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Aspiration Pneumonia in Cardiac Surgery: A Predictive Model

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Abstract

Background: Aspiration pneumonia is a rare but serious complication that carries significant morbidity following surgery. This study was undertaken to identify pre-operative and operative risk factors and develop a predictive model for aspiration pneumonia in cardiac surgery patients.

Methods: This study was a retrospective analysis of our institution's Society of Thoracic Surgeons' (STS) cardiac surgery database. Analysis was limited to adult patients (Age ≥ 18) who underwent cardiac surgery from January 2008 through July 2014. The cohort was divided into a derivation cohort (Jan 2008-Dec 2011) and a validation cohort (Jan 2012-July 2014). Logistic regression was used to identify significant predictors of aspiration pneumonia, and receiver operator characteristic (ROC) analysis was used to assess model performance.

Results: Of the 4,741 patients who underwent cardiac surgery during the study period, 70 cases of aspiration pneumonia were identified (1.5%). Multivariable analysis revealed preoperative dialysis, chronic lung disease, percutaneous coronary intervention, congestive heart failure, and urgent/emergent status as significant predictors of post-operative aspiration. The subsequently derived model had 73% sensitivity and 64% specificity across both cohorts when two or more factors were used as a cutoff. Aspiration pneumonia was associated with greater mechanical ventilation time, intensive care unit stay, and hospital length of stay (all $p < 0.001$).

Conclusions: Aspiration pneumonia is associated with significant morbidity after surgery. The developed model may help identify cardiac surgery patients at high-risk for post-operative aspiration pneumonia. Subsequent strategies for prevention of aspiration may thus be tailored accordingly.

Keywords: Aspiration Pneumonia; Cardiac Surgery; Outcomes

Introduction

Aspiration of gastric contents into the pulmonary tract is a prevalent complication that can lead to severe morbidity [1,2]. These aspiration events may be "silent", in which no overt response is noted and the inoculum is cleared by parenchymal defense systems, or large "macroaspiration" events, where sufficient quantities are inhaled to cause a catastrophic event. Aspiration of sterile gastric acids can result in a chemical pneumonitis, which while often self-limited, may progress to fulminant Acute Respiratory Distress Syndrome (ARDS) in a significant number of patients [3,4]. With the aspiration of non-sterile contents (often gastric contents buffered with ingested food), direct seeding of bacteria can result in aspiration-related bacterial pneumonia. Aspiration pneumonias represent up to 15% of in-hospital pneumonias, and are quoted as the second most common diagnosis among hospitalized Medicare patients [5,6].

Several known risk factors for aspiration make certain populations at greater risk for aspiration-related disease. Dysphagia is one of the most cited risk factors due to its causal relationship to subsequent aspiration [1,7,8]. Esophageal motility disorders can also impair normal oral trafficking and increase aspiration risk. While enteral tube feeding may decrease the risk of aspiration during ingestion, there still remains a risk during reflux events, particularly in critically ill patients with associated Gastroesophageal Reflux Disease (GERD) or gastric motility disorders [9-11]. Other reported risk factors include mental status changes, medications, and comorbidities such as diabetes [12,13].

Cardiac surgery patients may be at higher risk for aspiration pneumonia due to a variety of factors. The nature of surgery in the chest involves changes in chest anatomy and lung atelectasis, which may contribute to impaired cough reflex and mucociliary clearance and the development of pneumonia after an aspiration event [14]. The use of Cardiopulmonary Bypass (CPB) with cardiac surgery has known neurologic complications that are surprisingly prevalent; these complications may contribute to neurogenic dysphagia and subsequent aspiration [15]. In addition, direct damage to recurrent laryngeal, vagal, and phrenic nerves may contribute to dysphagia, impaired cough reflex, and aspiration.

This study was undertaken to identify perioperative risk factors and develop a predictive model for aspiration pneumonia in the general cardiac surgery population at our center. Armed with this model, certain high risk patients can be identified who would benefit from measures of varying stringency to prevent this complication.

Methods

Study Design & Data collection

This study was approved by the Institutional Review Board at UCLA and was a retrospective review of our institution's Society of Thoracic Surgeons' (STS) adult cardiac surgery database from January 1st, 2008 to July 31st, 2014. Records from all adult patients (Age ≥ 18) who received cardiac surgery at UCLA were analyzed.

