Journal of Critical Care xxx (2014) xxx–xxx

Contents lists available at ScienceDirect

Journal of Critical Care

journal homepage: www.jccjournal.org

Duration of oral endotracheal intubation is associated with dysphagia symptoms in acute lung injury patients☆,☆☆

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ARTICLE INFO

Keywords:
Deglutition
Dysphagia
Intubation
Mechanical ventilation
Acute lung injury

ABSTRACT

Purpose: The purpose of this study is to evaluate demographic and clinical factors associated with self-reported dysphagia after oral endotracheal intubation and mechanical ventilation in patients with acute lung injury (ALI).

Materials and methods: This is a prospective cohort study of 132 ALI patients who had received mechanical ventilation via oral endotracheal tube.

Results: The primary outcome was binary, whether clinically important symptoms of dysphagia at hospital discharge were reported by patients, using the Sydney Swallowing Questionnaire score 200 or more. Of 132 patients, 29% reported clinically important symptoms of dysphagia. Of 18 relevant demographic and clinical variables, only 2 were found to be independently associated with clinically important symptoms of dysphagia in a multivariable logistic regression model: upper gastrointestinal comorbidity (odds ratio, 2.82; 95% confidence interval, 1.09-7.26) and duration of oral endotracheal intubation (odds ratio, 1.79; [95% confidence interval, 1.15-2.79] per day for first 6 days, after which additional days of intubation were not associated with a further increase in the odds of dysphagia).

Conclusions: In ALI survivors, patient-reported, postextubation dysphagia at hospital discharge was significantly associated with upper gastrointestinal comorbidity and a longer duration of oral endotracheal intubation during the first 6 days of intubation.

1. Introduction

There are an estimated 5.7 million intensive care unit (ICU) admissions in the United States annually [1], with at least one-third requiring intubation with mechanical ventilation [2,3]. The number of adults requiring mechanical ventilation is growing, most rapidly for individuals more than 65 years old, with an expected 80% increase from 2000 to 2026 [4,5].

With the introduction of an oral endotracheal tube, laryngeal injury [6,7] and altered laryngeal sensation [8-11] frequently occur and may result in impaired swallowing [12]. Postextubation swallowing disorders (ie, dysphagia) have been reported in 14% to 83% of adult patients undergoing prolonged mechanical ventilation [13-17].

Dysphagia can have significant sequelae, including aspiration leading to lung injury and death [18-22]. Clinical studies of dysphagia after extubation have largely evaluated the presence of aspiration alone and are frequently limited by small sample sizes and heterogeneous patient groups [23,24]. Acute lung injury (ALI) is an archetype of critical illness [25], with patients having a high severity of illness, prolonged mechanical ventilation, and ICU-acquired muscle weakness, all of which may put patients at high risk for postextubation dysphagia. The aim of this study was to evaluate the association between the duration of oral endotracheal intubation and patient-reported dysphagia at hospital discharge in mechanically ventilated ICU patients with ALI.

☆ Research completed at Johns Hopkins Hospital, Johns Hopkins Bayview Medical Center, University of Maryland Medical Center, and Baltimore VA Medical Center.

☆☆ This research was supported by the National Institutes of Health (P050HL73994 and 5KL2RR025006).

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http://dx.doi.org/10.1016/j.jcrc.2014.02.015

2. Materials and methods

2.1. Study population

This evaluation was conducted as part of a prospective, multisite cohort study [26] evaluating consecutive mechanically ventilated patients with ALI, as defined by the American-European Consensus Conference criteria [27]. Eligible patients were recruited from 13 ICUs at 4 teaching hospitals in Baltimore, MD. Key patient exclusion criteria for this prospective cohort study were (1) more than 5 days of mechanical ventilation before ALI, (2) preexisting cognitive impairment or communication/language barrier, (3) transfer into a study site ICU with preexisting ALI of more than 24-hour duration, (4) limitations in advancing ICU care at the time of study eligibility (eg, no use of vasopressors), and (5) preexisting illness with a life expectancy of less than 6 months. To avoid including patients with primary neurologic disease or head trauma, neurologic specialty ICUs at participating hospitals were excluded from the study. In addition, because of this evaluation's focus on dysphagia symptoms after oral endotracheal intubation, for purposes of this analysis, we excluded study patients who (1) had a tracheostomy or nasal endotracheal tube during their ICU stay, (2) had a history of prior tracheostomy, (3) were not consented, not eating by mouth or not capable of completing the Sydney Swallowing Questionnaire (SSQ) (eg, due to physical or cognitive impairment) at hospital discharge, or (4) discharged directly to another acute care hospital (ie, discharge from study site hospital did not represent the ultimate timing of acute care hospital discharge). All institutional review boards at participating sites approved this study, and written informed consent was obtained from each study participant or their substitute decision maker.

