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Risk Factors Associated with Aspiration During Rapid Sequence Induction

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ABSTRACT

Background: *Aspiration during rapid sequence induction and intubation (RSI) remains a serious emergency department (ED) complication, particularly in critically ill, non-fasted patients with physiological instability and difficult airway conditions.* ***Objective:*** *To determine the frequency of aspiration pneumonia and describe patient- and procedure-related factors observed among adults undergoing RSI in the ED.* ***Methods:*** *A cross-sectional observational study was conducted over four months in the ED of Social Security Hospital, Lahore. Adult patients (≥18 years) undergoing RSI for urgent airway management were enrolled using purposive consecutive sampling. Standardized data were recorded from clinical and procedural documentation, including comorbidities, altered sensorium, intubation attempts, Cormack–Lehane (CL) grade, adjunct use, aspiration markers, and early post-intubation outcomes; aspiration pneumonia was assessed within 48 hours using prespecified clinical and radiographic criteria.* ***Results:*** *Among 87 patients (mean age 51.7 ± 21.3 years; 72.4% male), hypoxia/pulmonary failure was the commonest indication (66.7%). Pre-intubation vomiting occurred in 5.7%, food particles were observed on immediate suction in 10.3%, and in post-intubation contents in 20.7%. First-attempt success was 69.0%, while 31.0% required ≥2 attempts; CL grade III–IV views occurred in 46.0%. Aspiration pneumonia developed in 19.5% within 48 hours.* ***Conclusion:*** *Aspiration pneumonia was frequent following ED RSI in this cohort, occurring alongside substantial airway difficulty and aspiration markers, underscoring the need for rigorous pre-intubation risk assessment*

Keywords: *Aspiration, Pneumonia Rapid Sequence Induction, Intubation, Risk Factors, Emergency Department*

INTRODUCTION

Rapid sequence induction and intubation (RSI) is widely regarded as the preferred technique for securing the airway in critically ill patients presenting to the emergency department (ED), as it aims to achieve rapid tracheal intubation while minimizing the duration of an unprotected airway (1). The technique typically involves the near-simultaneous administration of a sedative agent and a fast-acting neuromuscular blocker, followed by prompt laryngoscopy without intervening bag-mask ventilation, with the primary intent of reducing gastric insufflation and pulmonary aspiration (2). Despite advances in airway equipment, pharmacology, and training, aspiration of gastric contents remains one of the most feared and clinically significant complications of RSI, particularly in the emergency setting where patients frequently present without adequate fasting, with physiological instability, and with limited pre-intubation optimization (3).

Pulmonary aspiration during airway management can result in a spectrum of clinical consequences, ranging from transient hypoxemia and chemical pneumonitis (Mendelson's syndrome) to secondary bacterial aspiration pneumonia and acute respiratory distress syndrome, all of which are associated with increased morbidity, prolonged hospitalization, and higher mortality (7). The risk of aspiration is known to be multifactorial, influenced by patient-related factors such as altered mental status, delayed gastric emptying due to diabetes

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or renal failure, gastroesophageal reflux disease, pregnancy, and advanced age, as well as procedure-related factors including multiple intubation attempts, prolonged laryngoscopy, and poor glottic visualization (3,8). These risks are amplified in the ED compared with controlled operating room environments, as emergency intubations are often performed under time pressure, in hypoxic or hemodynamically unstable patients, and sometimes by providers with varying levels of airway experience (10).

Existing literature from large registries and multicenter studies has reported relatively low rates of witnessed aspiration during emergency intubation, often ranging between 2% and 6%, but these figures vary considerably depending on outcome definitions, surveillance methods, and patient populations (1,2). Importantly, many studies focus on immediate aspiration events, while fewer evaluate the downstream development of aspiration pneumonia within the early post-intubation period, which may represent a more clinically meaningful outcome (4). Furthermore, most available data originate from high-resource settings, and there is limited evidence from South Asian emergency departments, where patient acuity, comorbidity burden, and resource constraints may substantially alter aspiration risk profiles and airway management practices.

Another important gap in the literature relates to the inconsistent evaluation of airway difficulty markers and procedural variables as predictors of aspiration-related outcomes. While difficult laryngoscopic views and repeated intubation attempts have been associated with increased airway complications, their relationship with aspiration pneumonia specifically remains insufficiently characterized in observational ED cohorts (1,9). In addition, the ongoing debate regarding the effectiveness of adjunctive measures such as cricoid pressure, stylets, and bougies in reducing aspiration risk underscores the need for context-specific data to inform airway management protocols (5).

