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Mortality in Emergently Admitted Patients with Empyema: *An Analysis of 18,033 Adult Patients*

Lior Levy, BA,[1] Abbas Smiley, MD, MSc, PhD,[2] Rifat Latifi, MD, FACS, FKCS, FICS*[3]

1. *Medical Student, New York Medical College, Valhalla, NY.*
2. *Assistant Professor, Department of Surgery, Westchester Medical Center Health and New York Medical College, School of Medicine, Valhalla, New York*
3. *Department of Surgery, Westchester Medical Center Health, Valhalla, NY 10595, USA.*

***The Corresponding author:**
RIFAT LATIFI, MD, FACS, FICS, FKCS
Minister of Health of Kosova, Department of Surgery, Westchester Medical Center Health, Taylor Pavilion, Suite D334, 100 Woods Road, Valhalla, NY 10595, USA.
e-mail: *Rifat.Latifi@wmchealth.org*
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Abstract

Introduction: Empyema is associated with significant morbidity and mortality, if not treated properly. The aim of this study is to assess the prevalence and risk factors of mortality in emergency-admitted patients with the primary diagnosis of empyema (plural empyema), during the years 2005-2014.

Methods: This was a retrospective cohort study. Demographics and clinical data obtained from the National Inpatient Sample, 2005-2014, to evaluate non-elderly adult (18-64 years) and elderly (65+years) patients with the primary diagnosis of empyema (ICD-9 code 510) who underwent emergency hospital admission. Multivariable generalized additive model (GAM) and multivariable logistic regression model with backward elimination were used to identify association of predictors and in-hospital mortality.

Results: A total of 11,616 non-elderly adults and 6,417 elderly patients were studied. 29.4% in the non-elderly and 34.7 % in the elderly adults were females. 280 (2.4%) non-elderly adults (28.9% female), and 511 (8.0%) elderly (32.7% female), died in the hospital. The mean (SD) age of the non-elderly adults was 48 (11) years and elderly 76 (8) years. The mean (SD) age at the time of death of non-elderly adults was 54 (9) years and for elderly 79 (8) years. 30% of the deceased non-elderly adult patients and 9.3% of the survived had a fistula (P<0.001), while, 17% of the deceased and 10.2% of the survived among the elderly had a fistula (P<0.001). Mean (SD) modified frailty index in survived and deceased nonelderly adult patients was 1.22 (1.09) and 1.65 (1.06), respectively (P<0.001). Mean (SD) modified frailty index in survived and deceased elderly patients was 1.97 (1.13) and 2.14 (1.15), respectively (P<0.001). 17.2% of the non-elderly adult patients were operated on and 82.8% were not, of which 2.3% and 3% died, respectively. 15.0% of the elderly patients were operated on and 85% were not, of which, 7.9% and 8.6% died, respectively. In the final regression model, time to operation, age, modified frailty index and presence of an associated fistula, were the significant risk factors for mortalities in all patients with operation. In patients who were not operated, age significantly increased the odds of mortality. In elderly patients with no operation, presence of an associated fistula significantly increased the odds of mortality.

Conclusions: Delay in operation, age, presence of a fistula and modified frailty index were the common risk factors of mortality in operated patients with the primary diagnosis of empyema admitted emergently. In elderly patients who did not undergo an operation and were

diagnosed with an empyema, having an associated fistula also significantly predicted higher odds of mortality.

Keywords: empyema, emergency general surgery, in-hospital mortality, hospital length of stay.

Introduction

Empyema is a condition that often results from an infected parapneumonic effusion. Alternatively, it can be seen following trauma, surgery, esophageal perforation, or secondary to local spread from an adjacent subphrenic abscess or osteomyelitis. In the United States, there are approximately 32,000 cases per year. Empyema is associated with elevated morbidity and mortality. Chalmers et al., has identified seven key independent predictors that can determine patients at risk of development complicated parapneumonic effusion or empyema; low serum albumin <30 g/l, CRP >100 mg/l, platelet count >400×10^9/l, serum sodium <130 mmol/l, intravenous drug use, and chronic alcohol abuse. Additionally, Eren et al., established that prolonged duration of tube thoracostomy and length of intensive care unit stay, presence of contusion, laparotomy and retained haemothorax are independent predictors of posttraumatic empyema. When taking the proposals for empyema management guidelines issued by prolific scientific societies into consideration, it is evident that strong contradictions and interpretative limits emerge in finding the best treatment to be adopted. Interestingly, the relatively small size of existing studies has limited the ability to study rare outcomes of empyema including in-hospital mortality. Therefore, the roles of comorbidity and risk factors of in-hospital stay, are poorly known as well. Insufficient emphasis has been placed on drawing a clear patient profile, on practices for management and understanding of the clinical, and demographic difference. This data is essential to the clarity required for an early initiation of treatment, and, therefore, is a determinant of successful outcome. The variation in demographic, clinical, and hospitalization characteristics of the patients, require a thorough analysis of clinical data, management implementation, and treatment outcomes. The aim of this study is to evaluate empyema prevalence, risk factors of mortality and hospitalized patient characteristics on a larger scale, spanning over a study of 10 years.

Methods

The Healthcare Cost and Utilization Project (HCUP) was established to provide multistate, administrative, population-based data on patients in a uniform format. The data is designed for health services research to enhance health care provision. The National Inpatient Sample (NIS), a large administrative database produced by the Agency for Healthcare Research and Quality (AHRQ), has been progressively used as a country-wide publicly data source, holding much potential and support for the assessment of care patterns and research outcomes. It allows novel approaches to investigate disease conditions, optimal care, and patient outcomes. The NIS utilizes the process of weighting when generating discharge samples from community hospitals in the US, excluding rehabilitation centres, and long-term acute care facilities. This method of stratification makes it possible to make a national estimate of hospitalizations for certain factors. This retrospective cohort study extracted data on adult and elderly patients with empyema that had emergency general surgery (EGS) procedures. The sample extracted from the NIS-2005-2014. The ICD-9 code to identify patients with empyema were 510. The following characteristics of patients and hospitals were collected and analyzed: age, gender, race, income quartile, primary diagnosis, hospital ownership (government vs. private), health care insurance (Medicare, Medicaid, private insurance, self-paid, and no charge), invasive diagnostic status, surgical status, days to first procedure, hospital length of stay (HLOS), total charges and the associated comorbidities (Deficiency anemias, chronic pulmonary disease, coagulopathy, hypertension, liver disease, fluid and electrolyte disorders, metastatic cancer, renal failure, and weight loss). R software was used for statistical analysis and $p<0.01$ was set significant.

Statistical Analysis

Descriptive and analytical, statistical indicators were used to present the findings. Mean, standard deviation (SD), and confidence interval at 95% (CI) were calculated for numerical variables. The comparisons were done by $\chi 2$ test for categorical variables, by t-test for parametric continuous variables, and Mann-Whitney U test for non-parametric continuous variables. The behavior of different variables in predicting the presence of mortality was evaluated by multivariable logistic regression analysis. Backward stepwise regression analysis was used to find the final predictors of mortality in the adjusted model. The p values less than 0.05 were considered significant. All analyses were done by SPSS software version 17 (SPSS Inc., Chicago, IL).

