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## Risk Factors for Pneumonia Following Rib Fractures

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**Risk Factors for Pneumonia Following Rib Fractures**  
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Clinical Research

Scholarship in Medicine Final Report

**By checking this box, I indicate that my mentor has read and reviewed my draft proposal prior to submission**

**Abstract**

*Objective:* Pneumonia is a known complication following rib fractures. The purpose of this study is to identify factors associated with the development of pneumonia following rib fractures.

*Methods:* In this retrospective chart review, eligible participants included trauma patients with one or more rib fractures who were admitted to Miami Valley Hospital during 2012 through 2017. Variables studied included age, gender, injury severity score (ISS), mechanism of injury, smoking status, alcohol use, administration of influenza and pneumococcal vaccine, number and side of rib fracture(s), spirometer use, blood transfusion, and intravenous fluid administration.

*Results:* Among 78 cases and 74 controls, matched for age and ISS, patients who developed pneumonia were more likely to be male, had higher number of rib fractures, consumed alcohol of 1 to 5 drinks per day, and had a higher rate of intravenous fluid administration during the initial 24 hours following trauma.

*Conclusions:* Risk factors for the development of pneumonia following rib fractures include male gender, higher number of rib fractures, alcohol consumption, and higher rates of intravenous fluid administration during the initial 24 hours following trauma.

*Key Words:* rib fractures, pneumonia, trauma

## **Introduction/Literature Review**

Thoracic trauma accounts for more than 796,000 Emergency Department visits annually.<sup>1</sup> Rib fractures are a common thoracic injury, accounting for 10 to 26% of all cases of thoracic injury.<sup>2</sup> Rib fractures and other severe chest injuries have been shown to be strong predictors of poor outcomes such as pneumonia and mortality.<sup>3</sup> Rib fractures have an associated mortality rate as high as 20% from complications, and pneumonia is the major cause of deaths in these patients.<sup>4</sup>

Pneumonia results from decreased respiratory defense mechanisms that allow for the entrance and replication of pathogenic organisms within the lungs.<sup>5</sup> Impaired respiratory defense mechanisms such as cough reflex and mucociliary clearance can contribute to the development of pneumonia.<sup>3</sup> Additionally, smoking, COPD, asthma, and inhalation or oxygen therapy are confirmed risk factors for developing pneumonia.<sup>1,5</sup>

Patients with rib fractures may develop progressive atelectasis and impaired cough reflex secondary to pain with respiratory excursion, and this may lead to subsequent pneumonia.<sup>4</sup> Studies have shown that age and injury severity score (ISS) are important predictors of development of pneumonia.<sup>3,4,6</sup> Prior studies have presented that vital capacity may be used to predict those at most risk for developing pneumonia following rib fracture.<sup>4</sup> Currently the risk

stratification for the development of pneumonia focuses on age, ISS, and the number of fractures.<sup>6</sup> Pain control and aggressive respiratory therapy have shown a decrease in pneumonia and mortality following rib fractures.<sup>4,6</sup> Early identification and treatment of patients with increased risk for the development of pneumonia can prevent disease progression and improve mortality rates.

### **Hypothesis/Specific Aims/ Research Question**

The purpose of this study is to determine factors associated with the development of pneumonia following rib fractures. Previous studies have identified certain risk factors for pneumonia, but this study strives to better understand these risk factors for the complication of pneumonia following rib fractures. Identifying patients with increased risk can allow for earlier treatment and prevention of disease progression. The hypothesis is there will be a clinical factor other than age, ISS, and the number of fractures that is associated with increased risk of pneumonia, such as tobacco use, alcohol use, influenza vaccination, or pneumococcal vaccination.

### **Methods**

#### *Context/Protocol*

A retrospective chart review was performed using the Miami Valley Hospital Trauma Registry and the EPIC medical record to collect standardized data points on both patients and controls. Using the Miami Valley Hospital Trauma Registry, patients and controls were first identified by searching for the admission criteria of one or more rib fractures. The patient population was further identified by searching for those with pneumonia listed as a complication. Adult patients who presented to Miami Valley Hospital with rib fractures from January 1, 2012 through December 31, 2017 were included within the study. Patients who were less than eighteen

years old, pregnant, prisoners, or patients who were admitted under a non-trauma service were excluded from the study. Controls were chosen from the study period as patients with rib fractures, who did not develop pneumonia, and were matched by age and ISS. A sample size of 78 patients and 74 controls were obtained for a standardized difference between the means of the two groups to be 0.5. The trauma registry allowed collection of age, mechanism of injury, injury severity score, chest abbreviated injury scale, ICD-10 codes, diagnosis, procedures, complications including pneumonia, and comorbidities.

#### *Data Collection*

Once identified via the Trauma Registry, each encounter was opened on the EPIC medical record, and additional standardized data points were collected. Smoking and alcohol intake was collected from the social history, while date of last influenza vaccine and pneumococcal vaccine was collected from the immunization history. Using the input and output flowsheets, intravenous fluid administration within the first four hours and first 24 hours were collected. The number of rib fractures was determined from the radiologist's reading of the chest radiograph and chest computed tomography scans. The activity level was collected based on the physical therapist, occupational therapist, or physician's recommended level of activity. The use of incentive spirometer use was collected based on respiratory therapist's record.

