocardial infarction) (13,14). Surgery was treated as a time-varying variable; patients were classified as not having had surgery until the day of their first procedure. Inpatient complications were assessed using multivariable logistic regression, and time to surgery (among patients undergoing surgery) using multivariable linear regression.

All analyses were performed using SAS 9.4 (SAS Inc., Cary, NC, USA). The complex sampling design and weighting were accounted for in all analyses; cluster variables included year and hospital ID (15). Weighted results are reported unless otherwise noted.

Results

Patient characteristics

Overall, there were 36,531 hospitalizations (7,526 unweighted observations) included in the study. One quarter of hospitalizations were among racial-ethnic minorities (NH Black 13%, Hispanic 8%, NH other race 5%), *Table 1*. NH White patients were significantly older at admission compared to Hispanics and other race patients (median age 58 *vs.* 41 and 47 years, respectively, P<0.0001). The majority of patients were Medicaid/Medicare-insured, and NH Black patients had the highest proportion insured by Medicaid/Medicare (57%). NH White patients had the lowest proportion of self-pay patients (10%). NH White patients were also more likely to be transferred in from an outside hospital compared to NH Black and Hispanic patients (19% *vs.* 14% and 13%, P<0.0001 and P=0.0003, respectively).

EP trends over time among racial-ethnic groups

Between 2000 and 2017, the rate of EP admissions significantly increased for NH White, NH Black, Hispanic, and other race patients (P<0.0001), *Figure 1*. In-hospital mortality decreased for both NH White and NH Black patients (P<0.0001) but increased for Hispanic and other race patients (P<0.0001), *Figure 2*. Until 2012, NH White patients had the highest crude mortality. The use of esophageal stents also significantly increased for all racial-ethnic groups during the study period (P<0.0001 for each), while rates of primary repair decreased for all groups (P<0.0001 for each), *Figure 3*. After adjustment, NH Black [odds ratio (OR) =0.84; 95% confidence interval (CI): 0.60 to 1.19], Hispanic (OR =1.29; 95% CI: 0.78 to 2.12), and NH other race patients (OR =1.24; 95% CI: 0.72 to 2.14) were similarly likely to receive esophageal stents as compared to NH White patients.

Race-ethnicity and patient outcomes

The majority of patients in all racial-ethnic groups received medical management or no surgery for a diagnosis of EP (*Table 2*). The median length of stay (LOS) for patients

Table 1 Patient and hospital characteristics, stratified by patient race-ethnicity

Characteristics	NH White (n=26,892, 74%)	NH Black (n=4,674, 13%)	Hispanic (n=2,991, 8%)	NH other (n=1,975, 5%)
Age (years), median (IQR)	58 (40, 73)	50 (30, 63)	41 (21, 57)	47 (26, 65)
Male, n [%]	16,634 [62]	3,070 [66]	1,921 [64]	1,310 [66]
Insurance, n [%]				
Medicaid/Medicare	14,247 [53]	2,610 [57]	1,476 [50]	874 [45]
Private	9,631 [36]	1,091 [24]	786 [27]	679 [35]
Other/self-pay	2,774 [10]	877 [19]	691 [23]	407 [21]
ZIP code income[†], n [%]				
Low	5,357 [23]	2,088 [51]	922 [36]	449 [27]
Medium	6,262 [27]	902 [22]	644 [25]	362 [22]
High	5,940 [26]	665 [16]	595 [23]	333 [20]
Highest	5,507 [24]	411 [10]	423 [16]	529 [32]
Admitting diagnosis, n [%]				
Esophageal injury	18,733 [70]	3,513 [75]	2,189 [73]	1,319 [67]
Esophageal cancer	651 [2]	203 [4]	34 [1]	55 [3]
Foreign body	2,396 [9]	300 [6]	377 [13]	288 [15]
Accidental puncture or laceration during procedure	3,110 [12]	339 [7]	176 [6]	158 [8]
Benign esophageal condition[‡]	2,001 [7]	318 [7]	215 [7]	155 [8]
CCI, median (IQR)	0 (0, 0.9)	0 (0, 1.1)	0 (0, 0.3)	0 (0, 0.8)
Underlying esophageal pathology, n [%]				
Achalasia	454 [2]	83 [2]	39 [1]	40 [2]
Esophageal stricture	4,064 [15]	466 [10]	286 [10]	226 [11]
Esophageal cancer	1,225 [5]	267 [6]	58 [2]	90 [5]
Dysphagia	3,332 [12]	485 [10]	338 [11]	207 [10]
Tobacco use, n [%]	6,151 [23]	1,011 [22]	519 [17]	307 [16]
Alcohol abuse, n [%]	1,183 [4]	290 [6]	187 [6]	93 [5]
Transferred, n [%]	5,241 [19]	652 [14]	400 [13]	376 [19]
Hospital region, n [%]				
Northeast	5,408 [20]	905 [19]	398 [13]	418 [21]
Midwest	5,487 [20]	831 [18]	192 [6]	288 [15]
South	10,385 [39]	2,458 [53]	1,101 [37]	592 [30]
West	5,612 [21]	480 [10]	1,300 [43]	676 [34]
Hospital type, n [%]				
Urban, teaching	16,896 [63]	3,684 [79]	2,120 [71]	1,427 [74]
Urban, non-teaching	8,091 [30]	843 [18]	804 [27]	472 [24]
Rural, non-teaching	1,760 [7]	127 [3]	51 [2]	35 [2]