Results

Gender Differences

Adult Group

11,616 adult patients (age 18-64) were admitted with the primary diagnosis of empyema and included in this study. This group was composed of 8,199 males (70.6%) and 3,417 females (29.4%) of a similar mean age. The mean (SD) age of the 280 patients who died during the study period of 2005-2014 was 54.03 (9.16) years old of which 199 were males (71.1%) and 81 were females (28.9%). Regardless of gender, most patients were white, of the first income quartile, funded largely by private insurance, and admitted to an urban teaching hospital (Table 1). The most pertinent comorbidities among the emergently admitted adult patients were hypertension, deficiency anemias, chronic pulmonary disease, uncomplicated diabetes, as well as fluid/electrolyte disorders. Men manifested significantly more comorbidities of alcohol abuse and liver disease while women showed more with deficiency anemias, chronic pulmonary disease, uncomplicated diabetes, metastatic cancer, obesity, and hypothyroidism. Further,

men manifested a significantly lower rate of the presence of a fistula relative to females, 9.2% vs 11.4% respectively (Table 1, p<0.001). All of the patients' characteristics and clinical data are summarized in Table 1.

Elderly Group

A total of 6,417 elderly adult patients (age 65+ years) were admitted with the primary diagnosis of empyema and included in the current study. Out of this, 4,193 were men (65.3%) and 2,224 were women (34.7%). The mean (SD) age of the female group was 76.67 (8.04), which was significantly higher than the mean age of the males at 75.49 (7.41) (p<0.001). Regardless of gender, most patients were white, of income quartile 2, funded mostly by Medicare, and admitted to an urban teaching hospital. The major comorbidities among the emergently admitted elderly patients were hypertension, chronic pulmonary disease, deficiency anemias, uncomplicated diabetes, renal failure, and fluid/electrolyte disorders. Men manifested significantly more likely to suffer from comorbidities of alcohol abuse and liver disease while women suffered from comorbidities of deficiency anemias, chronic pulmonary disease, fluid/electrolyte disorders, obesity, and hypothyroidism. These patients' characteristics and clinical data are summarized in Table 1.

Table 1. Characteristics of emergency admitted patients with the primary diagnosis of empyema. Data was stratified according to sex categories, NIS 2005-2014.

Patients' Characteristics		Adult, N (%)			Elderly, N (%)		
		Male	Female	p	Male	Female	p
All Cases		8,199	3,417		4,193	2,224	
		(70.6%)	(29.4%)		(65.3%)	(34.7%)	
Race	**White**	5,084	2,220	**<0.001**	3,018	1,627	0.150
		(72.6%)	(76.5%)		(83.9%)	(86.2%)	
	Black	805	338		219	104	
		(11.5%)	(11.6%)		(6.1%)	(5.5%)	
	Hispanic	722	209		174	78	
		(10.3%)	(7.2%)		(4.8%)	(4.1%)	
	Asian/Pacific Islander	137	44		93	34	
		(2.0%)	(1.5%)		(2.6%)	(1.8%)	
	Native American	61	18		19	5	
		(0.9%)	(0.6%)		(0.5%)	(0.3%)	
	Other	197	74		72	40	
		(2.8%)	(2.5%)		(2.0%)	(2.1%)	
Income Quartile	**Quartile 1**	2,356	938	0.340	955	482	0.670
		(29.5%)	(28.1%)		(23.3%)	(22.1%)	
	Quartile 2	2,144	900		1,080	586	
		(26.8%)	(27.0%)		(26.4%)	(26.9%)	
	Quartile 3	1,959	864		1,052	553	
		(24.5%)	(25.9%)		(25.7%)	(25.4%)	
	Quartile 4	1,530	636		1,010	557	
		(19.2%)	(19.1%)		(24.7%)	(25.6%)	

Patients' Characteristics		Adult, N (%)			Elderly, N (%)		
		Male	Female	p	Male	Female	p
Insurance	Private Insurance	3,380 (41.4%)	1,515 (44.5%)	<0.001	375 (9.0%)	160 (7.2%)	0.007
	Medicare	1,341 (16.4%)	643 (18.9%)		3,686 (88.1%)	2,017 (90.8%)	
	Medicaid	1,401 (17.1%)	707 (20.8%)		53 (1.3%)	24 (1.1%)	
	Self-Pay	1,334 (16.3%)	347 (10.2%)		22 (0.5%)	5 (0.2%)	
	No Charge	166 (2.0%)	57 (1.7%)		0 (0%)	0 (0%)	
	Other	551 (6.7%)	137 (4.0%)		50 (1.2%)	15 (0.7%)	
Hospital Location	Rural	667 (8.1%)	273 (8.0%)	0.970	390 (9.3%)	200 (9.0%)	0.840
	Urban: Non-Teaching	3,074 (37.5%)	1,283 (37.5%)		1,739 (41.5%)	914 (41.1%)	
	Urban: Teaching	4,458 (54.4%)	1,861 (54.5%)		2,064 (49.2%)	1,110 (49.9%)	
Comorbidities	AIDS	67 (0.8%)	22 (0.6%)	0.330	0 (0%)	1 (0.0%)	0.350
	Alcohol Abuse	1,067 (13.0%)	167 (4.9%)	<0.001	177 (4.2%)	30 (1.3%)	<0.001
	Deficiency Anemias	2,587 (31.6%)	1,326 (38.8%)	<0.001	1,518 (36.2%)	868 (39.0%)	0.026
	Rheumatoid Arthritis	151 (1.8%)	183 (5.4%)	<0.001	143 (3.4%)	157 (7.1%)	<0.001
	Chronic Blood Loss	109 (1.3%)	62 (1.8%)	0.048	72 (1.7%)	48 (2.2%)	0.210
	Congestive Heart Failure	531 (6.5%)	220 (6.4%)	0.940	950 (22.7%)	492 (22.1%)	0.630
	Chronic Pulmonary	2,222	1,081	<0.001	1,847	812	<0.001

