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Prognostic indicators for early mortality after tracheostomy in the intensive care unit

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ABSTRACT

Background: Tracheostomy is indicated for patients requiring prolonged mechanical ventilation. The aim of this study is to identify prognostic indicators for early mortality after tracheostomy to potentially avoid futility in the intensive care unit.

Methods: Patients who underwent tracheostomy and died within 30 d of admission (futile group) were compared with patients who underwent tracheostomy and survived more than 30 d after admission (nonfutile group). Categorical data were analyzed using chi-square and Fisher's exact tests. Continuous variables were analyzed using T-tests and Mann–Whitney *U* tests. Prognostic factors were evaluated with univariable and multivariable logistic regression analyses.

Results: Overall, 88.3% of patients underwent nonfutile tracheostomy, while 11.7% underwent futile tracheostomy. Serum albumin level (1.5 g/dL *versus* 1.9 g/dL, $P = 0.040$) and mechanical ventilation duration before procedure (10 *versus* 12 d, $P = 0.029$) were significantly less in the futile group. Hypoalbuminemia (<2 g/dL) and preoperative mechanical ventilation ≤10 d were also predictive of futile tracheostomy in multivariable analysis.

Conclusions: Hypoalbuminemia may serve as a prognostic indicator and risk factor for early mortality after tracheostomy. In patients with hypoalbuminemia, treatment of underlying disease processes and trending serum albumin level recovery in response to treatment may provide some insight to clinicians with regard to timing of tracheostomy. Better prognostic tools are still needed for critically ill patients to avoid futility in the intensive care unit. In this cohort, 88.3% of patients undergoing tracheostomy survived past 30 d.

Introduction

Tracheostomy is indicated for patients requiring prolonged mechanical ventilation. It offers greater patient comfort, decreased sedative and antipsychotic use, increased airway security, lower prevalence of unplanned extubation, and easier patient mobility.[1,2] In addition, early tracheostomy has been shown in select patient groups to decrease intensive care

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unit (ICU) length of stay (LOS) and duration of mechanical ventilation.[3] However, randomized control studies and meta-analyses comparing early and late tracheostomy have shown that timing does not affect mortality or overall hospital outcome.[2,4-6]

Although the incidence of tracheostomy in critically ill patients continues to increase, it is not without risks. Loss of airway, bleeding, and infection comprise early complications.[7] Excess granulation tissue with tracheal stenosis, tracheomalacia, tracheoarterial fistula, and persistent stoma can be seen in the late period.[7] Tracheostomy is associated with a major complication rate of 4.3% and mortality rate of 0.7%.[8] The purpose of this study is to identify prognostic indicators of early mortality in patients who underwent tracheostomy to avoid the performance of futile procedures.

Methods

Our institutional review board reviewed this retrospective study of 500 consecutive critically ill patients who underwent tracheostomy, and determined that it was exempt from review and the need for patient consent. All patients had tracheostomies performed for respiratory failure at a single, tertiary care center between August 20, 2009 and October 12, 2013. Inclusion criteria consisted of adult patients at least 18 years of age with respiratory failure requiring mechanical ventilation. Patients with missing operative data, presentation from an outside facility, history of prior tracheostomy, tracheostomy procedures for oral cavity or upper airway malignancy, and emergent cricothyroidotomy or ambulatory procedures were excluded from the analysis. Patients who underwent tracheostomy and died within 30 d of admission were identified and labeled as having undergone futile procedures (futile group [FG]). These patients were compared to patients who underwent tracheostomy and survived more than 30 d after admission (nonfutile group [NFG]). Days were defined based on a 24-h period with a new day beginning after midnight. We collected specific demographic and clinical variables, as well as other characteristics regarding each patient's course, including: age, gender, preoperative laboratory data; length of ICU stay; length of hospital stay; body mass index; type of procedure; disposition on discharge; reoperation due to tracheostomy complications; medical ICU (MICU) admission *versus* surgical ICU (SICU) admission; otorhinolaryngology *versus* surgery performance of tracheostomy; history of trauma; positive end-expiratory pressure $\geq$10 cm H_2O; and history of cervical spine injury.

Categorical data were analyzed using chi-square and Fisher's exact tests. Continuous variables were analyzed using T-tests and Mann–Whitney *U* tests. Prognostic factors for futility were evaluated with univariable and multivariable logistic regression analyses. Based on the differences that we found between the two groups (Table 1), we selected preoperative serum albumin, age, preoperative serum creatinine, and duration of mechanical ventilation before tracheostomy for logistic regression analysis. An analysis of "days on mechanical ventilation" before tracheostomy revealed that the mode was 10 d, and the mean was 12.2 (±5.9) d (Fig. 1). Distribution of days on mechanical ventilation between the two groups is demonstrated in box plots (Fig. 2). There were 12 patients with 0 d of mechanical ventilation before tracheostomy. Five of these 12 patients underwent tracheostomy on the same day of admission, and 7 of the 12 underwent tracheostomy between 4 and 14 d after admission. Based on these findings, we incorporated a cutoff of 10 d for the duration of mechanical ventilation before tracheostomy and included it as a separate variable in the logistic regression tests to evaluate prognostic factors for futile tracheostomy. Similarly, we defined benchmarks of 60 years for age, 2 g/dL for preoperative serum albumin, and 1.3 mg/dL (which is abnormal in our laboratory) for preoperative serum creatinine (Tables 2 and 3). The statistical significance for the difference of creatinine between the two groups was marginal (P value = 0.051). As such, although nonsignificant, we included the preoperative serum creatinine with the defined benchmark in our logistic regression. The calibration of the final model was tested with a Hosmer–Lemeshow test.

Results

Retrospective review identified 500 consecutive patients who underwent tracheostomy at a tertiary care ICU during the study period, of which 82 were excluded. About 369 of 418 (88%) survived beyond 30 d after admission and were placed in the NFG. Overall, 49 of 418 (12%) patients died within 30 d of admission and were therefore placed in the FG. Twenty-five of these patients (51%) were identified as "do not resuscitate" or withdrawal of care and/or comfort care status at some point in their hospitalization. Comparative analysis of these cohorts is described in the following paragraphs and presented in Table 1.

The two groups were well matched with regard to basic demographics. There were no significant differences in age, gender, or weight. In addition, no difference was detected in ICU setting (MICU *versus* SICU) between the cohorts. Etiologies such as cervical spine injury or trauma were compared between cohorts with no difference. Overall, the two cohorts underwent similar procedural techniques. Percutaneous tracheostomy was performed more frequently than open tracheostomy with no statistical difference (57.2% *versus* 42.8%, $P = 0.217$). In the SICU, percutaneous tracheostomy was performed in 152 of 182 (83.5%). Whereas in the MICU, percutaneous tracheostomy was performed in 87 of 236 (36.9%). There was no statistically significant difference in futility based on technique (Table 4).

Significant differences in duration of mechanical ventilation, ICU, and hospital LOS, serum albumin level, discharge disposition, and mortality were identified between the cohorts. The median duration of mechanical ventilation before tracheostomy was 10 d for the FG (range, 0-21 d) compared with 12 d for the NFG (range, 0-42 d). This difference was statistically significant ($P = 0.029$). Mechanical ventilation days before tracheostomy in the entire cohort was 12 d (range, 0-42 d). Positive end-expiratory pressure $\geq$10 cm H_2O was observed in 40 of 418 (9.6%) of patients—no difference was seen between FG and NFG.

The median ICU LOS was 19 d (range, 0-29) in the FG compared with 25 d (range, 3-130) in the NFG ($P < 0.0001$). The