Preoperative variables queried included patient demographics, diabetes, dyslipidemia, dialysis, hypertension, endocarditis, chronic lung disease, immunosuppression, peripheral vascular disease, cerebrovascular disease, arrhythmias, previous cardiac interventions, and preoperative medications. Operative variables included type of procedure, urgent/emergent status, CPB time, aortic cross-clamp time, use of circulatory arrest, and requirement of post-operative Intra-Aortic Balloon Pump (IABP). Post-operatively, incidence of pneumonia, mechanical ventilation time, Intensive Care Unit (ICU) stay, and hospital length of stay were queried.

Primary outcome measure

In cases of reported post-operative pneumonia, the patient's electronic medical record was reviewed to verify the etiology of the pneumonia as aspiration-related. Noted aspiration events during hospitalization, radiographic evidence suggestive of aspiration-related pneumonia, and presence of swallowing dysfunction were utilized in determining etiology. Confirmed incidence of aspiration pneumonia was used as the primary outcome measure in this study.

Statistical Analysis

Perioperative characteristics were expressed as mean ± standard deviation for continuous variables or frequency and percentage of population for categorical variables. For comparisons between patients with and without post-operative aspiration pneumonia, the Mann-Whitney U-test was used for continuous variables while the x^2 test or Fisher's exact test was used for categorical variables.

Patient data was then categorized into 2 groups: a derivation cohort, which consisted of patients from January 2008 – December 2011, and a validation cohort, which consisted of patients from January 2012 – July 2014. Univariate logistic regression was performed to identify significant associations between variables and aspiration pneumonia. Continuous variables, such as age and body mass index, were grouped into categories based on clinical judgment for modeling purposes. Significant variables were entered into a multivariable logistic regression model with backward stepwise-elimination (elimination criteria: $p > 0.10$). The adjusted odds ratios of the resulting model were used to assign variables a risk score to serve as predictors for aspiration pneumonia. Receiver Operating Characteristic (ROC) analysis was performed on the derivation and validation cohorts to assess model performance. All statistical analyses were performed using SPSS 19 software (IBM, Armonk, NY). A p-value < 0.05 was considered statistically significant.

Results

During the study period, 4,741 cardiac surgeries were performed at our center. Of these, 70 patients had documented cases of aspiration pneumonia (1.5%). A patient flow diagram is illustrated in Figure 1. Amongst the derivation cohort (N=2,626), there were 44 cases of aspiration pneumonia, while the validation cohort (N=2,115) had 26 cases of aspiration pneumonia (1.7% vs. 1.2%, p = 0.205). Data was complete for all variables analyzed with exception of CPB time (missing N=55, 1.2%), weight (missing N=279, 5.9%), and height (missing N=369, 7.8%).

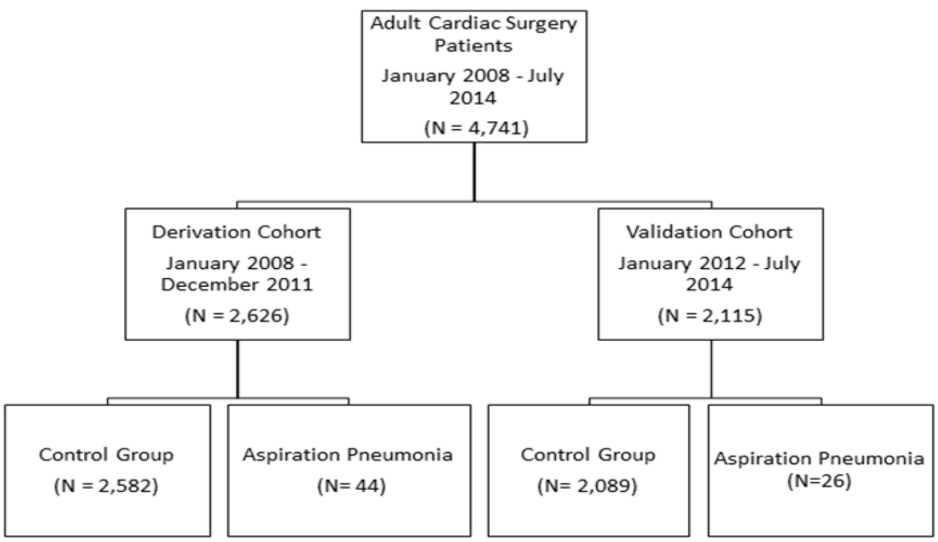

Figure 1: Patient Flow Diagram
Flow diagram of patients during the study period, All adult patients who received cardiac surgery were included in the analysis

