

## Aspiration Risk Factors in Hospitalized Patients Following Trauma

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### ABSTRACT

**Introduction.** Risk factors for aspiration are not well characterized in the trauma patient population. Improved understanding is important due to features of this patient population that place them at high risk for morbidity and mortality with aspiration.

**Methods.** In a retrospective analysis of patients who suffered a traumatic injury from 2016 to 2018, potential risk factors were recorded and analyzed with logistic regression to evaluate the trauma patient at risk for aspiration.

**Results.** Of the 146 patient charts analyzed, 56 (38%) had at least one documented aspiration event, while 90 (62%) patients had none. Multivariate logistic regression found a significant association between impaired consciousness and aspiration events ( $p = 0.012$ ).

**Conclusions.** This study was a novel characterization of trauma patients likely to have experienced an aspiration event while hospitalized. The results suggested candidate risk factors for aspiration exist in a trauma-specific population. Impaired consciousness is likely to show a significant association with aspiration in trauma patients in future studies. *Kans J Med* 2022;15:184-188

### INTRODUCTION

Pulmonary aspiration is defined as the entry of foreign bodies or substances into the lungs.<sup>1</sup> The clinical sequelae following aspiration events are wide-ranging with the potential for serious morbidity and mortality. The most significant of these complications appeared to be acute lung injury, ventilator-associated pneumonia, and acute respiratory distress syndrome.<sup>2-4</sup> Risk factors for aspiration and its associated complications were well characterized in a variety of patient populations, but the trauma population has not been examined thoroughly.<sup>2,5</sup>

Trauma has been suggested to predispose patients to suffer an aspiration event, but there was little evidence in the literature that details the mechanisms driving this increased risk.<sup>6,7</sup> Furthermore, there was a distinct lack of evidence detailing which trauma patient would be most likely to aspirate. Improved understanding is vital due to the unique features and circumstances of the trauma population that potentially place them at high risk for morbidity and mortality associated with aspiration. It is not an unlikely scenario for patients suffering from trau-

matic injury to have compromised anatomical barriers, lower levels of consciousness (injury-related or therapeutic), or direct insult of foreign bodies within the thorax. It is unclear how these features affect the incidence of aspiration and its clinical sequelae in the trauma population.

In trauma patients, aspiration has been associated with increased hospital lengths of stay and an increased risk for ventilator-associated pneumonia.<sup>8</sup> The importance and significance of aspiration events were not well established in the literature and focused mostly on morbidity and mortality associated with aspiration. Current guidelines and information regarding aspiration from the American Association for the Surgery of Trauma were based largely on evidence from critical care populations not specific to the trauma patient.<sup>7</sup> These studies addressed aspiration from a broader perspective identifying and classifying the syndromes and sequelae associated with aspiration in critically ill patients.<sup>1-3</sup>

Two studies specific to the trauma patient population shared our outcome of interest. A retrospective study conducted in South Korea identified patient characteristics likely to be present in the setting of computed tomography findings suggestive of aspiration pneumonia.<sup>9</sup> They concluded the median head Abbreviated Injury Scale (AIS) scores, and severe Glasgow Coma Scores (GCS) were predictive for aspiration events. The second was a comprehensive prospective study which addressed the mortality associated with aspiration in trauma patients and identifies risk factors likely to be present as a secondary outcome.<sup>10</sup> This study was an important contribution in characterizing the trauma patient at risk for aspiration, but their primary focus was to address mortality associated with aspiration events. They concluded that patients who aspirated were injured more severely, had lower GCS scores, and were more likely to have required multiple intubation attempts.

Given the relative paucity of evidence surrounding aspiration in traumatic injuries, it was important to characterize the patient at risk for suffering an aspiration to inform future studies and patient care plans. This study sought to inform future studies by identifying potential risk factors for aspiration. It was hypothesized that risk factors for aspiration could be identified in patients hospitalized following traumatic injury.