Patients' Characteristics	Adult, N (%)			Elderly, N (%)		
	Male	Female	p	Male	Female	p
Pulmonary Disease	(27.1%)	(31.6%)	**<0.001**	(44.0%)	(36.5%)	**<0.001**
Coagulopathy	438 (5.3%)	191 (5.6%)	0.590	236 (5.6%)	124 (5.6%)	0.930
Depression	688 (8.4%)	526 (15.4%)	**<0.001**	345 (8.2%)	300 (13.5%)	**<0.001**
Diabetes, Uncomplicated	1,402 (17.1%)	498 (14.6%)	**0.001**	914 (21.8%)	396 (17.8%)	**<0.001**
Diabetes, Chronic Complications	317 (3.9%)	114 (3.3%)	0.170	187 (4.5%)	78 (3.5%)	0.070
Drug Abuse	770 (9.4%)	272 (8.0%)	**0.014**	31 (0.7%)	13 (0.6%)	0.480
Hypertension	2,983 (36.4%)	1,178 (34.5%)	0.051	2,454 (58.5%)	1,336 (60.1%)	0.230
Hypothyroidism	316 (3.9%)	380 (11.1%)	**<0.001**	377 (9.0%)	438 (19.7%)	**<0.001**
Liver Disease	637 (7.8%)	197 (5.8%)	**<0.001**	110 (2.6%)	47 (2.1%)	0.210
Lymphoma	71 (0.9%)	29 (0.8%)	0.930	85 (2.0%)	43 (1.9%)	0.800
Fluid/Electrolyte Disorders	2,956 (36.1%)	1,317 (38.5%)	**0.011**	1,639 (39.1%)	990 (44.5%)	**<0.001**
Metastatic Cancer	309 (3.8%)	221 (6.5%)	**<0.001**	251 (6.0%)	136 (6.1%)	0.840
Other Neurological Disorders	486 (5.9%)	252 (7.4%)	**0.004**	342 (8.2%)	190 (8.5%)	0.590
Obesity	778 (9.5%)	509 (14.9%)	**<0.001**	195 (4.7%)	167 (7.5%)	**<0.001**
Paralysis	147 (1.8%)	64 (1.9%)	0.770	97 (2.3%)	39 (1.8%)	0.140
Peripheral	181	35		390	106	

Patients' Characteristics		Adult, N (%)			Elderly, N (%)		
		Male	Female	p	Male	Female	p
	Vascular Disorders	(2.2%)	(1.0%)	**<0.001**	(9.3%)	(4.8%)	**<0.001**
	Psychoses	527	295	**<0.001**	135	96	**0.025**
	Pulmonary Circulation Disorders	226 (2.8%)	133 (3.9%)	**0.001**	237 (5.7%)	139 (6.3%)	0.330
	Renal Failure	562 (6.9%)	233 (6.8%)	0.950	764 (18.2%)	324 (14.6%)	**<0.001**
	Solid Tumor	284 (3.5%)	142 (4.2%)	0.070	406 (9.7%)	138 (6.2%)	**<0.001**
	Peptic Ulcer	0 (0%)	0 (0%)		1 (0.0%)	1 (0.0%)	0.999
	Valvular Disease	193 (2.4%)	103 (3.0%)	**0.040**	360 (8.6%)	182 (8.2%)	0.580
	Weight Loss	1,344 (16.4%)	586 (17.1%)	0.320	1,024 (24.4%)	520 (23.4%)	0.350
Empyema	Without Fistula	7,448 (90.8%)	3,029 (88.6%)	**<0.001**	3,715 (88.6%)	2,015 (90.6%)	**0.014**
	With Fistula	751 (9.2%)	388 (11.4%)		478 (11.4%)	209 (9.4%)	
Invasive Diagnostic Procedure		2,550 (31.1%)	1,088 (31.8%)	0.430	1,230 (29.3%)	586 (26.3%)	**0.012**
Surgical Procedure		1,418 (17.3%)	587 (17.2%)	0.880	638 (15.2%)	322 (14.5%)	0.430
Invasive or Surgical Procedure		3,010 (36.7%)	1,301 (38.1%)	0.170	1,427 (34.0%)	690 (31.0%)	**0.015**
Deceased		199 (2.4%)	81 (2.4%)	0.860	344 (8.2%)	167 (7.5%)	0.330
		Mean (SD)	**Mean (SD)**	**P**	**Mean (SD)**	**Mean (SD)**	**p**
Age, Years		48.11 (11.44)	48.82 (11.38)	**0.001**	75.49 (7.41)	76.67 (8.04)	**<0.001**
Modified Frailty Index Score		1.23	1.26		2.04	1.87	

Patients' Characteristics	Adult, N (%)			Elderly, N (%)		
	Male	Female	p	Male	Female	p
Time to Invasive Diagnostic Procedure, Days	4.40 (4.65)	4.28 (4.48)	0.380	4.90 (5.33)	5.42 (5.58)	**0.004**
Time to Surgical Procedure, Days	2.16 (3.05)	2.30 (3.13)	0.100	2.31 (3.06)	2.46 (3.08)	0.130
Hospital Length of Stay, Days	12.06 (9.20)	12.51 (9.97)	**0.015**	13.11 (10.80)	12.65 (9.93)	0.530
Total Charges, Dollars	94,217 (104,502)	95,800 (112,281)	0.860	95,220 (101,345)	94,426 (105,689)	0.220

Mortality

Adult Group

97.6% of adult patients survived and 2.4% did not. The mean (SD) age of those who survived was 48.17 (11.44) years, of whom 8,285 were males (70.6%) and 3,331 were females (29.4%) with a similar mean age. The mean (SD) age of the 280 patients who died during the study period was significantly higher in comparison to the patients who survived, at 54.03 (9.16) and 48.17 (11.44) years old, respectively. 199 were males (71.1%) and 81 were females (28.9%), with a similar mean age. By comparing deceased to survived patients, significant differences can be seen in certain comorbidities. The deceased manifested with significantly higher rates of comorbidities of congestive heart failure, coagulopathy, liver disease, pulmonary circulation disorders, fluid/electrolyte disorders, metastatic cancer, solid tumor, renal failure, and weight loss. More of the deceased had a fistula compared to the survived group at 30% vs 9.3%, respectively (P<0.001). Another finding was that the hospital length of stay was significantly higher in the deceased vs. survived groups at 15.14 days vs. 3.07 days, respectively. (P<0.001). Patients' characteristics and clinical data can be found in Table 2.

Elderly Group

5,898 (92.0%) elderly patients lived and 511 (8.0%) died. The mean (SD) age of the deceased was significantly higher in comparison to the survived group, 78.70 (8.18) vs. 75.66 (7.56) years, respectively (P<0.001). In the survived patient group, 2,053 (34.8%) were women and 3,845 (65.2%) were men. The deceased group was composed of 167(32.7%) females and 344 (67.3%) males. When comparing deceased to survived patients, differences in co-morbidities were noticed. The deceased manifested higher rates of comorbidities such as: congestive heart failure, coagulopathy, fluid/electrolyte disorders, renal failure, and weight loss (P<0.001). Similarly, the deceased had higher rates of fistulas (17.0% vs. 10.2%, respectively) and a longer time of invasive diagnostic procedure (7.48 days vs. 4.85 days, respectively (P<0.001) relative to the survived group. Table 2 summarizes these patients' characteristics and clinical data.

Table 2. Characteristics of emergency admitted patients with the primary diagnosis of empyema. Data was classified according to outcome categories, NIS 2005-2014.