Demographic and clinical characteristics of the derivation and validation cohorts are summarized in Table 1. Variables significantly associated with aspiration pneumonia in both the derivation and validation cohort included preoperative dialysis, congestive heart failure (New York Heart Association Class II or higher), & urgent/emergent status. Several other variables were significant in one group and trended towards significance in the other, including peripheral vascular disease, preoperative percutaneous coronary intervention (PCI, defined as any PCI prior to cardiac surgery, with or without stent placement), preoperative arrhythmia, anticoagulation medications, and CPB time > 180 minutes.

After stepwise-elimination in a multivariable model, preoperative dialysis, chronic lung disease, preoperative PCI, congestive heart failure, and urgent/emergent status remained significant predictors of aspiration pneumonia (Table 2). The odds ratios from the resulting models were rounded to the nearest integer and used to develop a risk scoring system (Table 3).

Table 1: Demographic and Clinical Characteristics (Jan 2008-July 2014)

Variables	Derivation Cohort Jan 2008-Dec 2011		Validation Cohort Jan 2012-July 2014	
	Aspiration Pneumonia (N=44)	Other (N=2582)	Aspiration Pneumonia (N=26)	Other (N=2089)
Age	63.4 ± 17.6	61.3 ± 14.9	67.2 ± 11.4	63.5 ± 14.3
Male Gender	29 (65.9%)	1708 (66.2%)	19 (73.1%)	1387 (66.6%)
Height (cm)	171.2 ± 11.8	170.4 ± 10.5	171.9 ± 9.3	170.5 ± 12.1
Weight (kg)	76.3 ± 19.2	77.9 ± 18.6	83.5 ± 18.8	78.9 ± 19.9
Smoking History	7 (15.9%)	371 (14.4%)	8 (30.8%)	476 (22.4%)
Diabetes Mellitus	14 (31.8%)	649 (25.1%)	7 (26.9%)	486 (23.3%)
Dyslipidemia	22 (50%)	1349 (52.2%)	13 (50%)	857 (41%)
Dialysis	8 (18.2%)*	148 (5.7%)*	4 (15.4%)**	109 (5.2%)**
Systemic Hypertension	29 (65.9%)	1619 (62.7%)	15 (57.7%)	1097 (52.5%)
Endocarditis	1 (2.3%)	104 (4.0%)	2 (7.7%)	103 (4.9%)
Chronic Lung Disease	14 (31.8%)*	413 (16%)*	5 (19.2%)	281 (13.5%)
Preoperative Immunosuppression	11 (25%)*	341 (13.2%)*	3 (11.5%)	148 (7.1%)
Peripheral Vascular Disease	7 (15.9%)*	179 (6.9%)*	4 (15.4%)	132 (6.3%)
Cerebrovascular Disease	8 (18.2%)	282 (10.9%)	5 (19.2%)	214 (10.2%)
Cerebrovascular Accident	5 (11.4%)	172 (6.7%)	4 (15.4%)	146 (7.0%)
Previous Cardiac Surgery	22 (50%)	1064 (41.2%)	12 (46.2%)	740 (35.4%)
Previous PCI	14 (31.8%)*	303 (11.7%)*	5 (19.2%)	247 (11.8%)
Myocardial Infarction	15 (34.1%)*	487 (18.9%)*	6 (23.1%)	406 (19.4%)
Congestive Heart Failure	28 (63.6%)*	1128 (43.7%)*	19 (73.1%)**	922 (44.1%)**
Preoperative Arrhythmia	15 (34.1%)	637 (24.7%)	12 (46.2%)**	447 (21.4%)**
Preoperative Medications	-	-		
Beta Blocker	26 (59.1%)	1481 (57.4%)	8 (30.8%)	1033 (49.4%)
ACE Inhibitor	17 (38.6%)	1045 (40.5%)	3 (11.5%)	497 (23.8%)
Nitrate	4 (9.1%)	87 (3.4%)	1 (3.8%)	38 (1.8%)
Anticoagulation	13 (29.5%)	457 (17.7%)	10 (38.5%)**	277 (13.3%)**
Coumadin	5 (11.4%)	261 (10.1%)	7 (26.9%)**	201 (9.6%)**
Inotropes	6 (13.6%)	188 (7.3%)	2 (7.7%)**	43 (2.1%)**