Data were stored on password-protected computers using a password-protected Excel spreadsheet. The data were entered into the password-protected Excel spreadsheet. All patient data were de-identified prior to analysis, and univariate and multivariate analyses were performed to identify risk factors associated with pneumonia development.

#### *Data Analysis*

Data were analyzed using SAS v9.4. The Student's t-test and the Mann Whitney U test were used to compare continuous variables and are described with median and interquartile range. Categorical variables were tested between groups using the Chi-squared test and Fisher's exact test (for alcohol use) and are described with frequency count and percentage. All p-values are two-tailed.

## Results

Data were available for 78 cases and 74 controls. Results are shown in Table 1. Patients with rib fractures who developed pneumonia during their inpatient stay were more likely to have a higher number of rib fractures, had higher rates of IVF infusion during the initial 24 hours after injury, reported alcohol consumption of 1-5 drinks of alcohol per day, and were more likely to be male. Incentive spirometry was more likely to used with patients who developed pneumonia. No differences were found between groups by side of rib fractures, mechanism of injury, age, ISS, smoking status, influenza vaccination or within prior 2 years of injury nor pneumonia vaccination within prior 2 years.

*Table 1: Categorical variables are described with frequency count and percentage and tested between groups using Chi-square or Fisher's Exact Test (for alcohol use). Continuous variables are described with median and interquartile range and compared between groups with Mann Whitney Wilcox tests or Student T-test (for age). All p-values are two-tailed. Data were analyzed using SAS v9.4*

	Case	Control	p-value
No. Subjects	78	74	
Gender			0.005
Male	62 (79%)	42 (58%)	
Female	16 (21%)	30 (42%)	
2 missing			
Mechanism of Injury			0.84
FALL	19 (24%)	21 (28%)	
MVA	40 (51%)	35 (47%)	
Other	19 (24%)	18 (24%)	

Smoker <i>10 missing</i>	37 (49%)	34 (51%)	0.87
Alcohol			0.05*
none	44 (60%)	43 (72%)	
1-5 per day	26 (36%)	11 (18%)	
6+ per day	3 (4%)	6 (10%)	
Influenza vaccine within 2 years prior to injury <i>4 missing</i>	23 (30%)	19 (26%)	0.60
Pneumococcal vaccine within 2 years prior to injury <i>4 missing</i>	17 (22%)	10 (14%)	0.18
Side Rib			0.71
L	34 (44%)	27 (37%)	
R	24 (31%)	25 (43%)	
RL <i>1 missing</i>	20 (26%)	21 (29%)	
Spirometer (yes) <i>5 missing</i>	59 (78%)	24 (34%)	<0.001
Age (mean, SD) <i>2 missing</i>	53 (19)	54 (18)	0.71
ISS (median, IQR) <i>1 missing</i>	22 [17, 33]	19 [14, 29]	0.35
IV 24 hours (median, IQR) <i>11 missing</i>	4258 [2818, 7781]	3000 [1058, 4723]	<0.001
Number Rib Fx** (median, IQR)	5 [2, 7]	3.5 [2, 5]	0.05

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## Discussion

The total number of rib fractures was associated with an increased risk of developing pneumonia. The association is believed to be due to rib fractures causing pain with respiratory

excursion, which can lead to progressive atelectasis, impaired cough reflex, and subsequent pneumonia.<sup>4</sup>

Increased amounts of intravenous fluid administration given within the first 24 hours following trauma was determined to be associated with the development of pneumonia. Excessive fluid administration has been associated with poor outcomes among critical patients causing complications such as pulmonary edema, coagulopathy, and other complications.<sup>10, 11</sup> Therefore, thoracic trauma patients should be treated with appropriate volumes of intravenous fluids to avoid complication from excessive fluid administration.

Alcohol use was associated with the development of pneumonia following rib fractures. Studies have shown that alcohol consumption impairs immune defense, increases the susceptibility of gastrointestinal and pulmonary complications, and has other harmful physiologic effects.<sup>8</sup> Additionally, a 2015 study by Cremonte and Cherpitel found that alcohol consumption increases the risk of sustaining an injury requiring emergency care.<sup>9</sup>

Male gender was determined to be a risk factor for the development of pneumonia following rib fractures. This result is consistent with a study performed by Haider et al. that demonstrated that men are more likely to develop complications of traumatic injury such as pneumonia, acute respiratory distress syndrome, pulmonary embolism, acute renal failure, and intraabdominal abscess.<sup>7</sup> Experimental research has suggested that difference in sex hormones affects survival after traumatic injury due to differences in effect on inflammation.<sup>7</sup>

## **Conclusion**

Risk factors for the development of pneumonia following rib fractures include higher number of rib fractures, higher amounts of intravenous fluid administration in the first 24 hours, alcohol



consumption, and male gender. A limitation to this study is data was collected from a single institution, therefore the information may not be generalizable. The results obtained from this study can be used to identify patients at risk for development of pneumonia following trauma with rib fractures.

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