Patients' Characteristics	Adult, N (%)			Elderly, N (%)		
	Survived	Deceased	p	Survived	Deceased	p
All Cases	11,329 (97.6%)	280 (2.4%)		5,898 (92.0%)	511 (8.0%)	
Sex, Female	3,331 (29.4%)	81 (28.9%)	0.860	2,053 (34.8%)	167 (32.7%)	0.330
White	7,140 (73.9%)	156 (65.3%)		4,267 (84.8%)	374 (84.0%)	
Black	1,104	39		301	22	

Patients' Characteristics		Adult, N (%)			Elderly, N (%)		
		Survived	Deceased	p	Survived	Deceased	p
Race	Hispanic	(11.4%) 902	(16.3%) 26	**0.025**	(6.0%) 238	(4.9%) 14	**0.022**
	Asian/Pacific Islander	(9.3%) 175	(10.9%) 5		(4.7%) 112	(3.1%) 15	
	Native American	(1.8%) 78 (0.8%)	(2.1%) 1 (0.4%)		(2.2%) 21 (0.4%)	(3.4%) 3 (0.7%)	
	Other	259 (2.7%)	12 (5.0%)		95 (1.9%)	17 (3.8%)	
Income Quartile	Quartile 1	3,199 (29.0%)	92 (33.6%)	0.310	1,309 (22.7%)	127 (25.3%)	0.370
	Quartile 2	2,968 (26.9%)	74 (27.0%)		1,545 (26.8%)	121 (24.1%)	
	Quartile 3	2,755 (24.9%)	64 (23.4%)		1,477 (25.6%)	123 (24.5%)	
	Quartile 4	2,123 (19.2%)	44 (16.1%)		1,434 (24.9%)	131 (26.1%)	
Insurance	Private Insurance	4,793 (42.4%)	100 (35.8%)	**<0.001**	503 (8.5%)	29 (5.7%)	0.140
	Medicare	1,911 (16.9%)	71 (25.4%)		5,232 (88.9%)	466 (91.2%)	
	Medicaid	2,040 (18.1%)	66 (23.7%)		69 (1.2%)	8 (1.6%)	
	Self-Pay	1,655 (14.7%)	26 (9.3%)		24 (0.4%)	3 (0.6%)	
	No Charge	219 (1.9%)	3 (1.1%)		0 (0%)	0 (0%)	
	Other	675 (6.0%)	13 (4.7%)		60 (1.0%)	5 (1.0%)	
Hospital Location	Rural	918 (8.1%)	21 (7.5%)	**0.014**	537 (9.1%)	53 (10.4%)	0.550
	Urban: Non-Teaching	4,270 (37.7%)	83 (29.6%)		2,446 (41.5%)	203 (39.7%)	

Patients' Characteristics		Adult, N (%)			Elderly, N (%)		
		Survived	Deceased	p	Survived	Deceased	p
Comorbidities	Urban: Teaching	6,141 (54.2%)	176 (62.9%)		2,915 (49.4%)	255 (49.9%)	
	AIDS	85 (0.8%)	4 (1.4%)	0.170	0 (0%)	1 (0.2%)	0.080
	Alcohol Abuse	1,198 (10.6%)	32 (11.4%)	0.650	187 (3.2%)	20 (3.9%)	0.360
	Deficiency Anemias	3,844 (33.9%)	66 (23.6%)	**<0.001**	2,225 (37.7%)	159 (31.1%)	**0.003**
	Rheumatoid Arthritis	322 (2.8%)	12 (4.3%)	0.150	284 (4.8%)	16 (3.1%)	0.080
	Chronic Blood Loss	170 (1.5%)	1 (0.4%)	0.130	113 (1.9%)	7 (1.4%)	0.380
	Congestive Heart Failure	699 (6.2%)	49 (17.5%)	**<0.001**	1,270 (21.5%)	172 (33.7%)	**<0.001**
	Chronic Pulmonary Disease	3,221 (28.4%)	78 (27.9%)	0.830	2,463 (41.8%)	193 (37.8%)	0.080
	Coagulopathy	577 (5.1%)	51 (18.2%)	**<0.001**	306 (5.2%)	54 (10.6%)	**<0.001**
	Depression	1,197 (10.6%)	17 (6.1%)	**0.015**	604 (10.2%)	41 (8.0%)	0.110
	Diabetes, Uncomplicated	1,869 (16.5%)	29 (10.4%)	**0.006**	1,218 (20.7%)	92 (18.0%)	0.160
	Diabetes, Chronic Complications	417 (3.7%)	14 (5.0%)	0.250	239 (4.1%)	26 (5.1%)	0.260
	Drug Abuse	1,033 (9.1%)	8 (2.9%)	**<0.001**	42 (0.7%)	2 (0.4%)	0.580
	Hypertension	4,076 (36.0%)	82 (29.3%)	**0.021**	3,518 (59.6%)	268 (52.4%)	**0.001**
	Hypothyroidism	682 (6.0%)	14 (5.0%)	0.480	758 (12.9%)	57 (11.2%)	0.270
	Liver Disease	781 (6.9%)	52 (18.6%)	**<0.001**	142 (2.4%)	15 (2.9%)	0.460

Patients' Characteristics		Adult, N (%)			Elderly, N (%)		
		Survived	Deceased	p	Survived	Deceased	p
Empyema	Lymphoma	97 (0.9%)	3 (1.1%)	0.520	111 (1.9%)	17 (3.3%)	**0.025**
	Fluid/Electrolyte Disorders	4,113 (36.3%)	153 (54.6%)	**<0.001**	2,352 (39.9%)	273 (53.4%)	**<0.001**
	Metastatic Cancer	480 (4.2%)	49 (17.5%)	**<0.001**	340 (5.8%)	46 (9.0%)	**0.003**
	Other Neurological Disorders	710 (6.3%)	28 (10.0%)	**0.011**	492 (8.3%)	39 (7.6%)	0.580
	Obesity	1,277 (11.3%)	9 (3.2%)	**<0.001**	343 (5.8%)	19 (3.7%)	**0.049**
	Paralysis	191 (1.7%)	20 (7.1%)	**<0.001**	122 (2.1%)	14 (2.7%)	0.310
	Peripheral Vascular Disorders	204 (1.8%)	11 (3.9%)	**0.009**	447 (7.6%)	49 (9.6%)	0.100
	Psychoses	811 (7.2%)	11 (3.9%)	**0.037**	214 (3.6%)	17 (3.3%)	0.730
	Pulmonary Circulation Disorders	338 (3.0%)	21 (7.5%)	**<0.001**	340 (5.8%)	35 (6.8%)	0.320
	Renal Failure	762 (6.7%)	32 (11.4%)	**0.002**	942 (16.0%)	145 (28.4%)	**<0.001**
	Solid Tumor	393 (3.5%)	33 (11.8%)	**<0.001**	486 (8.2%)	58 (11.4%)	**0.016**
	Peptic Ulcer	0 (0%)	0 (0%)		2 (0.0%)	0 (0%)	0.999
	Valvular Disease	284 (2.5%)	11 (3.9%)	0.140	487 (8.3%)	55 (10.8%)	0.051
	Weight Loss	1,832 (16.2%)	94 (33.6%)	**<0.001**	1,380 (23.4%)	160 (31.3%)	**<0.001**
	Without Fistula	10,274 (90.7%)	196 (70.0%)	**<0.001**	5,299 (89.8%)	424 (83.0%)	**<0.001**
	With Fistula	1,055 (9.3%)	84 (30.0%)		599 (10.2%)	87 (17.0%)	