Steroids	9 (20.5%)	305 (11.8%)	2 (7.7%)	123 (5.9%)
Aspirin	18 (40.9%)	1172 (45.4%)	15 (57.7%)	899 (43.0%)
Lipid-Lowering Agent	24 (54.5%)	1371 (53.1%)	16 (61.5%)	977 (46.8%)
Urgent/Emergent Status	32 (72.7%)*	1104 (42.8%)*	19 (73.1%)**	945 (45.2%)**
Intraoperative Procedures	-	-	-	-
CABG	13 (29.5%)	814 (31.5%)	13 (50%)	742 (35.5%)
Valve	16 (36.4%)	1111 (43%)	14 (53.8%)	1011 (48.4%)
Other Cardiac Procedures	18 (40.9%)	1080 (41.8%)	10 (38.5%)	771 (36.9%)
Other Non-Cardiac Procedures	12 (27.3%)	473 (18.3%)	4 (15.4%)	291 (13.9%)
Use of Cardiopulmonary Bypass	38 (86.4%)	2064 (79.9%)	23 (88.5%)	1757 (84.1%)
Cardiopulmonary Bypass Time	195.6 ± 97.7*	165.1 ± 73.1*	195.7 ± 106.9	158.4 ± 74.4
Intraoperative IABP	4 (9.1%)	161 (6.2%)	5 (19.2%)	98 (4.7%)

ACE = angiotensin converting enzyme; CABG = Coronary Artery Bypass Grafting; IABP = Intra-Aortic Balloon Pump; PCI = Percutaneous Coronary Intervention; VAD = Ventricular Assist Device

*Indicates statistical significance amongst groups in the derivation cohort at $p < 0.05$

**Indicates statistical significance amongst groups in the validation cohort at $p < 0.05$

Table 2: Logistic Regression Analysis and Model Derivation

Variables	Odds Ratio (95% CI)	P-value	AOR (95% CI)	P-value
Age > 70 y	1.62 (0.88-2.97)	0.119		
Male Gender	0.99 (0.53-1.86)	0.973		
BMI > 30 kg/m²	1.35 (0.69-2.63)	0.386		
Smoking History	1.13 (0.50-2.55)	0.773		
Diabetes Mellitus	1.39 (0.73-2.64)	0.314		
Dyslipidemia	0.91 (0.50-1.66)	0.767		
Dialysis	3.66 (1.67-8.00)	0.001	3.09 (1.37-6.95)	0.007
Systemic Hypertension	1.15 (0.61-2.16)	0.663		
Endocarditis	0.55 (0.08-4.06)	0.561		
Chronic Lung Disease	2.45 (1.29-4.66)	0.006	2.44 (1.24 -4.80)	0.01
Preoperative Immunosuppression	2.19 (1.10-4.38)	0.026		
Peripheral Vascular Disease	2.54 (1.12-5.78)	0.026		
Cerebrovascular Disease	1.81 (0.83-3.94)	0.133		
Cerebrovascular Accident	1.80 (0.70-4.62)	0.224		
Previous Cardiac Intervention	1.43 (0.79-2.59)	0.243		
Percutaneous Coronary Intervention	3.51 (1.84-6.69)	< 0.001	2.76 (1.42-5.38)	0.003
Myocardial Infarction	2.23 (1.18-4.18)	0.013		
Congestive Heart Failure	2.26 (1.22-4.19)	0.01	1.85 (0.97-3.53)	0.061