2.2. Primary outcome

The primary outcome measure for this evaluation was self-reported, clinically important dysphagia symptoms at hospital discharge. Dysphagia symptoms were assessed using the SSQ. The SSQ is a patient-reported, 17-item, validated symptom inventory used to assess severity of dysphagia symptoms [28]. The SSQ primarily uses a visual analog scale, with items scored 0 to 100 and the total SSQ score ranging from 0 to 1700. The SSQ was scored in the same manner as the original validation study [28], with higher scores representing increased patient-perceived difficulty with swallowing. Scores 200 or more are considered indicative of clinically important dysphagia [28], which was the primary binary outcome used in this evaluation.

2.3. Primary exposure

The primary exposure measure was duration of incident oral endotracheal intubation, measured in days. Patients extubated for less than 48 hours before being reintubated were considered to be continuously intubated from the initial placement of the oral endotracheal tube until extubation for 48 continuous hours or more [29].

2.4. Covariates

Patient and ICU variables evaluated for their potential association with dysphagia in this study were selected based on the existing literature and investigators' prior knowledge in this field. The following patient characteristics were considered: age, sex, race, and body mass index (BMI). Body mass index was categorized according to the standard criteria [30] to assist with clinical interpretation. Overall comorbidity burden (as measured by the Charlson Comorbidity Index [31]) was evaluated. We also evaluated preexisting neurologic comorbid disease (defined as stroke and any other neurologic disease [eg, transient ischemic attack, Parkinson disease, multiple sclerosis, and dementia]) and comorbid upper gastrointestinal disease (defined to include peptic ulcer, hiatal hernia, and gastroesophageal reflux disease). The following variables related to patients' critical illness were also included in this evaluation: ICU admitting diagnosis category, severity of illness at ICU admission (Acute Physiology and Chronic Health Evaluation [APACHE] II score [32]), organ dysfunction at ALI onset (Sequential Organ Failure Assessment [SOFA] [33]), reintubation, and ICU length of stay.

2.5. Statistical analysis

Descriptive statistics were reported using median and interquartile range (IQR) for continuous data and proportions for categorical data. A Wilcoxon rank sum test was used to test for a significant difference in the time between extubation and completion of SSQ at hospital discharge for patients with vs without dysphagia. To confirm the appropriateness of modeling the odds of dysphagia as a linear function of each continuous variable, we examined a locally weighted smoother scatterplot [34-36] of the predicted odds vs the variable. Of all continuous variables, only the primary exposure variable demonstrated a potentially nonlinear relationship with the primary outcome, with a linear increase observed during the first 6 days of oral endotracheal intubation, followed by a plateau with minimal change thereafter (Fig. 1).

The associations of individual variables with the primary outcome (ie, binary indicator of dysphagia) were evaluated using logistic regression, with associations presented as odds ratios (OR). To prevent overfitting the multivariable logistic regression model, we limited the number of variables in this model to a ratio of 1 variable per 10 outcomes [37,38]. Individual covariates were included in the multivariable logistic model if they exhibited a bivariable association with the primary outcome with a $P < .10$. To address the nonlinear association of mechanical ventilation duration with the primary outcome in regression analyses, the duration of intubation was modeled using a linear spline with a "knot" at 6 days; thus, permitting different linear associations between the duration of intubation and the primary outcome before and after the designated "knot" [36,39].

As a secondary analysis, we evaluated the association of individual variables with the continuous SSQ score using linear regression, with associations presented as relative medians (RM). Because the distribution of SSQ scores was right skewed, we used the log-transformed SSQ score as the outcome variable for this model. As in the logistic regression model, duration of intubation was modeled using a linear spline with a "knot" at 6 days, and individual covariates were included in the final multivariable model if they exhibited bivariable associations with the outcome with a $P < .10$.

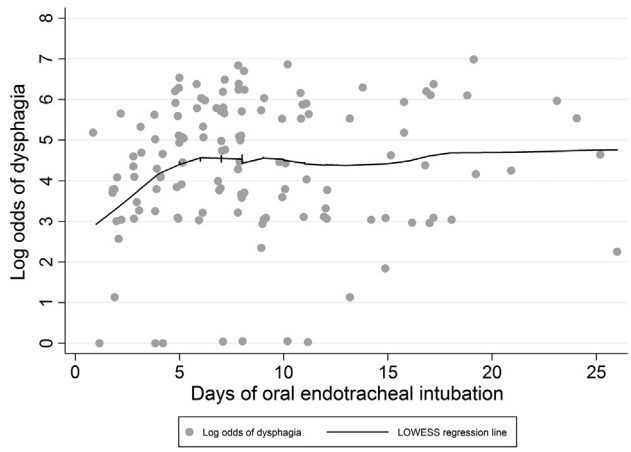

Fig. 1. Log odds of dysphagia (ie, SSQ score, ≥200) vs duration of mechanical ventilation with an oral endotracheal tube.

Please cite this article as: Brodsky MB, et al, Duration of oral endotracheal intubation is associated with dysphagia symptoms in acute lung injury patients, J Crit Care (2014), http://dx.doi.org/10.1016/j.jcrc.2014.02.015