Table 1 *(continued)*

Table 1 *(continued)*

Characteristics	NH White (n=26,892, 74%)	NH Black (n=4,674, 13%)	Hispanic (n=2,991, 8%)	NH other (n=1,975, 5%)
Hospital bed size[§], n [%]				
Small	2,259 [8]	291 [6]	262 [9]	173 [9]
Medium	6,417 [24]	1,106 [24]	732 [25]	394 [20]
Large	18,071 [68]	3,257 [70]	1,980 [67]	1,367 [71]

Some patient and hospital characteristic data were missing from the NIS database, as such the total N in some groups will not equal the total N value noted in the header. [†], median income in patient's ZIP code was characterized into quartiles each year and reported as low (bottom 25%), medium, high, and highest (top 25%); [‡], benign conditions include achalasia, esophageal stricture, esophageal ulcer, diverticulum of esophagus, Barrett's esophagus, and other conditions (see Table S1 for full list); [§], hospital size categories are based on the number of hospital beds; cut points were chosen for each region and location (rural, non-teaching, urban non-teaching, and urban teaching) combination so that approximately 1/3 of hospitals would appear in each size category. NH, non-Hispanic; IQR, interquartile range; CCI, Charlson comorbidity index.

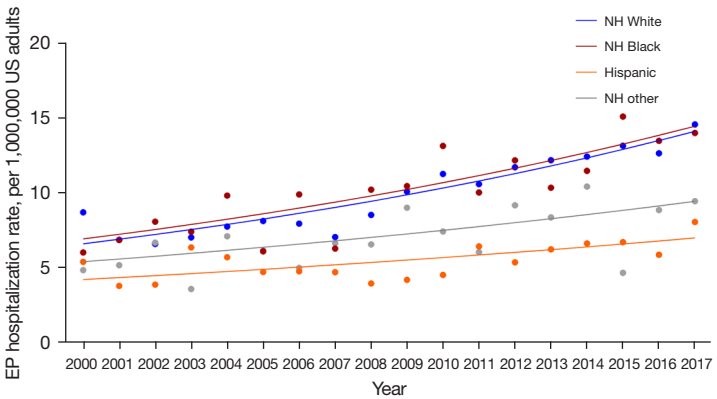

Figure 1 Rate of EP admissions, per 1,000,000 US adults, stratified by race-ethnicity. NH, non-Hispanic; EP, esophageal perforation; US, the United States.

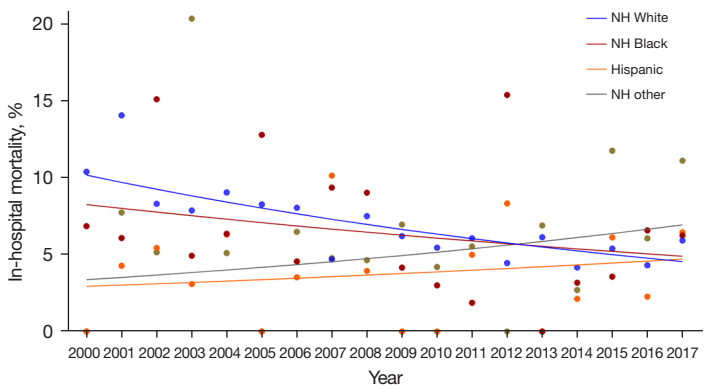

Figure 2 Trends in in-hospital mortality in patients with esophageal perforation hospitalized between 2000 and 2017, stratified by race-ethnicity. NH, non-Hispanic.