Arrhythmia	1.58 (0.84-2.97)	0.155		
Preoperative Medications				
Beta Blocker	1.07 (0.59-1.97)	0.818		
ACE Inhibitor	0.93 (0.50-1.71)	0.806		
Nitrate	2.87 (1.00-8.19)	0.049		
Anticoagulation	1.95 (1.01-3.76)	0.046		
Coumadin	1.14 (0.45-2.92)	0.785		
Inotropes	2.01 (0.84-4.82)	0.117		
Steroids	1.92 (0.91-4.03)	0.085		
Aspirin	0.83 (0.45-1.53)	0.554		
Lipid-Lowering Agent	1.06 (0.58-1.93)	0.849		
Urgent/Emergent Status	3.57 (1.83-6.96)	< 0.001	2.44 (1.22-4.89)	0.012
Intraoperative Procedures				
CABG	0.91 (0.47-1.75)	0.779		
Valve	0.76 (0.41-1.41)	0.377		
Other Cardiac Procedures	0.96 (0.53-1.77)	0.902		
Other Non-Cardiac Procedures	1.67 (0.86-3.27)	0.133		
CPB Time > 180 min	1.82 (0.99-3.34)	0.053		
Intra-aortic Balloon Pump	1.50 (0.53-4.26)	0.442		

ACE = angiotensin converting enzyme; AOR = adjusted odds ratio; CABG = coronary artery bypass grafting; CPB = cardiopulmonary bypass; VAD = ventricular assist device

Table 3: Aspiration Risk Scoring System

Variables	Adjusted Odds Ratio (95% CI)	Scoring Weight
Dialysis	3.09 (1.37-6.95)	3
Chronic Lung Disease	2.44 (1.24-4.80)	2
Preoperative PCI	2.76 (1.42-5.38)	3
Congestive Heart Failure	1.85 (0.97-3.53)	2
Urgent/Emergent Status	2.44 (1.22-4.89)	2

Odds ratios from the above model were rounded to the nearest whole integer to derive the scoring weight. For each patient, an Aspiration Risk Score was retrospectively calculated by summing his or her appropriate scoring weights

Receiver operating characteristic analysis was subsequently performed with the developed risk score (Figure 2). The resulting model had modest predictive power in both the derivation and validation cohorts, with an area under the curve (AUC) of 0.753 [0.687-0.819] in the derivation cohort and 0.698 [0.605-0.791] in the validation cohort. The sensitivities and specificities at various cutoff points for the entire study population are detailed in Table 4. In both cohorts, a score > 3 (translating to any two of the above risk criteria) was associated with sensitivity ~70% and specificity ~65% (Figure 2).

Figure 3 illustrates the number of patients in the study period along with the percentage of patients who suffered an aspiration pneumonia, stratified by the aspiration risk score. Of note, patients who had a score > 9 had a significantly larger risk of aspiration pneumonia, affecting 6/28 (21.4%) of this population. Aspiration pneumonia was associated with significantly prolonged mechanical ventilation times, intensive care unit stay, and total hospital length of stay (Figure 4, all $p < 0.001$).

Discussion

Aspiration pneumonia represents a potentially avoidable complication that significantly increases hospital morbidity and mortality [16]. The current study was undertaken to identify pre-operative and operative risk factors predictive of aspiration pneumonia in the general cardiac surgery population. Five variables were identified from the multivariable model: pre-operative dialysis, chronic lung disease, history of Percutaneous Coronary Intervention (PCI), history of Congestive Heart Failure (CHF), and urgent/emergent status.

The association of these risk factors sheds light on potential mechanisms of aspiration in this vulnerable population. Chronic lung disease may correspond with aspiration risk through a variety of mechanisms, including impaired swallowing function, cough reflex, and mucociliary clearance [14, 17]. Hyperinflation