Patients' Characteristics	Adult, N (%)			Elderly, N (%)		
	Survived	Deceased	p	Survived	Deceased	p
Invasive Diagnostic Procedure	3,555 (31.4%)	80 (28.6%)	0.320	1,670 (28.3%)	143 (28.0%)	0.870
Surgical Procedure	1,942 (17.1%)	61 (21.8%)	**0.042**	877 (14.9%)	82 (16.0%)	0.470
Invasive or Surgical Procedure	4,206 (37.1%)	101 (36.1%)	0.720	1,946 (33.0%)	167 (32.7%)	0.890
	Mean (SD)	**Mean (SD)**	**p**	**Mean (SD)**	**Mean (SD)**	**p**
Age, Years	48.17 (11.44)	54.03 (9.16)	**<0.001**	75.66 (7.56)	78.70 (8.18)	**<0.001**
Modified Frailty Index Score	1.22 (1.09)	1.65 (1.06)	**<0.001**	1.97 (1.13)	2.14 (1.15)	**<0.001**
Time to Invasive Diagnostic Procedure, Days	4.29 (4.43)	7.63 (9.33)	**0.007**	4.85 (5.19)	7.48 (7.07)	**<0.001**
Time to First Surgical Procedure, Days	2.18 (2.99)	3.20 (5.70)	0.340	2.33 (3.01)	2.79 (3.69)	**0.031**
Hospital Length of Stay, Days	12.07 (9.15)	16.57 (16.79)	**0.030**	12.74 (9.68)	15.40 (17.29)	0.600
Total Charges, Dollars	92,277 (100,826)	190,996 (230,462)	**<0.001**	91,277 (95,230)	138,329 (162,229)	**<0.001**

Operation vs. No Operation

Adult Group

The stratified analysis, based on the surgical procedure status, is presented in Table 3. 2,005 (17.2%) adult patients had a surgical procedure. Most patients were males. The racial breakdown, by proportion of cases in decreasing order was White, Black, Hispanic, Asian/Pacific Islander, and Native American. Regardless of the gender, most patients were of income quartile 1 and were funded mostly by private insurance. A significantly higher rate of the surgery patient group was admitted to urban teaching hospitals, who were not operated on. In the surgical procedure group, the rate of the comorbidities of weight loss and fluid/electrolyte disorders, was significantly higher in comparison to the non-operated patients. They furthermore manifested higher rates of fistula compared to the latter group. The operated patient sample also underwent a significantly higher rate of invasive diagnostic procedure in comparison to the non-surgical procedure group as well as a significantly longer HLOS. Patients' characteristics and clinical data are found in Table 3.

Elderly Group

The stratified analysis, based on the surgery status, is presented in Table 3. 960 (15.0%) elderly patients had a surgery. Most patients were males, and the racial breakdown, by proportion of cases in decreasing order was White, Black, Hispanic, Asian/Pacific Islander, and Native American. Higher proportion of the surgery procedure group were admitted to urban teaching hospitals. In the group that had a surgical procedure, the rate of comorbidity with renal failure was significantly higher in comparison to the non-surgery procedure group. They furthermore manifested higher rate of fistula, higher rate of invasive diagnostic procedure, and longer HLOS. Patients' characteristics and clinical data are summarized in Table 3.

Table 3. Characteristics of emergency admitted patients with the primary diagnosis of empyema. Data was stratified according to surgery status, NIS 2005-2014.

Patients' Characteristics		Adult, N (%)			Elderly, N (%)		
		No Surgery	Surgery	p	No Surgery	Surgery	p
All Cases		9,619 (82.8%)	2,005 (17.2%)		5,457 (85.0%)	960 (15.0%)	
Sex, Female		2,830 (29.4%)	587 (29.3%)	0.880	1,902 (34.9%)	322 (33.5%)	0.430
Race	**White**	6,067 (74.0%)	1,237 (72.2%)	**0.014**	3,946 (84.8%)	699 (84.5%)	0.998
	Black	919 (11.2%)	224 (13.1%)		275 (5.9%)	48 (5.8%)	
	Hispanic	791 (9.7%)	140 (8.2%)		213 (4.6%)	39 (4.7%)	
	Asian/Pacific Islander	146 (1.8%)	35 (2.0%)		107 (2.3%)	20 (2.4%)	
	Native American	61 (0.7%)	18 (1.1%)		21 (0.5%)	3 (0.4%)	
	Other	212 (2.6%)	59 (3.4%)		94 (2.0%)	18 (2.2%)	
Income Quartile	**Quartile 1**	2,743 (29.3%)	551 (28.1%)	0.080	1,231 (23.0%)	206 (22.1%)	0.170
	Quartile 2	2,552 (27.2%)	496 (25.3%)		1,438 (26.9%)	228 (24.5%)	
	Quartile 3	2,316 (24.7%)	507 (25.9%)		1,365 (25.5%)	240 (25.8%)	
	Quartile 4	1,764 (18.8%)	405 (20.7%)		1,310 (24.5%)	257 (27.6%)	
Insurance	**Private Insurance**	3,982 (41.5%)	916 (45.8%)	**0.001**	452 (8.3%)	83 (8.7%)	0.620
	Medicare	1,673 (17.5%)	312 (15.6%)		4,855 (89.1%)	848 (88.4%)	
	Medicaid	1,730 (18.0%)	379 (19.0%)		63 (1.2%)	14 (1.5%)	
	Self-Pay	1,430 (14.9%)	251 (12.6%)		25 (0.5%)	2 (0.2%)	

Patients' Characteristics		Adult, N (%)			Elderly, N (%)		
		No Surgery	Surgery	p	No Surgery	Surgery	p
Hospital Location	No Charge	186 (1.9%)	37 (1.9%)		0 (0%)	0 (0%)	
	Other	586 (6.1%)	105 (5.3%)		53 (1.0%)	12 (1.3%)	
	Rural	835 (8.7%)	105 (5.2%)		536 (9.8%)	54 (5.6%)	
	Urban: Non-Teaching	3,609 (37.5%)	751 (37.5%)	**<0.001**	2,249 (41.2%)	404 (42.1%)	**<0.001**
	Urban: Teaching	5,175 (53.8%)	1,149 (57.3%)		2,672 (49.0%)	502 (52.3%)	
Comorbidities	AIDS	73 (0.8%)	16 (0.8%)	0.860	1 (0.0%)	0 (0%)	0.999
	Alcohol Abuse	1,010 (10.5%)	224 (11.2%)	0.370	183 (3.4%)	24 (2.5%)	0.170
	Deficiency Anemias	3,224 (33.5%)	689 (34.4%)	0.470	2,047 (37.5%)	339 (35.3%)	0.190
	Rheumatoid Arthritis	268 (2.8%)	66 (3.3%)	0.220	251 (4.6%)	49 (5.1%)	0.500
	Chronic Blood Loss	134 (1.4%)	37 (1.8%)	0.130	103 (1.9%)	17 (1.8%)	0.810
	Congestive Heart Failure	624 (6.5%)	127 (6.3%)	0.800	1,253 (23.0%)	189 (19.7%)	**0.025**
	Chronic Pulmonary Disease	2,672 (27.8%)	631 (31.5%)	**0.001**	2,233 (40.9%)	426 (44.4%)	**0.045**
	Coagulopathy	519 (5.4%)	110 (5.5%)	0.870	303 (5.6%)	57 (5.9%)	0.630
	Depression	1,017 (10.6%)	197 (9.8%)	0.320	551 (10.1%)	94 (9.8%)	0.770
	Diabetes, Uncomplicated	1,581 (16.4%)	320 (16.0%)	0.600	1,102 (20.2%)	208 (21.7%)	0.300
	Diabetes, Chronic Complications	365 (3.8%)	66 (3.3%)	0.280	232 (4.3%)	33 (3.4%)	0.240