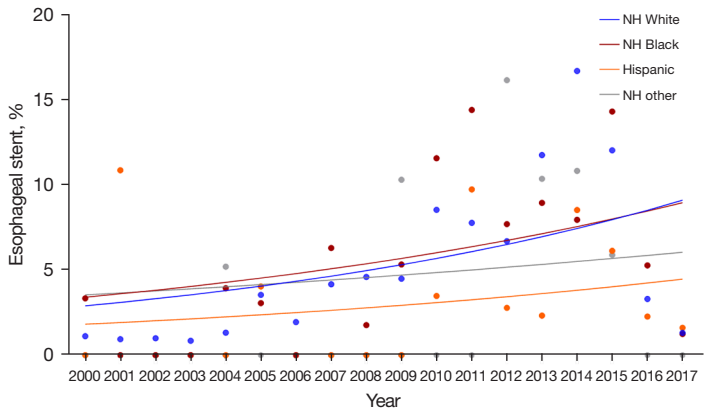

Figure 3 Trends in receiving esophageal stent in patients with esophageal perforation hospitalized between 2000 and 2017, stratified by race-ethnicity. NH, non-Hispanic.

Table 2 Inpatient outcomes, stratified by patient race-ethnicity

Inpatient outcomes	NH White (n=26,892, 74%)	NH Black (n=4,674, 13%)	Hispanic (n=2,991, 8%)	NH other (n=1,975, 5%)
Procedure[†], n [%]				
Esophagostomy	548 [2]	101 [2]	70 [2]	44 [2]
Esophagectomy	759 [3]	120 [3]	49 [2]	39 [2]
Other repair of esophagus	3,256 [12]	597 [13]	265 [9]	203 [10]
Insertion of chest tube	5,009 [19]	982 [21]	384 [13]	362 [18]
Decortication of lung	1,394 [5]	295 [6]	101 [3]	96 [5]
Insertion of permanent tube (or stent) into esophagus	1,566 [6]	284 [6]	95 [3]	84 [4]
Suture of esophagus	3,153 [12]	680 [15]	305 [10]	166 [8]
Gastrostomy	3,582 [13]	635 [14]	311 [10]	201 [10]
Other enterostomy	3,294 [12]	472 [10]	205 [7]	165 [8]
Incision of mediastinum	863 [3]	131 [24]	30 [1]	49 [2]
Time to procedure[‡] (days), median (IQR)	0 (0, 0.9)	0 (0, 0.8)	0.1 (0, 1.9)	0 (0, 1.7)
No surgery or procedure, n [%]	15,961 [59]	2,602 [56]	2,034 [68]	1,273 [64]
Pneumonia, n [%]	2,281 [8]	446 [10]	195 [7]	191 [10]
Sepsis, n [%]	3,835 [14]	752 [16]	245 [8]	225 [11]
Discharge disposition[§], n [%]				
Home/routine	14,633 [54]	2,627 [56]	2,123 [71]	1,259 [64]
Home health	3,497 [13]	642 [14]	273 [9]	220 [11]
Short-term transfer	1,990 [7]	242 [5]	126 [4]	119 [6]
Long-term transfer	4,750 [18]	758 [16]	286 [10]	244 [12]
Died	1,771 [7]	289 [6]	116 [4]	113 [6]
LOS (days), median (IQR)	6 (2, 14)	8 (3, 16)	5 (2, 12)	6 (2, 13)

Some procedure and discharge disposition data were missing from the NIS database, as such the total N in some groups will not equal the total N value noted in the header. [†], patients were able to undergo multiple procedures during their admission; [‡], among patients who underwent one of the procedures listed above (weighted n=14,660); time to first procedure was used among patients who underwent multiple surgeries; [§], 84 observations (unweighted) were discharged against medical advice. NH, non-Hispanic; IQR, interquartile range; LOS, length of stay.