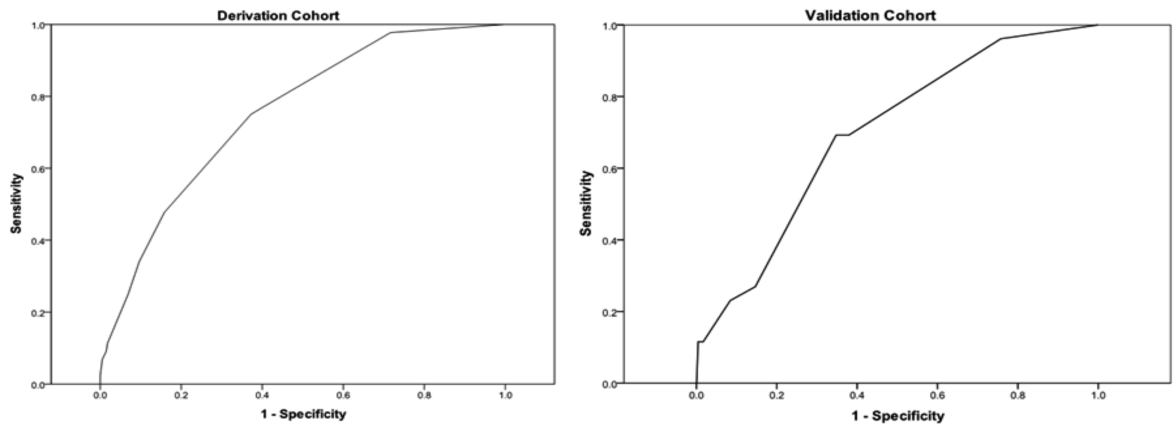

Figure 2 A-B: Receiver Operating Characteristic curves of derivation and validation cohorts
Receiver operating characteristic curves for the derivation (A) and validation (B) cohorts. (A) Derivation cohort, AUC = 0.753 [0.687-0.819]. At score > 3, sensitivity = 0.75, specificity = 0.64. (B) Validation cohort, AUC = 0.698 [0.605-0.791]. At score > 3, sensitivity = 0.69, specificity = 0.65

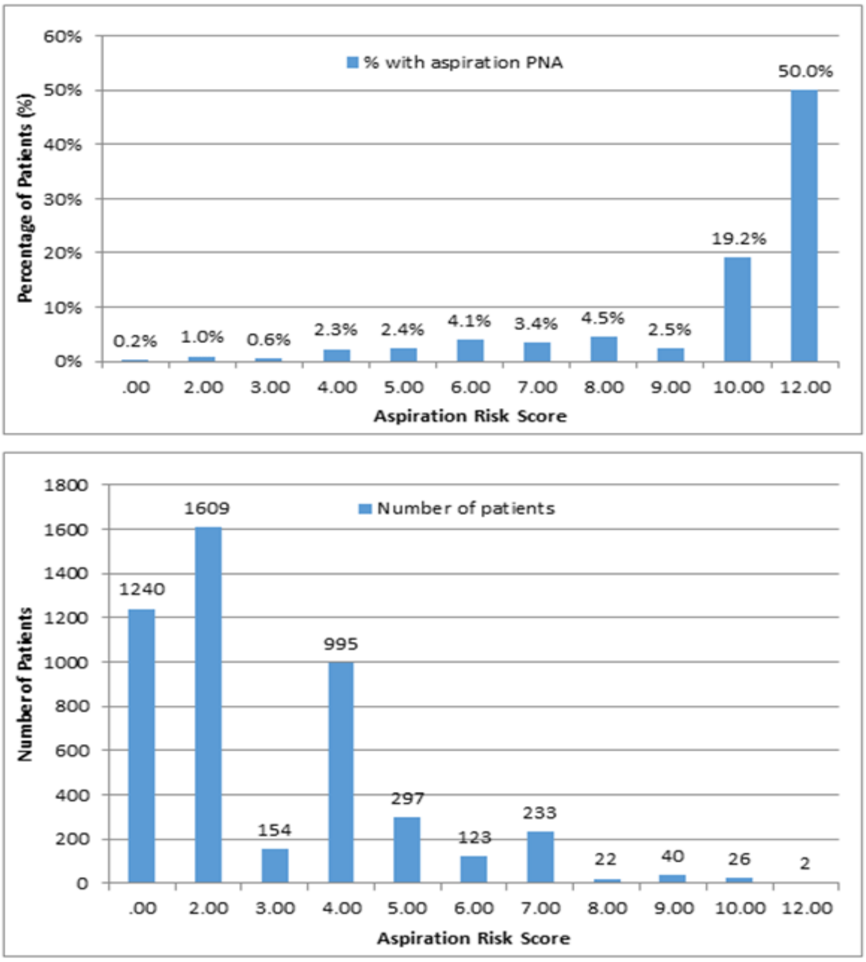

Figure 3 A-B: Incidence of Aspiration Pneumonia by Aspiration Risk Score
(A) Percentage of patients with aspiration pneumonia versus aspiration risk score. (B) Overall number of patients versus aspiration risk score