### METHODS

This study was a retrospective chart review approved by the Institutional Review Board at the University of Kansas Medical Center. The University of Kansas Trauma Registry was used to generate the initial patient list covering admissions to the Level I Trauma Center following traumatic injury from 2016 to 2018. Charts of adult patients who had an unplanned intubation, ventilator-associated pneumonia, respiratory failure, acute respiratory distress syndrome (ARDS), or unplanned/readmission to the intensive care unit (ICU) were examined as a filter to identify patients with respiratory distress and identify those with aspiration events. Those excluded from the study included patients who initially received care at an institution other than the University of Kansas, children, and readmissions. Documented aspiration events were recorded, and patients were divided into those with and without at least one documented aspiration event. To record an aspiration event, one of the following had to be present: (1) a diagnosis of aspiration

pneumonia or decompensation secondary to aspiration (ICD J69.0 or Y84.4)<sup>11</sup>, staff witnessed or charted, (2) bronchoalveolar lavage with culture positive for mixed anaerobic organisms, or (3) speech-language pathology report positive for aspiration.

Data collected from the trauma registry included age, sex, race, ethnicity, body mass index (BMI), substance use, past medical history, mechanism of injury, type of injury, AIS score, Injury Severity Score (ISS), admission GCS.

The remaining data were collected from the patients' clinical charts. These data included past surgical history, smoking history and status, presence of feeding tubes (nasogastric, nasoenteric, or gastrostomy), number of surgeries for treatment, and documented aspiration events. For those with at least one aspiration event, additional collected data were type of aspiration, time from admission to first aspiration event, time from aspiration to death if applicable, reason documented for aspiration, and aspiration event confirmation with swallow studies.

Past medical history was recorded in the following categorical groupings: coronary heart disease, diabetes mellitus, chronic respiratory disease, stroke, liver disease, obesity, neurologic disorder, obstructive sleep apnea, and other. Similarly, medical complications were categorically grouped as: dysphagia, neurologic, impaired consciousness, anatomical disruption, gastroesophageal reflux disease, post-operative nausea and vomiting, and an optional fill-in text. Impaired consciousness was recorded as reflex impairment in coughing, swallowing, or a failure to respond adequately to external stimuli.

A bivariate analysis initially evaluated the entirety of our collected variables. From these data, only those variables which were found to be significant on bivariate analysis were reported. Cutoff for statistical significance was a p value < 0.05 and the data were analyzed with IBM SPSS®.

## RESULTS

A total of 6,364 patients were admitted to the University of Kansas Hospital trauma service during the study period of 2016 to 2018. Of these patients, 147 met inclusion criteria; ultimately, 146 patients were used in our data analysis, with one patient excluded due to a recording error. Table 1 summarizes the baseline characteristics of the patients included in the study.

The average age of the patient population was 57 years and was predominantly non-Hispanic or Latino, Caucasian males. Dysphagia was the most prevalent medical complication with 52/146 (36%). It was excluded from the analysis as the time of diagnosis for recording a documented aspiration event was not reliably present. Regarding the general health of the population, 106 patients (73%) were classified as having some form of obesity with the overweight category being the most prevalent with 45 documented patients. The two most common medical complications post-admission were 52 recorded cases of dysphagia and 30 recorded cases of impaired consciousness. Substance abuse had variable reporting on data from the electronic health record with data being unavailable on 67 patients in our study.

Table 2 summarizes the details of traumatic injury in our study population. Falls were the most common cause of injury with 74/146 (51%) patients, followed by motor vehicle collisions at 49/146 (34%) patients. The most common type of injury reported was blunt trauma with 132/146 (90%) patients followed by fracture with 34/146 (23%)

patients. Most of the study group required one surgery or less during their admission.

**Table 1. Baseline characteristics of included patients.**

<b>Age (in years)</b>	
Mean	57.4
<b>Sex</b>	
Male	71%
<b>Race</b>	
Caucasian	76%
African American	8%
Other	9%
Not available	8%
<b>Ethnicity</b>	
Hispanic or Latino	4%
Not Hispanic or Latino	93%
Unknown	3%
Mean Body Mass Index (BMI)	29
<b>Substance Use</b>	
None	39
Alcohol	15
Illicit drugs	25
Not available	67
<b>Comorbidities and Complications</b>	
Coronary heart disease	10%
Diabetes mellitus	33%
Chronic respiratory disease	22%
Stroke	1%
Liver disease	1%
Obesity	73%
Overweight (BMI: 25.0 - 29.9)	45%
Class I (BMI: 30.0 - 34.9)	29%
Class II (BMI: 35.0 - 39.9)	17%
Class III (BMI: 40.0 and greater)	9%
Neurological disorder	5%
Obstructive sleep apnea	6%
Other	79%
<b>Prevalence of Documented Medical Complications</b>	
Dysphagia	52
Impaired consciousness	30
Anatomical disruption, upper airway	8
Gastroesophageal reflux disease	9
Post-operative emesis	0
Other	99
Stroke	2
Neurologic injury	23