Table 3 Adjusted odds of patient complications among NH Black, Hispanic, and NH other race patients, compared to NH White patients

Patient complications	NH Black	Hispanic	NH other
Pneumonia, OR (95% CI)[†]	1.26 (0.98, 1.63)	1.13 (0.80, 1.59)	1.44 (1.01, 2.07)
Sepsis, OR (95% CI)[†]	1.34 (1.08, 1.66)	0.78 (0.55, 1.09)	0.93 (0.64, 1.33)
Time to first surgery[‡], CIE (95% CI)[‡]	0.32 (–0.18, 0.82)	0.77 (0.29, 1.26)	0.41 (–0.28, 1.11)

[†], adjusted for year of admission, patient age, gender, comorbidities (COPD, obesity, weight loss, electrolyte disorders), transfer status, injury type, surgery, and hospital region, type, history of esophageal cancer, and bed size; [‡], adjusted for year of admission, patient age, gender, comorbidities (COPD, obesity, weight loss, electrolyte disorders), transfer status, injury type, and hospital region, type, and bed size. NH, non-Hispanic; OR, odds ratio; CI, confidence interval; CIE, change-in-estimate; COPD, chronic obstructive pulmonary disease.

Table 4 Racial-ethnic disparities in inpatient mortality after admission for esophageal perforation

Racial-ethnic groups	Deaths, n [%]	Total LOS (days)	HR (95% CI)	aHR (95% CI)[†]
NH White	1,771 [7]	301,520	1.00 (reference)	1.00 (reference)
NH Black	289 [6]	61,835	0.80 (0.61, 1.05)	1.16 (0.75, 1.56)
Hispanic	116 [4]	30,564	0.64 (0.42, 0.98)	1.16 (0.75, 1.81)
NH other	113 [6]	23,277	0.83 (0.54, 1.29)	1.14 (0.72, 1.80)

[†], adjusted for year of admission, patient age, gender, comorbidities (COPD, obesity, weight loss, electrolyte disorders), transfer status, injury type, surgery, history of esophageal cancer, and hospital region, type, and bed size; surgery was treated as time-varying. LOS, length of stay; HR, hazard ratio; CI, confidence interval; aHR, adjusted hazard ratio; NH, non-Hispanic; COPD, chronic obstructive pulmonary disease.

who did not receive any procedure was 4 days [interquartile range (IQR): 2–7] compared to 15 days (IQR: 9–25) for those who received a surgery or procedure. There were no significant differences in the time to first surgery or LOS among groups (*Table 3*).

After adjustment, NH Black patients were more likely to have inpatient sepsis (OR =1.34; 95% CI: 1.08 to 1.66), and NH other race patients were more likely to have inpatient pneumonia (OR =1.44; 95% CI: 1.01 to 2.07) during their EP hospitalization, *Table 3*. Despite these differences in inpatient complications, there was no significant difference in inpatient mortality between all groups (*Table 4*).

Discussion

Disparities in health care treatment and outcomes have been widely studied, especially when it pertains to examining racial-ethnic differences. Numerous studies have identified racial-ethnic disparities among management and outcomes of esophageal cancers and emergency general surgeries, but few have studied EPs (16-19). To the best of our knowledge, this is the first analysis to assess trends in the management and outcomes of EPs specifically among racial-ethnic groups using a comprehensive national database. Our data demonstrates that EP have increased over time with non-surgical management as the preferred treatment option. Further, a higher proportion of NH Black patients with EP lived in low-income neighborhoods, compared to NH White, Hispanic, and NH other race patients. Esophageal injury was the most common reason for EP, while foreign bodies, accidental puncture, and cancer were less common. There was no significant difference in inpatient mortality among racial-ethnic groups. However, hospitalizations for NH Black patients with EP were more likely to be complicated by sepsis, while hospitalizations for NH other race patients were more likely to be complicated by pneumonia.