Patients' Characteristics	Adult, N (%)			Elderly, N (%)		
	No Surgery	Surgery	p	No Surgery	Surgery	p
Drug Abuse	872 (9.1%)	170 (8.5%)	0.400	31 (0.6%)	13 (1.4%)	**0.006**
Hypertension	3,472 (36.1%)	689 (34.4%)	0.140	3,268 (59.9%)	522 (54.4%)	**0.001**
Hypothyroidism	575 (6.0%)	121 (6.0%)	0.920	699 (12.8%)	116 (12.1%)	0.530
Liver Disease	703 (7.3%)	131 (6.5%)	0.220	144 (2.6%)	13 (1.4%)	**0.018**
Lymphoma	83 (0.9%)	17 (0.8%)	0.950	108 (2.0%)	20 (2.1%)	0.830
Fluid/Electrolyte Disorders	3,461 (36.0%)	812 (40.5%)	**<0.001**	2,214 (40.6%)	415 (43.2%)	0.120
Metastatic Cancer	443 (4.6%)	87 (4.3%)	0.600	339 (6.2%)	48 (5.0%)	0.150
Other Neurological Disorders	623 (6.5%)	115 (5.7%)	0.220	462 (8.5%)	70 (7.3%)	0.220
Obesity	1,088 (11.3%)	199 (9.9%)	0.070	303 (5.6%)	59 (6.1%)	0.460
Paralysis	189 (2.0%)	22 (1.1%)	**0.008**	113 (2.1%)	33 (2.4%)	0.520
Peripheral Vascular Disorders	179 (1.9%)	37 (1.8%)	0.960	426 (7.8%)	70 (7.3%)	0.580
Psychoses	680 (7.1%)	142 (7.1%)	0.980	184 (3.4%)	47 (4.9%)	**0.019**
Pulmonary Circulation Disorders	282 (2.9%)	77 (3.8%)	**0.032**	329 (6.0%)	47 (4.9%)	0.170
Renal Failure	659 (6.9%)	136 (6.8%)	0.910	967 (17.7%)	121 (12.6%)	**<0.001**
Solid Tumor	358	68	0.470	467	77	0.580

Patients' Characteristics		Adult, N (%)			Elderly, N (%)		
		No Surgery	Surgery	p	No Surgery	Surgery	p
	Peptic Ulcer	0 (0%)	0 (0%)		2 (0.0%)	0 (0%)	0.999
	Valvular Disease	243 (2.5%)	53 (2.6%)	0.760	472 (8.6%)	70 (7.3%)	0.160
	Weight Loss	1,504 (15.6%)	426 (21.2%)	**<0.001**	1,305 (23.9%)	239 (24.9%)	0.510
Empyema	**Without Fistula**	8,784 (91.3%)	1,700 (84.8%)	**<0.001**	4,935 (90.4%)	795 (82.8%)	**<0.001**
	With Fistula	835 (8.7%)	305 (15.2%)		522 (9.6%)	165 (17.2%)	
Invasive Diagnostic Procedure		2,307 (24.0%)	1,332 (66.4%)	**<0.001**	1,157 (21.2%)	659 (68.6%)	**<0.001**

Fistula Status

Adult Group

Table 4 presents the stratified analysis, based on fistula status. 1,140 (9.8%) adult patients had fistula. The mean age of the fistula group was significantly higher in comparison to the non-fistula group. The fistula group had higher rate of comorbidities such as chronic pulmonary disease, metastatic cancer, solid tumor, weight loss and obesity. They furthermore manifested higher rates of invasive or surgical procedure compared to the non-fistula group as well as longer time to their first procedure, higher mortality rate and a longer HLOS. Patient characteristics and clinical data are summarized in Table 4.

Elderly Group

The stratified analysis, based on the fistula status, is presented in Table 4. 687 (10.7%) elderly patients had fistula. The mean age of the fistula group was significantly lower in comparison to the non-fistula group. The fistula group had higher rate of comorbidities with solid tumour and weight loss. They, furthermore, manifested a higher rate of invasive or surgical procedure compared to the other groups, and higher rate of mortality. Patients' characteristics and clinical data are summarized in Table 4.

Table 4. Characteristics of emergency admitted patients with the primary diagnosis of empyema. Data was stratified according to fistula status, NIS 2005-2014.

Patients' Characteristics		Adult, N (%)			Elderly, N (%)		
		No Fistula	Fistula	p	No Fistula	Fistula	p
All Cases		10,484 (90.2%)	1,140 (9.8%)		5,730 (89.3%)	687 (10.7%)	
Sex, Female		3,029 (28.9%)	388 (34.1%)	**<0.001**	2,015 (35.2%)	209 (30.4%)	**0.014**
Race	**White**	6,619 (74.0%)	685 (71.1%)		4,146 (84.9%)	499 (83.6%)	
	Black	1,007 (11.3%)	136 (14.1%)	0.110	283 (5.8%)	40 (6.7%)	0.930
	Hispanic	841 (9.4%)	90 (9.3%)		224 (4.6%)	28 (4.7%)	

