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Predictors of extubation success in acute ischemic stroke patients

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ABSTRACT

Background: Acute ischemic stroke (AIS) patients often undergo intubation and mechanical ventilation (MV). Prolonged intubation and MV have disadvantages and complications. Conventional extubation criteria based only on respiratory parameters are insufficient to guide extubation practices in stroke patients where capacity for airway protection is a major concern.
Objective: To identify clinical and neuroanatomical markers of successful extubation in AIS patients requiring MV.
Methods: Retrospective review of tertiary care hospital patient database from May 2009–November 2012 to identify consecutive patients with AIS intubated during hospitalization. We assessed the effect of age, sex, baseline National Institutes of Health Stroke Scale (NIHSS) score, level of consciousness, facial weakness, dysarthria, neglect, infarct location, dysphagia, respiratory parameters and history of pneumonia on successful extubation by hospital discharge using multivariate logistic regression analysis.
Results: 112 subjects met study criteria and were included in the analysis. Age and NIHSS scores (mean ± standard deviation) were 74.5 ± 16.1 years and 19 ± 9.8, respectively; 56% were women. In multivariate analysis, NIHSS score ≤ 15 (Odds Ratio 4.6, 95% Confidence Interval 1.9–11.3, $p < 0.001$) and absence of dysarthria prior to intubation (Odds Ratio 3.0, 95% Confidence interval 1.1–8.3, $p = 0.04$) were independently associated with successful extubation. Conventional respiratory parameters had no effect on extubation success in this cohort.
Conclusions: Milder stroke and absence of dysarthria prior to intubation were independently associated with extubation success. Our findings could help inform extubation practices in patients with AIS though prospective validation is necessary.

1. Introduction

Acute Ischemic Stroke (AIS) stroke patients may require intubation and mechanical ventilation (MV). In the acute stroke phase, decisions regarding extubation are driven by concerns stemming from a depressed level of consciousness (LOC) and/or inability to handle oral secretions rather than concerns about primary respiratory failure. Patients with brain injury meet conventional extubation criteria which are classically based only on pulmonary mechanics, such as spontaneous breathing trials and rapid shallow breathing indices. Perhaps due to this fact, extubation failure rates in these patients can be as high as 40% [1]. In prior studies of intubated patients with primary neurologic injury, depressed LOC and inability to follow commands, predicted extubation failure [2], increased mortality [3] and poor long-term outcome [4]. Another small study that included only middle cerebral artery infarcts suggested that laterality might be associated with extubation success, with left hemisphere AIS having considerably better outcome [5]. However, there are no well-defined clinical tools to guide extubation practices in AIS patients [6].

The purpose of our study was to identify early predictors of extubation success in AIS and elucidate the relative contribution of neurologic and respiratory parameters. We focused on clinical parameters that can be easily detected and recorded and are present on patient presentation, immediately preceding the initial intubation and hypothesized that there are distinct neurologic clinicoanatomical variables that are associated with successful extubation after adjusting for patient's respiratory status.

2. Materials and methods

2.1. Study population

We performed a retrospective study of all patients with AIS admitted to a large academic medical center in Boston between November 2009 and May 2012. We screened consecutive patients admitted to the hospital during this period using ICD-9 codes (433.11, 433.21, 433.31, 434.01, 434.11, 459.0) and isolated those with AIS who required endotracheal intubation. Alternative neurological diagnoses, including transient ischemic attacks, seizures intracerebral hemorrhage, subarachnoid hemorrhage, subdural hemorrhage, traumatic brain injury, intracranial tumors, were excluded. Patients intubated for emergent surgery or other procedures were included in the analysis if not extubated

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immediately after the procedure due to concern for their ability to protect their airway. We identified 1612 patients, 1500 of which were excluded: 851 of those had AIS but did not necessitate intubation; 370 had an intracerebral hemorrhage and 279 were excluded because of alternate diagnosis. The remaining 112 patients met our inclusion criteria and were included in the final analysis. Of these 112, 7 were intubated specifically for surgical or medical procedures (6 for carotid endarterectomy, 1 for transesophageal echocardiogram). All 7 patients were extubated successfully.

2.2. Procedures

Endotracheal intubation took place either in the Emergency Department or in the Neuro – Intensive Care Unit (ICU). All intubated patients received MV and were weaned to pressure support as tolerated if breathing spontaneously. Nursing oral and airway care was delivered according to institutional protocol. They were evaluated daily by qualified respiratory technicians and underwent daily spontaneous breathing trials to assess their readiness for extubation as indicated by institutional intensive care unit ventilator protocols. The final extubation decision was made by the treating Neuro ICU attending physician.