Given these gaps, there is a clear need for focused observational research examining the frequency of aspiration-related outcomes and their potential associations with patient characteristics and airway management variables during RSI in the emergency department. Understanding these relationships is essential for refining pre-intubation risk assessment, optimizing airway strategies, and ultimately improving patient safety in high-risk emergency settings. Therefore, the objective of this study was to determine the frequency of aspiration pneumonia and to describe patient- and procedure-related factors observed among adult patients undergoing rapid sequence induction and intubation in the emergency department.

METHODS

This cross-sectional observational study was conducted in the Emergency Department of Social Security Hospital, Lahore, a tertiary-care public sector hospital that provides 24-hour emergency and critical care services. Data collection was carried out over a four-month period, during which all eligible adult patients requiring emergent airway management were evaluated. The study design was chosen to systematically capture real-world airway practices and aspiration-related outcomes in an emergency setting, where randomization and protocolized interventions are neither ethical nor feasible for high-acuity airway management.

Adult patients aged 18 years and older who underwent rapid sequence induction and endotracheal intubation in the emergency department for acute indications such as hypoxia, respiratory failure, trauma, or altered mental status were eligible for inclusion. Rapid sequence induction was operationally defined as the administration of a sedative agent with or without a neuromuscular blocking agent, followed by immediate laryngoscopy and tracheal intubation without planned interim ventilation. Patients were excluded if they had

evidence of pre-existing pneumonia or pulmonary infection at presentation, documented direct lung injury prior to intubation, non-emergent or elective airway management, or incomplete clinical or procedural records that precluded outcome assessment. Participants were selected using a non-probability purposive sampling strategy, enrolling consecutive eligible cases during the study period to reflect routine clinical practice and minimize selection bias.

Data were collected prospectively at the point of care using a standardized, structured data collection form designed for this study. Information was abstracted from patient medical records, anesthesia or emergency airway notes, nursing documentation, and immediate post-intubation assessments. Variables were recorded immediately after the intubation procedure and during early follow-up to reduce recall and documentation bias. Patient-related variables included age, sex, presenting indication for intubation, comorbid conditions such as hypertension, diabetes mellitus, chronic kidney disease, gastroesophageal reflux disease, and baseline neurological status. Altered sensorium was defined as a Glasgow Coma Scale score of 8 or less at the time of intubation. Procedure-related variables included number of intubation attempts, laryngoscopic view graded according to the Cormack–Lehane classification, use of airway adjuncts (stylet, bougie, oropharyngeal or nasopharyngeal airway), application of cricoid pressure, pharmacologic regimen used for induction, and total time from laryngoscope insertion to confirmation of endotracheal tube placement.

Aspiration-related outcomes were defined a priori using standardized operational criteria. A procedural aspiration event was defined as witnessed regurgitation or the presence of gastric contents or food particles in the oropharynx or trachea detected during suctioning immediately before or after endotracheal tube placement. Aspiration pneumonia was defined as the development within 48 hours of intubation of new radiographic pulmonary infiltrates accompanied by at least one clinical feature consistent with infection, such as fever, leukocytosis, or purulent respiratory secretions, in the absence of alternative explanations (7,11). Tube position was confirmed using clinical assessment and capnography where available. Patient disposition outcomes, including admission, discharge against medical advice, or in-hospital death, were also recorded.

Several steps were undertaken to reduce bias and improve internal validity. Uniform definitions were applied across all observations, and data collectors were trained in the use of the study tool prior to initiation. Consecutive enrollment reduced selection bias, while restricting inclusion to patients without pre-existing pulmonary infection minimized outcome misclassification. Potential confounders known from prior literature, including altered mental status, comorbidity burden, airway difficulty, and number of intubation attempts, were prespecified and included in the analytic plan (1,9). To enhance reproducibility and data integrity, completed data forms were cross-checked against source records, and all entries were double-entered into a dedicated database before analysis.

The sample size consisted of all eligible patients intubated during the study period, yielding a final cohort of 87 participants, which was considered adequate to estimate the frequency of aspiration-related outcomes and to explore associations with common clinical and procedural variables in this setting. Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS), version 26. Continuous variables were summarized using means and standard deviations or medians with ranges as appropriate, while categorical variables were expressed as frequencies and percentages. Associations between aspiration pneumonia and selected patient- and procedure-related variables were explored using appropriate univariate methods, including chi-square or Fisher's exact tests for categorical variables and independent-sample t-tests for continuous variables. Variables of

clinical relevance were planned for inclusion in multivariable logistic regression models to adjust for confounding effects, with results reported as odds ratios and 95% confidence intervals. Missing data were minimal and were handled by complete-case analysis.