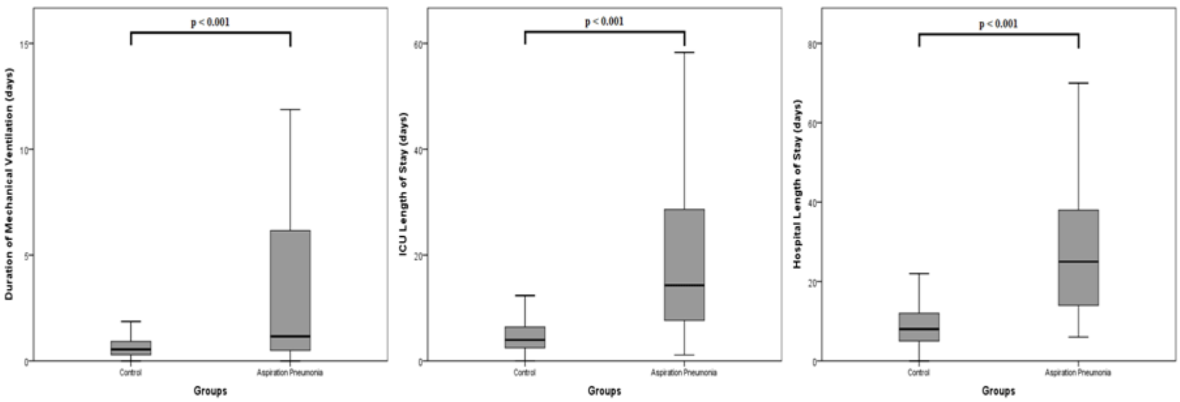

Figure 4 A-C: Short-term outcomes of aspiration pneumonia
Box plots of mechanical ventilation time (A), intensive care unit stay (B), and total hospital length of stay (C) among control and aspiration pneumonia patients. In all cases, significant differences between groups were noted (*p < 0.001*)

Table 4: Model Performance and Receiver-Operating Characteristic Analysis

			Aspiration Pneumonia (N=70)		Control (N=4,741)	
Scale	**Sensitivity (%)**	**Specificity (%)**	**True Positive (n)**	**False Negative (n)**	**True Negative (n)**	**False Positive (n)**
Score > 0	0.97	0.27	68	2	1280	3461
Score > 2	0.74	0.61	52	18	2892	1849
Score > 3	0.73	0.64	51	19	3034	1707
Score > 4	0.4	0.85	28	42	4030	711
Score > 5	0.3	0.91	21	49	4313	428
Score > 6	0.23	0.95	16	54	4504	237
Score > 7	0.11	0.98	8	62	4646	95
Score > 9	0.09	0.99	6	64	4694	47

Model assessed using all patients in the current study (derivation & validation cohort)
Overall model AUC = 0.733 [0.679-0.788]

of the lungs in chronic obstructive pulmonary disease (COPD) patients alters chest anatomy and disrupts swallowing function, contributing to a higher rate of dysphasia-related aspiration pneumonia [18]. In addition, the association of lung disease with GERD is a well-known phenomenon. The extent to which chronic microaspirations seen in GERD correlate with macroaspiration events, however, is not well understood [2].

The association between percutaneous coronary intervention and aspiration may be more difficult to explain. It may be that PCI serves as a more sensitive measure of silent ischemic brain injury than previous myocardial infarction or stroke. Of note, a history of cerebrovascular disease was not significantly predictive of aspiration pneumonia in our analysis despite the greatly increased incidence of aspiration reported in the stroke population [7,8]. This may be attributed to statistical error due to low sample size, but may also be a related to the selection bias of cardiac surgery patients for less severe cerebrovascular disease. Neural reflex arcs between the esophageal and cardiac plexuses have been described, and also may play a role in the current finding. In a study by Makk, et al. of patients undergoing cardiac catheterization, patients undergoing catheterization with PCI had significantly higher esophageal sensitivity than those undergoing isolated catheterization [19]. Although their report was low-powered, it demonstrates that coronary artery disease can have direct effects on the esophageal nervous system, which may play a role in the propensity to develop dysphagia.