2.3. Data collection

Variables were determined by hospital record review: Age, sex, National Institutes of Health Stroke Scale scores (NIHSS) on presentation prior to intubation. The following parameters were recorded as binary (yes/no)smoking status, history of primary respiratory illness (Chronic obstructive respiratory disease or asthma), history of Congestive heart failure (CHF), development of ventilator-associated pneumonia (VAP), stroke location (right-, left- or bi- hemispheric, or brainstem/infratentorial), re-intubation history, terminal extubation and in-hospital mortality. When missing, NIHSS scores were estimated retrospectively using validated algorithms [7]. We also recorded the following respiratory parameters for each patient, for the duration of their intubation: Fraction of inspired oxygen (FiO2), minute volume ventilation, total positive end expiratory pressure (PEEP) and the rapid shallow breathing index (RSBI) which is the ratio of respiratory frequency to tidal volume and used as an indicator of weaning readiness to extubation [8]. For each of the respiratory variables the average value over the length of intubation was calculated and used in the statistical analyses.

2.4. Definitions

Extubation success was defined as lack of a need for re-intubation for 48 h after extubation. Terminal extubation, need for tracheostomy and re-intubation were classified as "extubation failures". Terminal extubation, per our institutional nomenclature is used to imply extubation in the context of transitioning care toward comfort measures. Terminal extubation was classified as extubation failure as in the vast majority of these patients in our cohort, the decisive, explicit reason driving the decision was the necessity for tracheostomy and percutaneous gastrostomy (if care were to be continued in these group of patients, all of them would have necessitated tracheostomy). Pneumonia diagnosis was based on clinical criteria by the treating physician and confirmed by chart review. A combination of fever, leukocytosis and presence of infiltrate in chest radiograph were required to adjudicate the diagnosis. VAP was defined as pneumonia after 48 h of ventilation with a clean chest X-ray on presentation; eventually both VAP and other cases of pneumonia were clustered together as "pneumonia". CHF was defined as confirmed history of it or a transthoracic echocardiogram with an ejection fraction of <30%. Dysarthria and facial weakness were defined as present (score ≥ 1 in the relevant NIHSS item) or absent (score = 0). LOC was defined as awake (score = 0 in item LOC1a of the NIHSS) or not awake (score ≥ 1 in item LOC1a). Severe stroke was defined as NIHSS ≥ 15; old age as >75 years. Cutoff values were chosen based on clinical relevance and prior studies [9].

2.5. Statistical analysis

Patients were dichotomized in two groups based on extubation success. Descriptive statistics were obtained, using chi-squared test for categorical dichotomous variables and two-tailed Student's *t*-test for continuous variables. Continuous variables are expressed as means and standard deviations or median and interquartile range as specified and dichotomous variables expressed as proportions.

A multivariate logistic regression model was constructed, with extubation success as the event of interest, utilizing a priori chosen clinically relevant covariates as well as covariates whose difference between the groups reached statistical significance, denoted as p value < 0.05 (age, stroke severity, presence of pneumonia, stroke location, dysarthria, facial weakness). Data were analyzed using STATA/IC 13.1 (StataCorp, College Station, Texas, USA).

3. Results

3.1. Patient characteristics

Characteristics of our patient cohort are summarized in Table 1. Strokes were severe as suggested by a median NIHSS severity of 19 and when dichotomized as severe vs mild, 38% were mild. 56 (50%) of the patients were extubated successfully. The median day of intubation relative to ischemic stroke was 0, range (0–8). Of the 27 infratentorial strokes, 11 were restricted to the cerebellum only, although on all occasions there was significant brain edema with compression of the brainstem.

3.2. Between group comparisons, univariate and multivariate analyses

In the univariate analysis, stroke severity using total NIHSS scores was significantly lower in the group of successfully extubated patients and naturally the proportion of patients with "severe" stroke was significantly higher in the group that failed extubation (Table 2). Presence of dysarthria and depressed LOC were also strongly associated with extubation failure. Stroke location, facial weakness, aphasia or neglect did not demonstrate a significant association with extubation success. There were no significant differences in any of the respiratory variables (Table 2). None of the respiratory parameters were associated with extubation success.

In multivariate analysis, milder stroke (OR 4.6, 95% CI 1.9–11.3) and absence of dysarthria on presentation (OR 3.0, 95% CI 1.1–8.3) were independently associated with extubation success (Table 3). NIHSS score introduced as a continuous instead of dichotomous variable in the model retained a robust association with extubation success (results

Table 1
Baseline characteristics of the patients in our cohort. The numbers in parentheses denote percentage of patients with the relevant characteristic.

	N = 112
Age (median, IQR)	74.5 (62–84)
NIHSS (median ± SD)	19 (11–26)
Gender (N, % female)	63 (56)
Pneumonia (N, %)	33 (29)
Smoking (N, %)	23 (21)
Right hemisphere (N, %)	51 (46)
Left hemisphere (N, %)	69 (61)
Bihemispheric (N, %)	20 (18)
Infratentorial (N, %)	27 (24)
Mild stroke (NIHSS ≤ 15)	42 (38)
Absence of dysarthria (score 0 in NIHSS)	30 (27)
Old (age > 75 years)	51 (46)