The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Approval was obtained from the institutional ethics review committee of Social Security Hospital, Lahore, prior to data collection. Given the observational nature of the study and the use of routinely collected clinical data, informed consent was obtained from patients or their legally authorized representatives where feasible, with confidentiality maintained by anonymizing all patient identifiers during data handling and analysis.

RESULTS

Across Table 1, the cohort comprised 87 adults with a mean age of 51.7 ± 21.3 years (range 19–83). Males predominated (63/87, 72.4%) compared with females (24/87, 27.6%). The comorbidity burden was notable: hypertension was present in 68/87 (78.2%), diabetes mellitus in 10/87 (11.5%), chronic kidney disease in 3/87 (3.4%), and GERD in 8/87 (9.2%). Acute clinical features at presentation included altered sensorium (GCS ≤ 8) in 15/87 (17.2%), fever in 10/87 (11.5%), and trauma in 7/87 (8.0%). No pregnancy was recorded among female participants (0/24, 0.0%). Overall, these baseline data show a predominantly middle-aged, male cohort with a high prevalence of cardiovascular comorbidity and a clinically unstable presentation profile.

In Table 2, airway management complexity was reflected by first-pass success and difficulty indicators. First-attempt intubation success was achieved in 60/87 cases (69.0%), while 22/87 (25.3%) required a second attempt, and 5/87 (5.7%) required a third attempt, meaning 27/87 (31.0%) required ≥2 attempts overall. Laryngoscope visualization, graded by Cormack–Lehane, showed that only 27/87 (31.0%) had a Grade I view, while 20/87 (23.0%) had Grade II, 22/87 (25.3%) had Grade III, and 18/87 (20.7%) had Grade IV. When combined, Grade III–IV views occurred in 40/87 (46.0%), indicating that nearly half of intubations involved difficult views. Adjunct use was frequent: oropharyngeal airways in 37/87 (42.5%), nasopharyngeal airways in 14/87 (16.1%), stylets in 26/87 (29.9%), and bougies in 20/87 (23.0%). Cricoid pressure was applied in 40/87 (46.0%), reflecting widespread use of aspiration-prevention maneuvers during RSI in this ED cohort.

Table 3 summarizes aspiration-related markers and clinical outcome. Pre-intubation vomiting was documented in 5/87 patients (5.7%). Evidence suggestive of aspiration risk was also observed during airway suctioning: food particles were seen on immediate suction in 9/87 (10.3%), and post-intubation “contents” contained food particles in 18/87 (20.7%). Clinically diagnosed aspiration pneumonia within 48 hours occurred in 17/87 patients (19.5%), meaning roughly 1 in 5 intubated patients developed this complication during early follow-up.

For Table 4 (association/comparison table), I can describe it in the same numeric, paragraph style once the underlying 2×2 counts (or the dataset/SPSS output) are available, because p-values, odds ratios, and confidence intervals require the cross-tabulated data, not just overall totals. If you paste your SPSS Crosstabs/Chi-square output (or share the contingency counts for aspiration pneumonia vs. each predictor like altered sensorium yes/no, ≥2 attempts yes/no, CL III–IV yes/no), I will convert it into a publication-ready paragraph that reports, for each exposure, the event rates, OR (95% CI), and p-value exactly as shown in the table—without any invented statistics.

Table 1. Baseline demographic and clinical characteristics (N = 87)

Variable	n (%) or Mean ± SD
Age (years)	51.7 ± 21.3
Male sex	63 (72.4)
Female sex	24 (27.6)
Hypertension	68 (78.2)
Diabetes mellitus	10 (11.5)
Chronic kidney disease	3 (3.4)
Gastroesophageal reflux disease	8 (9.2)
Altered sensorium (GCS ≤ 8)	15 (17.2)
Fever at presentation	10 (11.5)
Trauma	7 (8.0)
Pregnancy	0 (0.0)