Our analysis found differences in inpatient complications among racial-ethnic groups, but no significant differences in inpatient mortality. These results are similar to Causey *et al.*'s study that demonstrated that non-White race was independently associated with increased post-operative complications in emergency abdominal surgeries (18). Although we did not find a difference in inpatient mortality among racial-ethnic groups, the differences in postoperative complications suggest that some potential racial-ethnic

disparities exist in this patient population—though the data is limited. It has been shown that time to perforation to diagnosis is a predictor of outcome with delayed diagnosis causing complications such as sepsis and pneumonia (20). Schrader and Lewis has found that NH Black patients presenting to the ED received lower acuity ratings and experienced significantly longer wait times following triage compared to NH White patients (16). NH Black patients waited on average 95.6 and 98.3 minutes for chest pain and dyspnea compared to 74.6 and 74.9 minutes in NH White patients, respectively (16). Perhaps, the racial-ethnic differences in postoperative complications may be partially explained by the ED triage process and early identification of EP. While we did not examine the management of these postoperative complications, Mayr *et al.* also reported that patients treated at hospitals with higher proportions of NH Black patients were less likely to receive antibiotics within 4 hours or receive guideline concordant therapy for pneumonia (21). These differences in postoperative complications among racial-ethnic minorities suggest potential disparities in quality or access to care that warrants further research, as studies have shown that increased post-operative complications lead to prolonged hospitalization and increased overall costs (22,23).

Over half of our study population did not receive any surgical intervention after an EP admission. It is possible that iatrogenic perforations (the most common etiology) occurring during endoscopy are being treated endoscopically during the index procedure, and as a result appearing to not have a surgery/procedure (24,25). Additionally, we cannot differentiate between contained perforations or post-operative leaks *vs.* full thickness perforations from diagnosis codes, as the former process is often managed non-operatively with antibiotics and percutaneous drainage at the index operation. However, our findings seem consistent with Sdralis *et al.*'s recent systematic review on EP which showed non-operative management in approximately 50% of EP cases (26). Additionally, our mortality rate for all racial-ethnic groups who underwent a surgical intervention was similar to Sdralis *et al.* reported mortality rate of 10% (26).

Our study also showed that the rates of EP admissions have increased for all racial-ethnic groups since 2000. The reason(s) for the observed increase is unclear from our study. However, this increase in EP admission may be due to the improved attention to non-specific symptoms and signs and early diagnosis based on imaging over time. A significant proportion of EP are iatrogenic with endoscopic procedures as the most common cause of iatrogenic EP (27,28). Iatrogenic causes were also seen as the most common cause of EP in our data and Sdralis *et al.*'s systematic review (26). As such, the increase in EP admission may also be associated with the potential increase in endoscopic procedures over time. Future study examining these associations with the increase in EP are needed.

Limitations

Although our study was large and nationally representative, there are several limitations. First, the NIS captures patient diagnoses using ICD-9-CM and ICD-10-CM codes. These codes lack granular information regarding patient hospitalization and are limited by the potential for unreported diagnoses and potential coding errors, such as false positive EP (i.e., patients with pneumomediastinum who are miscoded as having EP) within the administrative discharge data. However, missing data is expected to bias results towards the null (i.e., underestimate the true magnitude of our estimates). Further, we cannot differentiate between contained perforations or post-operative leaks *vs.* full thickness perforations from diagnosis codes, which could explain our observed large non-operative EP population. Additionally, while studies have validated the use of ICD codes for EP, there are no studies that have validated the complications of EP using a "gold standard" medical record review. Finally, due to differences in hospital reporting, we were missing race-ethnicity for 17% of EP hospitalizations. This means that our EP hospitalization rates and potentially our mortality rates are slightly underestimated. This missing data may also affect our generalizability if certain hospitals (e.g., rural) are more likely to be excluded. Missing race-ethnicity was also more common in earlier years of NIS data and may also partially explain the increasing EP hospitalization rates. Despite these limitations, we believe that our study provides valuable and robust information in the context of EP among racial-ethnic groups.

Conclusions

The rate of EP admissions has increased among racial-ethnic groups between 2000 and 2017. Non-surgical management appears to be the most common treatment option for patients with an EP diagnosis. Mortality rates have decreased among NH White and NH Black patients but have increased among Hispanic patients and NH other

race patients. Despite similar rates of mortality across groups, NH Black and NH other race patients were more likely to experience postoperative, inpatient complications, suggesting potential racial-ethnic disparities in quality or access to care that warrants future research.

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Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://jtd.amegroups.com/article/view/10.21037/jtd-23-1004/rc

Peer Review File: Available at https://jtd.amegroups.com/article/view/10.21037/jtd-23-1004/prf

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://jtd.amegroups.com/article/view/10.21037/jtd-23-1004/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013).