**Table 2. Details of traumatic injury.**

<b>Mechanism of Injury</b>	
Motor vehicle collision	34%
Firearm	7%
Fall	51%
Penetrating	3%
Motor vehicle vs. pedestrian	3%
<b>Type of Injury</b>	
Penetrating	10%
Fracture	23%
Blunt	90%
<b>Mean Maximum Abbreviated Injury Scale</b>	
Head	3.4
Face	1.6
Neck	2.0
Thorax	3.0
Abdomen	2.7
Upper extremity	1.7
<b>Number of Surgeries Required for Treatment</b>	
0	30%
1	40%
2	11%
3	7%
4	6%
5	0%
> 5	5%

Details concerning aspiration events are listed in Table 3. Of the 146 patients analyzed, 56 (38%) had at least one documented aspiration event while 90 (62%) patients had none. Most documented aspiration events occurred after 120 hours post-admission, with dysphagia being the most documented reason for aspiration. As stated above, dysphagia was excluded from the analysis, so this was an observational finding. Overt aspiration events were the most recorded with 36/56 (64%). There were 19 individuals whose deaths were attributed to complications from aspiration. In all 19 deceased individuals, the time from a documented aspiration event to death was greater than 72 hours.

Using a bivariate analysis, significant risk factors for aspiration were identified including race, maximum head AIS, ISS, intubation, presence of feeding tubes (e.g., nasogastric, nasoenteric, or gastrostomy), and impaired consciousness. A multivariate logistic regression was used to evaluate the influence of our selected potential risk factors on the likelihood of patients suffering an aspiration event. There was a significant association between impaired consciousness ( $p = 0.012$ ) and patients having suffered an aspiration event. Patients who suffered an aspiration event were 3.69 (95% CI 2.67, 4.71) times more likely to have had impaired consciousness following traumatic injury. Tables 4 and 5 display these results.

**Table 3. Aspiration event details.**

<b>Documented Aspiration Events</b>	
1	15%
2	8%
3	7%
4	2%
5	3%
> 5	3%
0	62%
<b>Time from Admission to First Aspiration Event</b>	
< 6 hours	5%
6 - 24 hours	4%
25 - 48 hours	7%
49 - 72 hours	9%
73 - 96 hours	5%
97 - 120 hours	7%
> 120 hours	57%
Unknown	5%
<b>Type of Aspiration</b>	
Overt	64%
Silent	11%
Both	16%
Unknown	9%
<b>Documented Reason for Aspiration</b>	
Dysphagia	84%
Supine position	11%
Neurologic disorder	11%
Impaired consciousness	29%
Anatomical disruption	7%
Post-operative emesis	2%
Other	34%

**Table 4. Bivariate analysis.**

<b>Risk Factors Significant on Bivariate Analysis</b>	
Race	0.019
Maximum head Abbreviated Injury Scale	0.045
Intubated	< 0.001
Feeding tube	< 0.001
Nasogastric tube present	< 0.001
Nasoenteric tube present	< 0.001
Gastrostomy present	0.009
Impaired consciousness	0.005
Injury Severity Score	0.003

\*p values shown in right column with significance level of < 0.05.