Pre-operative dialysis has not been previously reported as a risk for aspiration pneumonia; however, pre-operative renal dysfunction has been identified as a risk factor for post-operative dysphagia in patients undergoing cardiac operations in one single-center study [20]. Likewise, history of CHF has been proposed as possible risk factor, although its mechanism for contributing to aspiration pneumonia is unknown [20]. Finally, urgent status may play a role in aspiration pneumonia by serving as a marker of incomplete fasting before surgery, contributing to macroaspiration risk and raising the pH of gastric contents allowing pathogenic organisms to flourish [21,22].

Aspiration pneumonia is a relatively rare but catastrophic event, with an overall prevalence of 1.48% (70/4741) at our center throughout the study period. This inherently low-powered analysis limits the predictive abilities of statistical modeling. Despite these limitations, our modeling procedure resulted in estimated AUC of 73% over the entire study period. Using a cutoff of > 2 risk criteria (score > 3), the model captures most aspiration cases, but has a high false positive rate (Table 4). However, this is an expected outcome when modeling low frequency occurrences. The gradual increase in aspiration pneumonia prevalence with higher Risk Score can be appreciated in Figure 3. Furthermore, there is a significant increase in patients with a score > 9, such that 21% (6/28) of patients had aspiration pneumonia.

The high morbidity associated with aspiration pneumonia demands an efficacious prevention plan. Semi-recumbent positioning and head-of-bead elevation is recommended to reduce aspiration risk postoperatively, although evidence supporting its use is lacking [23]. Swallowing rehabilitation and speech therapy may be used to promote faster resolution of dysphagia; Starks and colleagues report a 0% aspiration pneumonia incidence amongst their cardiac surgery patients after implementation of strict protocols involving extensive swallowing rehabilitation [24]. Warusevitane, et al. showed that metoclopramide reduces pneumonia rates in subacute stroke patients requiring enteral feeding in a small, randomized clinical trial [25]. Enteral feeding is known to significantly increase aspiration pneumonia risk. Although post-pyloric placement of feeding tubes is thought to lower aspiration risk, multiple comparisons of gastric vs post-pyloric feeding tubes have failed to show convincing evidence supporting this [2]. Percutaneous Endoscopic Gastrostomy (PEG) tubes have been shown to have superior feeding capabilities in patients with swallowing disturbances, but equal rates of pneumonia when compared to nasogastric tubes [26]. Because of the retrospective nature of this study, we were unable to assess which patients received postoperative enteral feeding and how it may have impacted aspiration incidence. Finally, early tracheostomy has been proposed for patients requiring longer-term postoperative mechanical ventilation, although its benefit is controversial [27].

The above preventative strategies all carry associated costs of implementation. Choosing when to apply more expensive interventions must be guided by both clinical intuition and careful identification of patients at high risk. In the model described above, optimum sensitivity and specificity was achieved at a Score > 3, or any 2 of the derived risk factors, although applying this criteria still results in many false positives. Thus, a conservative strategy involving low-cost, non-invasive prevention techniques is appropriate for this population. In contrast, individuals with a Score > 9 had a 21% risk of aspiration pneumonia; in this population, a more intensive prevention strategy should be tailored to address this high risk group. By stratifying patients by risk using the developed Aspiration Risk Score, preventative measures may be utilized to both improve patient outcomes and optimize cost associated with post-operative care.

This study has several weaknesses. As mentioned previously, aspiration pneumonia is a rare complication, and the low statistical power limits the analyses performed. Furthermore, we were unable to document all cases of aspiration and instead focused on those cases that lead to infectious pneumonitis. In this way, we do not account for cases of strict chemical pneumonitis or so-called "silent aspirations" that do not progress to pneumonia. In addition, factors that may have impacted aspiration incidence such as enteral feeding or poor oral hygiene could not be assessed. Finally, this study carries limitations associated with the retrospective, single-center design. Prospective studies are needed to evaluate the efficacy of this model in aspiration prevention protocols.

In summary, aspiration pneumonia represents a rare but serious postoperative complication in the cardiac surgery population. We identified several variables associated with aspiration pneumonia, and proposed and validated a scoring system to help identify patients at high risk. This system may have implications in patient selection, postoperative management, and prophylactic prevention measures in the future.

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