Patients' Characteristics		Adult, N (%)			Elderly, N (%)		
		No Fistula	Fistula	p	No Fistula	Fistula	p
Income Quartile	Asian/Pacific Islander	160 (1.8%)	21 (2.2%)	0.390	113 (2.3%)	14 (2.3%)	0.170
	Native American	74 (0.8%)	5 (0.5%)		22 (0.5%)	2 (0.3%)	
	Other	244 (2.7%)	27 (2.8%)		98 (2.0%)	14 (2.3%)	
	Quartile 1	2,982 (29.2%)	312 (28.2%)		1,268 (22.6%)	169 (25.2%)	
	Quartile 2	2,727 (26.7%)	321 (29.0%)		1,481 (26.4%)	185 (27.6%)	
	Quartile 3	2,560 (25.0%)	263 (23.8%)		1,455 (26.0%)	150 (22.4%)	
	Quartile 4	1,958 (19.1%)	211 (19.1%)		1,401 (25.0%)	166 (24.8%)	
Insurance	Private Insurance	4,411 (42.2%)	487 (42.8%)	**<0.001**	484 (8.5%)	51 (7.4%)	0.520
	Medicare	1,778 (17.0%)	207 (18.2%)		5,086 (88.9%)	617 (89.8%)	
	Medicaid	1,861 (17.8%)	248 (21.8%)		66 (1.2%)	11 (1.6%)	
	Self-Pay	1,583 (15.1%)	98 (8.6%)		26 (0.5%)	1 (0.1%)	
	No Charge	211 (2.0%)	12 (1.1%)		0 (0%)	0 (0%)	
	Other	605 (5.8%)	86 (7.6%)		58 (1.0%)	7 (1.0%)	
Hospital Location	Rural	866 (8.3%)	74 (6.5%)	**<0.001**	547 (9.5%)	43 (6.3%)	**0.001**
	Urban: Non-Teaching	3,990 (38.1%)	370 (32.5%)		2,390 (41.7%)	263 (38.3%)	
	Urban: Teaching	5,628 (53.7%)	696 (61.1%)		2,793 (48.7%)	381 (55.5%)	

Patients' Characteristics		Adult, N (%)			Elderly, N (%)		
		No Fistula	Fistula	p	No Fistula	Fistula	p
Comorbidities	AIDS	74 (0.7%)	15 (1.3%)	**0.025**	1 (0.0%)	0 (0%)	0.999
	Alcohol Abuse	1,133 (10.8%)	101 (8.9%)	**0.043**	188 (3.3%)	19 (2.8%)	0.470
	Deficiency Anemias	3,547 (33.8%)	366 (32.1%)	0.240	2,177 (38.0%)	209 (30.4%)	**<0.001**
	Rheumatoid Arthritis	275 (2.6%)	59 (5.2%)	**<0.001**	276 (4.8%)	24 (3.5%)	0.120
	Chronic Blood Loss	152 (1.4%)	19 (1.7%)	0.560	114 (2.0%)	6 (0.9%)	**0.041**
	Congestive Heart Failure	692 (6.6%)	59 (5.2%)	0.060	1,345 (23.5%)	97 (14.1%)	**<0.001**
	Chronic Pulmonary Disease	2,825 (26.9%)	478 (41.9%)	**<0.001**	2,275 (39.7%)	384 (55.9%)	**<0.001**
	Coagulopathy	565 (5.4%)	64 (5.6%)	0.750	326 (5.7%)	34 (4.9%)	0.430
	Depression	1,100 (10.5%)	114 (10.0%)	0.610	590 (10.3%)	55 (8.0%)	0.060
	Diabetes, Uncomplicated	1,743 (16.6%)	158 (13.9%)	**0.016**	1,183 (20.6%)	127 (18.5%)	0.190
	Diabetes, Chronic Complications	406 (3.9%)	25 (2.2%)	**0.004**	245 (4.3%)	20 (2.9%)	0.090
	Drug Abuse	969 (9.2%)	73 (6.4%)	**0.001**	36 (0.6%)	8 (1.2%)	0.110
	Hypertension	3,801 (36.3%)	360 (31.6%)	**0.002**	3,429 (59.8%)	361 (52.5%)	**<0.001**
	Hypothyroidism	620 (5.9%)	76 (6.7%)	0.310	756 (13.2%)	59 (8.6%)	**0.001**
	Liver Disease	757 (7.2%)	77 (6.8%)	0.560	138 (2.4%)	19 (2.8%)	0.570
	Lymphoma	85 (0.8%)	15 (1.3%)	0.080	122 (2.1%)	6 (0.9%)	**0.026**
	Fluid/Electrolyte Disorders	3,855 (36.8%)	418 (36.7%)	0.950	2,398 (41.8%)	231 (33.6%)	**<0.001**

Patients' Characteristics	Adult, N (%)			Elderly, N (%)		
	No Fistula	Fistula	p	No Fistula	Fistula	p
Metastatic Cancer	383 (3.7%)	147 (12.9%)	**<0.001**	305 (5.3%)	82 (11.9%)	**<0.001**
Other Neurological Disorders	678 (6.5%)	60 (5.3%)	0.110	491 (8.6%)	41 (6.0%)	**0.019**
Obesity	1,227 (11.7%)	60 (5.3%)	**<0.001**	346 (6.0%)	16 (2.3%)	**<0.001**
Paralysis	195 (1.9%)	16 (1.4%)	0.270	127 (2.2%)	9 (1.3%)	0.120
Peripheral Vascular Disorders	186 (1.8%)	30 (2.6%)	**0.042**	447 (7.8%)	49 (7.1%)	0.540
Psychoses	756 (7.2%)	66 (5.8%)	0.080	202 (3.5%)	29 (4.2%)	0.360
Pulmonary Circulation Disorders	314 (3.0%)	45 (3.9%)	0.080	334 (5.8%)	42 (6.1%)	0.760
Renal Failure	736 (7.0%)	59 (5.2%)	**0.019**	1,024 (17.9%)	64 (9.3%)	**<0.001**
Solid Tumor	301 (2.9%)	125 (11.0%)	**<0.001**	402 (7.0%)	142 (20.7%)	**<0.001**
Peptic Ulcer	0 (0%)	0 (0%)		2 (0.0%)	0 (0%)	0.999
Valvular Disease	271 (2.6%)	25 (2.2%)	0.430	509 (8.9%)	33 (4.8%)	**<0.001**
Weight Loss	1,605 (15.3%)	325 (28.5%)	**<0.001**	1,354 (23.6%)	190 (27.7%)	**0.020**
Invasive Diagnostic Procedure	3,223 (30.7%)	416 (36.5%)	**<0.001**	1,566 (27.3%)	250 (36.4%)	**<0.001**
Surgical Procedure	1,700 (16.2%)	305 (26.8%)	**<0.001**	795 (13.9%)	165 (24.0%)	**<0.001**
Invasive or Surgical Procedure	3,761 (35.9%)	551 (48.3%)	**<0.001**	1,801 (31.4%)	316 (46.0%)	**<0.001**

Patients' Characteristics	Adult, N (%)			Elderly, N (%)		
	No Fistula	Fistula	p	No Fistula	Fistula	p
Valvular Disease	271 (2.6%)	25 (2.2%)	0.430	509 (8.9%)	33 (4.8%)	**<0.001**
Weight Loss	1,605 (15.3%)	325 (28.5%)	**<0.001**	1,354 (23.6%)	190 (27.7%)	**0.020**
Invasive Diagnostic Procedure	3,223 (30.7%)	416 (36.5%)	**<0.001**	1,566 (27.3%)	250 (36.4%)	**<0.001**
Surgical Procedure	1,700 (16.2%)	305 (26.8%)	**<0.001**	795 (13.9%)	165 (24.0%)	**<0.001**
Invasive or Surgical Procedure	3,761 (35.9%)	551 (48.3%)	**<0.001**	1,801 (31.4%)	316 (46.0%)	**<0.001**
Total Charges, Dollars	91.293 (87,753)	125,568 (165,788)	**<0.001**	92,972 (94,657)	111,615 (154,936)	0.220