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Supplementary

Table S1 ICD-9-CM and ICD-10-CM diagnosis and procedure codes used to identify esophageal perforation, esophageal conditions, comorbidities, procedures, and inpatient complications

Diagnosis/procedure	ICD-9-CM	ICD-10-CM[†]
Esophageal injury		
Esophageal perforation	530.4	K22.3
Injury to esophagus, without cavity entry	862.22	S27.818A, S27.819A
Injury to esophagus, with cavity entry	862.32	S21.309A, S27.813A[‡]
Open wound of pharynx, uncomplicated	874.4	S11.20XA, S11.21XA, S11.23XA, S11.25XA
Open wound of pharynx, complicated	874.5	S11.22XA, S11.24XA
Esophageal conditions		
Malignant neoplasm of esophagus	150.0-150.9	C15.3, C15.4, C15.5, C15.8, C15.9
Benign conditions		
Achalasia	530.0	K22.0
Esophagitis	530.10-530.19	K20.0, K20.8, K20.9, K21.0
Esophageal ulcer	530.20, 530.21	K22.10, K22.11
Esophageal stricture	530.3	K22.2
Dyskinesia of esophagus	530.5	K22.4
Diverticulum of Esophagus	530.6	K22.5
Gastroesophageal laceration-hemorrhage syndrome	530.7	K22.6
Barrett's esophagus	530.85	K227.0, K227.10, K227.11, K227.19
Other esophageal conditions	530.81-530.84, 530.86-530.9	K21.9, K22.8, K22.9, K23, J86.0, K94.30, K94.31, K94.32, K94.33, K94.39
Foreign body in esophagus	935.1	T18.100A, T18.108A, T18.110A, T18.118A, T18.120A, T18.128A, T18.190A, T18.198A
Accidental puncture or laceration during procedure	998.2	K91.71, K91.72
Esophageal procedures		
Esophagostomy	42.10, 42.11, 42.82	0D15074[§], 0D150J4[§], 0D150K4[§], 0D150Z4[§], 0D153J4[§], 0D15474[§], 0D154J4[§], 0D154K4[§], 0D154Z4[§], 0D11074, 0D110J4, 0D110K4, 0D110Z4, 0D113J4, 0D11474, 0D114J4, 0D114K4, 0D114Z4, 0D11876, 0D118J6, 0D118K6, 0D118Z6, 0WQ6XZ2
Esophagectomy	42.40, 42.41, 42.42, 42.51	0DB50ZZ, 0DB53ZZ, 0DB57ZZ, 0DB10ZZ, 0DB13ZZ, 0DB17ZZ, 0DB20ZZ, 0DB23ZZ, 0DB27ZZ, 0DB30ZZ, 0DB33ZZ, 0DB37ZZ, 0DB50ZZ, 0DB53ZZ, 0DB57ZZ, 0DT10ZZ, 0DT14ZZ, 0DT17ZZ, 0DT18ZZ, 0DT20ZZ, 0DT24ZZ, 0DT27ZZ, 0DT28ZZ, 0DT30ZZ, 0DT34ZZ, 0DT37ZZ, 0DT38ZZ, 0DT50ZZ, 0DT54ZZ, 0DT57ZZ, 0DT58ZZ
Other repair of esophagus	42.89, 42.99, 42.87	0DR507Z, 0DR50JZ, 0DR50KZ, 0DR547Z, 0DR54JZ, 0DR54KZ, 0DR577Z, 0DR57JZ, 0DR57KZ, 0DR587Z, 0DR58JZ, 0DR58KZ, 0DQ10ZZ, 0DQ13ZZ, 0DQ14ZZ, 0DQ17ZZ, 0DQ18ZZ, 0DQ20ZZ, 0DQ23ZZ, 0DQ24ZZ, 0DQ27ZZ, 0DQ28ZZ, 0DQ30ZZ, 0DQ33ZZ, 0DQ34ZZ, 0DQ37ZZ, 0DQ38ZZ, 0DQ50ZZ, 0DQ53ZZ, 0DQ54ZZ, 0DQ57ZZ, 0DQ58ZZ