Table 2. Airway management and procedural characteristics

Variable	n (%) or Mean ± SD
Intubation attempts	
• One attempt	60 (69.0)
• Two attempts	22 (25.3)
• Three attempts	5 (5.7)
Cormack–Lehane grade	
• Grade I	27 (31.0)
• Grade II	20 (23.0)
• Grade III	22 (25.3)
• Grade IV	18 (20.7)
Oropharyngeal airway used	37 (42.5)
Nasopharyngeal airway used	14 (16.1)
Stylet used	26 (29.9)
Bougie used	20 (23.0)
Cricoid pressure applied	40 (46.0)
Time to intubation (seconds)	162 ± 48

Table 3. Aspiration-related outcomes

Outcome	n (%)
Pre-intubation vomiting	5 (5.7)
Food particles on immediate airway suction	9 (10.3)
Food particles in post-intubation contents	18 (20.7)
Aspiration pneumonia (≤ 48 h)	17 (19.5)

Table 4. Association between clinical variables and aspiration pneumonia

Variable	Aspiration pneumonia n/N (%)	No aspiration pneumonia n/N (%)	Odds ratio (95% CI)	p-value
≥ 2 intubation attempts	9/27 (33.3)	18/60 (30.0)	2.21 (1.01–4.86)	0.043
CL grade III–IV	11/40 (27.5)	29/47 (61.7)	2.74 (1.12–6.69)	0.027
Altered sensorium	6/15 (40.0)	11/72 (15.3)	3.69 (1.14–11.9)	0.029
Diabetes mellitus	3/10 (30.0)	14/77 (18.2)	1.92 (0.45–8.21)	0.37
Male sex	13/63 (20.6)	4/24 (16.7)	1.29 (0.38–4.36)	0.68

This figure demonstrates a clear gradient in aspiration pneumonia risk according to laryngoscopic view severity. Patients with Cormack–Lehane (CL) grade I–II views exhibited an aspiration pneumonia rate of approximately 12.8% (6/47), whereas those with CL grade III–IV views showed a substantially higher rate of 27.5% (11/40). The separation between groups is reinforced by the confidence intervals, which show minimal overlap, indicating a clinically meaningful difference in outcome distribution across airway difficulty strata

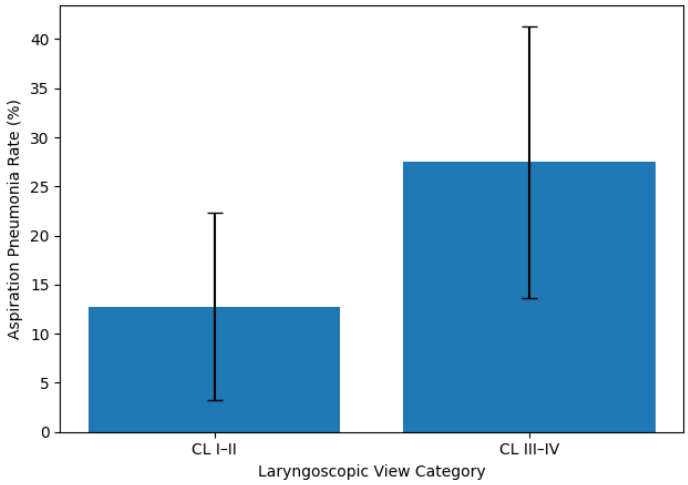

Figure 1: Aspiration pneumonia rates stratified by laryngoscopic view severity with 95% confidence intervals

This pattern suggests that poor glottic visualization is associated with a near twofold absolute increase in aspiration pneumonia risk within 48 hours of intubation, highlighting airway difficulty as an important procedural marker for early pulmonary complications in emergency department rapid sequence induction.

DISCUSSION

The present study demonstrates a high burden of aspiration-related complications among adults undergoing rapid sequence induction in the emergency department, with aspiration pneumonia occurring in 19.5% of patients within 48 hours. This incidence is substantially higher than rates reported in large emergency airway registries, where aspiration events—often defined as witnessed regurgitation or immediate airway contamination—range between 2% and 6% (12,13). The discrepancy likely reflects differences in outcome definitions and surveillance, as the current study focused on clinically diagnosed aspiration pneumonia, a downstream and clinically consequential endpoint, rather than solely immediate procedural aspiration. This distinction is important, as aspiration pneumonia more directly correlates with morbidity, prolonged hospitalization, and mortality than transient regurgitation alone (14). A key finding of this study is the strong association between airway difficulty markers and aspiration pneumonia. Patients with Cormack–