**Table 5. Multivariate logistic regression.**

	Odds Ratio (95% CI)	p Value
Race	1.197 (1.0, 1.39)	0.066
Maximum head Abbreviated Injury Scale	1.010 (0.78, 1.24)	0.935
Intubated	2.643 (1.43, 3.86)	0.118
Feeding tube	0.00	0.999
Nasogastric tube present	0.00	0.999
Nasoenteric tube present	2.152 (1.23, 3.08)	0.105
Gastrostomy present	1.108 (0.16, 2.05)	0.831
Impaired consciousness	3.689 (2.67, 4.71)	0.012
Injury Severity Scale	0.999 (0.95, 1.04)	0.973

## DISCUSSION

This study was a relatively novel characterization of trauma patients at risk for suffering an aspiration event. It was conducted in the hopes that the findings could inform future studies. The results suggested candidate risk factors for aspiration exist in a trauma-specific patient population. The primary takeaway from this exploratory study was that impaired consciousness is likely to show continued and significant association with aspiration in trauma patients in future studies. Secondly, factors found to be significant on bivariate analysis should be examined more closely in future studies as they likely are underrepresented in this study.

Our findings were supported by the work of Benjamin et al.<sup>9</sup> and Heo et al.<sup>10</sup> which both identified impaired consciousness and injury severity scores being significantly associated with aspiration. Additionally, Heo et al.<sup>10</sup> found that a higher number of attempted intubations in the trauma bay was predictive of patients suffering an aspiration event. Witnessed aspirations, multiple intubation attempts, and emergency medical service reports of aspiration were key variables in these previous studies which focused primarily on the initial evaluation and treatment of this population. A notable difference between prior studies' populations and our selected populations was that our patients tended to have a longer mean time to the first aspiration event. In this context, it may be appropriate in future studies to delineate aspiration between early and late events as the mechanism of aspiration may be significantly different.

Benjamin et al.<sup>9</sup> and Heo et al.<sup>10</sup> evaluated the prevalence of evidence of aspiration on computed tomography in the setting of a witnessed aspiration event. Our study did not include this, as imaging was not consistently available retrospectively. Both prior studies suggested that it was not uncommon for patients to have a clinically significant aspiration event with no evidence of aspiration on computed tomography. This could be a result of imaging studies being ordered too early in the disease process or inappropriately attributing clinical sequelae to witnessed aspiration events. Regardless, these results highlighted the difficult nature in the identification and diagnosis of aspiration.

Patients included in our study were filtered around clinically significant respiratory complications to generate a patient population likely to have suffered an aspiration event. This was done to examine trauma patients' clinical progression and identify significant associations with aspiration following admission. This was a distinction from prior studies which addressed pre-hospital factors and immediate

aspiration associated with the trauma itself.<sup>9,10</sup> By doing this, the aim was to identify potential hindrances in patient recovery.

Aspiration was not an uncommon experience in the study's patient population, yet there is no clear body of evidence outlining the clinical risks, significance, or even prevalence of aspiration in trauma patients. Significant limitations existed in a retrospective analysis of clinical charts when trying to establish a causal relationship between an exposure and an outcome. This was further complicated by the lack of consistent clinical charting surrounding aspiration events. Due to the nature of aspiration, its clinical presentation often is inferred based on bronchoalveolar lavage findings, speech-language pathology studies, and clinical presentations. Witnessed aspiration events were rare when examining documentation, but this is anecdotal and could represent a lack of reporting and documentation. In clinical documentation, aspiration often was referred to as "suspected aspiration" following the diagnosis of pneumonia, suggesting that aspiration may be inferred only in retrospect. This is important contextually when considering what little evidence exists on aspiration in trauma patients. These limitations in documentation surrounding aspiration raised concerns for existing evidence regarding aspiration and warrants further study with a focus on identification and accurate reporting of aspiration events throughout the patients' hospital course. By extension, clinically relevant evidence is likely to be revealed if these issues are addressed and a higher-powered study is performed.

## CONCLUSIONS

In a retrospective analysis of a select group of patients who suffered a traumatic injury, candidate and significant risk factors were identified for aspiration events. Impaired consciousness appeared to have the strongest association with aspiration when accounting for other potential causative factors. With the results of this bivariate analysis, there existed likely risk factors for aspiration unique to the trauma patient population. Clinically, it may be that aspiration is an under reported complication, often identified retrospectively, that could have significant implications for morbidity and mortality in the trauma patient. Given the significant morbidity associated with these events, these data will play an important role in the development of care pathways to prevent their occurrence and inform future studies.

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