Insertion of chest tube	34.04, 34.09	0W9930Z, 0W9B30Z, 0B9N00Z, 0B9N0ZZ, 0B9N30Z, 0B9N40Z, 0B9N4ZZ, 0B9N80Z, 0B9P00Z, 0B9P0ZZ, 0B9P30Z, 0B9P40Z, 0B9P4ZZ, 0B9P80Z, 0BCN0ZZ, 0BCN3ZZ, 0BCN4ZZ, 0BCP0ZZ, 0BCP3ZZ, 0BCP4ZZ, 0BHQ0YZ, 0BHQ3YZ, 0BHQ4YZ, 0BHQ7YZ, 0BHQ8YZ, 0W9900Z, 0W990ZZ, 0W9B00Z, 0W9B0ZZ, 0WC90ZZ, 0WC93ZZ, 0WC94ZZ, 0WCB0ZZ, 0WCB3ZZ, 0WCB4ZZ, 0WCQ0ZZ, 0WCQ3ZZ, 0WCQ4ZZ
Decortication of lung	34.51, 34.52	0BDN0ZX, 0BDN0ZZ, 0BDN3ZX, 0BDN3ZZ, 0BDP0ZX, 0BDP0ZZ, 0BDP3ZX, 0BDP3ZZ, 0BDN4ZX, 0BDN4ZZ, 0BDP4ZX, 0BDP4ZZ
Insertion of permanent tube into esophagus	42.81	0DH50DZ, 0DH53DZ, 0DH54DZ, 0DH57DZ, 0DH58DZ
Suture of laceration of esophagus	42.82	0DQ50ZZ, 0DQ53ZZ, 0DQ54ZZ, 0DQ57ZZ, 0DQ58ZZ
Gastrostomy	43.1	0DH63UZ, 0DH64UZ, 0DH60UZ
Other enterostomy	46.31, 46.32, 46.39	0DHA3UZ, 0DHA4UZ, 0DHA8UZ, 0DH80UZ, 0DH83UZ, 0DH84UZ, 0DH87UZ, 0DH88UZ, 0DH90UZ, 0DH93UZ, 0DH94UZ, 0DH97UZ, 0DH98UZ, 0DHA0UZ, 0DHA7UZ, 0DHB0UZ, 0DHB3UZ, 0DHB4UZ, 0DHB7UZ, 0DHB8UZ
Incision of mediastinum	34.1	0W9C00Z, 0W9C0ZZ, 0W9C40Z, 0W9C4ZZ, 0WCC0ZZ, 0WCC3ZZ, 0WCC4ZZ, 0WHC03Z, 0WHC0YZ
Comorbidities		
Dysphagia	787.2	R13.0, R13.10, R13.11, R13.12, R13.13, R13.14, R13.19
Tobacco use	305.1, V15.82	Z87.891, F17.200, F17.201, F17.210, F17.211, F17.220, F17.221, F17.290, F17.291, Z87.891
Alcohol use	305.00-305.03	F10.10, F10.120, F10.129, F10.11
Chronic obstructive pulmonary disease	491.0-491.9, 492.0-492.9, 496.0-496.9	J41, J42, J43, J44
Electrolyte disorders	276.0-276.9	E87
Abnormal weight loss	783.21	R63.4
Inpatient complications		
Pneumonia	480-480.9, 481, 482-482.9, 483-483.8, 485, 486, 487, 997.31	J12.0-J12.2, J12.81, J12.89, J12.9, J13, J18.1, J14, J15-J15.9, J16.0, J16.8, J18.0, J18.8, J18.9, J11.00, J11.08, J95.851
Sepsis[¶]	038-038.9, 785.52, 790.7, 995.9-995.94	A22.7, A26.7, A32.7, A40-A40.9, A41-A41.9, A42.7, A54.86, R65.1-R65.21, R78.81

[†], ICD-10-CM codes were identified using forward and backward mapping to the GEMs provided by CMS; irrelevant codes flagged through mapping were removed using clinical review; [‡], mapped to both Injury to esophagus with entry and injury to esophagus without entry; [§], mapped to both esophagostomy and esophagectomy; [¶], includes bacteremia, septicemia, SIRS, sepsis, severe sepsis, and septic shock. ICD-9-CM, International Classification of Disease, 9th revision, Clinical Modification; ICD-10-CM, International Classification of Disease, 10th revision, Clinical Modification; GEMs, general equivalence mappings; CMS, Centers for Medicare and Medicaid Services; SIRS, systemic inflammatory response syndrome.

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