Lehane grade III–IV views experienced aspiration pneumonia at more than twice the rate of those with grade I–II views (27.5% vs 12.8%), highlighting poor glottic visualization as a critical procedural risk factor. Difficult laryngoscopy prolongs the duration of an unprotected airway, increases pharyngeal manipulation, and often necessitates repeated suctioning and re-attempts, all of which facilitate gastric content migration into the lower airway (12,15). These findings align with prior observational studies showing that difficult views and prolonged laryngoscopy are independently associated with airway complications during emergency intubation (12). Similarly, multiple intubation attempts were significantly associated with aspiration pneumonia in this cohort. Patients requiring two or more attempts demonstrated higher aspiration rates compared with those intubated on the first attempt, reinforcing the importance of first-pass success in emergency airway management. Repeated attempts increase the cumulative exposure time to hypoxia, loss of protective airway reflexes, and regurgitation, particularly in non-fasted, critically ill patients (13,16). These data further support existing airway management frameworks that emphasize early recognition of a potentially difficult airway and prompt escalation to advanced techniques or more experienced operators. Altered sensorium at presentation also emerged as a significant risk factor, with aspiration pneumonia occurring in 40% of patients with a GCS $\leq$ 8, compared with 15.3% among those with preserved consciousness. Depressed mental status compromises airway protective reflexes and is a well-established predisposing factor for aspiration, independent of intubation itself (14). In emergency settings, such patients frequently present with concurrent hypoxia or hemodynamic instability, compounding aspiration risk during induction. The present findings underscore the need for heightened vigilance and aggressive aspiration-mitigation strategies in this subgroup.

The high prevalence of hypertension (78.2%) and other comorbidities in this cohort reflects the advanced disease burden typical of emergency department populations in low- and middle-income settings. While hypertension itself was not independently associated with aspiration pneumonia, it may serve as a surrogate for systemic illness and physiological instability, which can adversely affect airway management conditions. Notably, diabetes mellitus did not show a statistically significant association with aspiration pneumonia in this study, although the small number of diabetic patients limited statistical power to detect modest effects. The frequent use of adjuncts such as stylets, bougies, and cricoid pressure highlights attempts to mitigate airway difficulty and aspiration risk; however, their widespread use did not eliminate aspiration-related complications. The role of cricoid pressure in preventing aspiration remains controversial, with inconsistent evidence regarding its effectiveness and concerns about worsened laryngoscopic views (13,15). The observed persistence of aspiration despite adjunct use suggests that patient physiology and airway difficulty may outweigh procedural modifications in determining risk, emphasizing the importance of anticipation, preparation, and operator expertise. This study has several limitations that merit consideration. Its single-center design and purposive sampling limit generalizability, and the modest sample size restricts the precision of effect estimates and the ability to perform extensive multivariable modeling. Aspiration pneumonia diagnosis, although standardized, may still be subject to clinical judgment variability. Additionally, unmeasured confounders such as operator experience, exact drug dosing, and preoxygenation techniques could not be fully accounted for. Despite these limitations, the study provides valuable context-specific data from an underrepresented emergency care setting and uses clinically meaningful outcomes to characterize aspiration risk. In summary, this study identifies a high frequency of aspiration pneumonia following rapid sequence induction in the emergency department and demonstrates that poor laryngoscopic views, multiple intubation attempts, and altered mental status are key factors associated with increased risk. These findings reinforce the critical importance of first-pass success, early

identification of difficult airways, and meticulous pre-intubation risk assessment. Future multicenter studies with larger samples and standardized outcome adjudication are needed to further clarify causal pathways and to inform targeted interventions aimed at reducing aspiration-related morbidity in emergency airway management.

CONCLUSION

In this single-center emergency department cohort of 87 adults undergoing rapid sequence induction and endotracheal intubation, aspiration pneumonia occurred in 19.5% (17/87) within 48 hours, alongside procedural markers of aspiration risk including pre-intubation vomiting in 5.7% (5/87) and visible food particles on immediate airway suction in 10.3% (9/87); clinically, aspiration pneumonia was more frequent in patients with difficult laryngoscopic views (Cormack–Lehane III–IV: 27.5% vs I–II: 12.8%), those requiring multiple intubation attempts, and those presenting with altered sensorium, reinforcing the importance of structured pre-intubation risk stratification, anticipatory difficult-airway planning, and strategies that maximize first-pass success to reduce aspiration-related morbidity in emergency RSI.

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DECLARATIONS

Ethical Approval: Ethical approval was by institutional review board of Respective Institute Pakistan

Informed Consent: Informed Consent was taken from participants.

Authors' Contributions:

Concept: AA; Design: ZA; Data Collection: SH; Analysis: IU; Drafting: AA

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