Risk Factors of Mortality

The multivariable logistic regression model for mortality was built for the group with operation and, subsequently, compared with the model built for the group with no operation. The findings are presented in Tables 5 and 6. Common variables used to adjust the two models were age, sex, income, insurance, and empyema with fistula. In the final multivariable regression model for both age groups that underwent an operation, time to operation, age, modified frailty index and presence of an associated fistula were the significant risk factors for mortalities (Table 5). In all patients that were not operated, just age significantly increased the odds of mortality (Table 6). In adults and elderly patients who underwent a surgical operation, each additional day of delay in time to operation increased the odds of mortality by 4.9% and 3.7%, respectively. The frailty index revealed 15.1% and 14.6% higher odds of mortality for each additional score increase in adults and elderly's scores, respectively, who had surgery. (Table 5). In adults and elderly who did not have a surgery, each year of older age correlated with increased odds of mortality by 3.9% and 5.4%, respectively. In the elderly group also having a fistula was associated with 92.7% increased odds of mortality (Table 6).

Table 5. Backward logistic regression analysis to evaluate the associations between mortality and different factors in emergency admitted patients with the primary diagnosis of empyema and undergoing an operation. Mortality was the dependent variable. NIS 2005-2014.

	Adult Patients with Operation		Elderly Patients with Operation	
	OR (95% CI)	P	OR (95% CI)	P
Time to Operation, Days	1.049 (1.017, 1.081)	**0.002**	1.037 (1.008, 1.067)	**0.012**
Empyema with Fistula	4.081 (2.966, 5.615)	**<0.001**	2.169 (1.605, 2.932)	**<0.001**
Age, Years	1.053 (1.035, 1.071)	**<0.001**	1.060 (1.046, 1.074)	**<0.001**
Modified Frailty Index Score	1.151 (1.012, 1.309)	**0.032**	1.146 (1.047, 1.255)	**0.003**
Sex, Female				
Invasive Diagnostic Procedure				
Race	**Removed Via Backward Elimination**		**Removed Via Backward Elimination**	
Income Quartile				
Insurance				
Hospital Location				

Table 6. Backward logistic regression analysis to evaluate the associations between mortality and different factors in emergency admitted patients with the primary diagnosis of empyema and not undergoing an operation. Mortality was the dependent variable. NIS 2005-2014.

	Adult Patients, Not Operated		Elderly Patients, Not Operated	
	OR (95% CI)	P	OR (95% CI)	P
Age, Years	1.039 (1.005, 1.073)	**0.024**	1.054 (1.023, 1.086)	**<0.001**
Modified Frailty Index Score	1.283 (0.985, 1.672)	0.070	1.145 (0.938, 1.397)	0.180
Empyema with Fistula			1.927 (1.133, 3.275)	**0.015**
Sex, Female				
Invasive Diagnostic Procedure	**Removed Via Backward Elimination**		**Removed Via Backward Elimination**	
Race				
Income Quartile				
Insurance				
Hospital Location				
Hospital Length of Stay, Days				

Discussion

Time to Operation

The primary aim of this study was to evaluate associations between demographics, socioeconomic status, clinical status, comorbidities and HLOS and overall postoperative mortality in emergency admitted non-elderly adult and elderly patients with the primary diagnosis of empyema admitted emergently. Each additional day delay in time to operation increased the odds of mortality by 4.9% in adults and 3.7% in elderly patients who underwent a surgical operation. Our results are supported by Meschino et al., who showed that increasing time from admission to operation was associated with greater mortality for EGS patients. Furthermore, McIsaac et al., in a propensity score–matched observational cohort study, demonstrated a continuous, but possibly nonlinear, association of delay of urgent or emergency surgery with mortality and use of health care resources. Miraflor et al., added that delayed intubation was shown to be associated with increased mortality in trauma patients. Interestingly, emergency surgery without stabilization prior to surgical repair for total anomalous pulmonary venous connection, managed to reduce duration of mechanical ventilation without reducing survival. Understanding potential trajectories in morbidity and mortality is crucial to guiding long-term investments and policy implementation. Strategies to provide timely access to the operating room should be considered in order to reduce mortality rate. This analysis was recorded in an exhaustive nationwide distinctive database during a 10-year period in the United States, 2005-2014. The large patient population enabled us to estimate the mortality associated with empyema, and to identify multiple adjusted predictors of in-hospital death.

Fistula

Our results showed that in patients with fistula, the rate of surgical procedure, invasive diagnostic procedures, mortality and HLOS are significantly higher than in those with no fistula, indicating patients in higher risk. Treatment of empyema associated with bronchopleural fistula (BPF) remains a challenge to thoracic surgeons. It is crucial to have a prompt and complete seal of BPF for a successful closure of a persistent empyema cavity. The fistula, a potentially fatal direct communication between the bronchus and pleural cavity, is associated with significant morbidity such as tension pneumothorax, aspiration, and respiratory failure and mortality. Previous studies showed that BPF-related mortality ranges from 18 to 71% in the literature. Age (>60), gender (male), and induction chemotherapy have been cited as the risk factors for postpneumonectomy BPF. Bronchopleural fistula may need prolonged HLOS for a close follow-up, complex surgical procedures, and management of the life-threatening conditions like sepsis, tension

pneumothorax, and respiratory failure. Systemic factors included the patient's nutritional status, diabetes mellitus, steroid use, presence of sepsis, and preoperative chemotherapy. Most fistulas with a viable bronchial stump can be managed endoscopically, using mechanical abrasion, polidocanol sclerosing agent, and cyanoacrylate glue. Pedicled muscle flap transfer combined with endoscopic therapies for bronchopleural fistula with empyema, is a feasible and efficient surgical for treatment.

HLOS

Sziklavari et al., have shown that for debilitated patients, immediate minimally invasive technique and instillation, intrathoracic vacuum therapy is a safe and viable alternative to open window thoracostomy. It has been shown to have the fastest clearance and healing rates of empyema as well as shortened HLOS. However, initial treatment with intrapleural fibrinolytic therapy or surgical procedures did not result in shorter HLOS. Bailey et al., showed that the shorter preoperative HLOS for video-assisted thoracoscopic surgery can be achieved by earlier intervention using less invasive surgical procedures. Li et al., added that primary decortication within the first 2 days of hospitalization, may also contribute to a decrease in-hospital length of stay.

Conclusions

Age and modified frailty index were the common risk factors of mortality in all patients with the primary diagnosis of empyema, regardless of surgical status. Furthermore, delay in operation and the presence of a fistula were significantly associated with in-hospital mortality in adult and elderly patients that underwent emergency surgery. In those elderly patients that did not undergo an emergency surgery and were diagnosed with an empyema, having an associated fistula was correlated with higher mortality.

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Conflict of Interest Disclosure Statement

The authors have no conflict of interest to declare.

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