Unanticipated difficult intubation in the medical-surgical intensive care unit: its effect on outcome of critically-ill adults.

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Citation

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Abstract

Background: Difficult intubation (DI) occurs more frequently in the intensive care unit (ICU) than in the operating room and is associated with severe complications including hypotension, hypoxemia, and even cardiac arrest.Objective: To investigate the effects of unanticipated difficult intubations on intensive care related outcomes in adults.Methods: Retrospective chart-review of intubations performed in the medical/surgical ICU of a University hospital by the anesthesia service over a 12-month period where direct laryngoscopy (DL) was attempted initially. DI was defined as > 3 attempts at DL or > 2 attempts with an airway adjunct. Dependent variables were ventilator days, tracheostomy, ICU length of stay (LOS), and ICU mortality. ICU mortality was adjusted by calculating the standardized mortality ratio (SMR) using APACHE-predicted mortality as the denominator. The relationship between intubation attempts and mortality was assessed by Spearman nonparametric correlation (r^2).Results: 22% of 113 intubations were difficult. Baseline characteristics, predicted mortality, and indication for intubation were similar between groups. The most used medications and airway adjunct were Etomidate and Succinylcholine and the Eschmann tracheal tube introducer, respectively. Overall, SMR was not significantly higher in DI group (1.76, 1.01). A correlation between number of airway manipulations (>2) and mortality was found (r^2=0.8, p=0.04). The odds of tracheostomy were higher in DI [OR=3.7 (95% CI 1.1-12), p=0.03]. Ventilator days and LOS were similar between groups.Conclusion: Unanticipated difficulty with intubating adult ICU patients increases the odds of tracheostomy and may lead to higher than expected ICU mortality.

INTRODUCTION

Tracheal intubation is a commonly performed and essential procedure in critical care. Thus, expertise in airway management is a requisite skill for clinicians caring for critically ill patients. Airway management in the critical care setting compared to the operating room (OR) is a distinctly different clinical entity dependent upon the patient's primary diagnoses, indication for intubation, urgency, and presence of active and/or suboptimally treated comorbid diseases frequently associated with poor physiologic reserve and minimal margin of safety when an unanticipated difficult airway is encountered. The incidence of difficult intubation (DI) under critical care conditions has been reported to be 8-13.2% (1-3). Airway management-related morbidity (e.g. hypoxemia, hypotension, esophageal intubation, and aspiration) and mortality reportedly occurs in 28-39% (2-3) and 3% of patients (1), respectively. The odds of complications and death correlate with increasing numbers of airway manipulations (4). Severity of illness adjusted rather than gross mortality is often reported in the context of interventions in critical care, but has not been reported in the context of airway management.

The primary purpose of this investigation was to examine the impact of unanticipated DI on severity adjusted intensive care unit (ICU) mortality. Secondary outcomes of interest were resource consumption, tracheostomy rates, and whether severity of illness is an independent predictor of DI.

MATERIALS AND METHODS

The study is a retrospective chart review of critically ill adults in the University of Wisconsin Hospital and Clinics (UWHC) 24-bed adult ICU, which admits non-cardiac medical and non-cardiothoracic surgical patients, including trauma and organ transplant recipients. Emergent tracheal intubation (ETI) performed by the anesthesia service in patients ≥18 years-of-age outside of the OR between July 1, 2006 to June 31, 2007 were identified retrospectively from departmental records. Only the first intubation performed was included. Cardiopulmonary arrest and re-intubations were excluded. A difficult intubation (DI) was defined as one requiring ≥3 attempts by direct laryngoscopy (DL) or ≥2 attempts by DL with an airway adjunct such as an eschmann tracheal tube introducer. All others were considered easy (EI). An airway manipulation was further defined as an attempt using any equipment to intubate the trachea. Data collected from departmental records included medications administered by the anesthesia provider to facilitate intubation, the types of equipment used, the number of attempts made by various means in order to secure the airway, and the operator or operators who performed the intubation. Anesthesia trainees with at least 6 months of intra-operative experience performed all intubations. The least experienced trainee included in this analysis performed at least 200 tracheal Paper and electronic medical records were used to corroborate information and to record the dates of admission and discharge from the ICU, days of mechanical ventilation, need for tracheostomy, and body weight and height in order to calculate body mass index. Admission source and other data required to calculate the APACHE III scores were gathered within 24 hours of admission to the ICU using APACHE III software (Cerner, McLean, VA.) by a trained outcomes coordinator. The University of Wisconsin institutional review board approved the study and waived the requirement for informed consent.

STATISTICAL ANALYSIS

Measured dependent variables included whether or not tracheostomy was required, ventilator days, ICU length of stay, and mortality. Groups were divided into DI and EI. Categorical variables were compared using chi-square analyses or Fisher's exact test while differences in discrete variables were compared by nonparametric statistical tests. Continuous variables (age, body mass index (BMI), and APACHE score) were analyzed by parametric or non-parametric means depending on whether they were normally or non-normally distributed. The relationship between difficult intubation and continuous dependent outcomes (length of stay, ventilator days) and categorical dependent outcomes (tracheostomy, mortality) were evaluated by multivariate linear regression analysis and logistic regression with a backward elimination procedure, respectively. All covariates were selected based upon clinical judgment, those previously hypothesized to be confounders of the relationship between difficult intubation and patient outcomes, and those that the investigators felt confident would be consistently available for data extraction in paper or electronic format. Standardized mortality ratio (SMR) was calculated by dividing the actual number of deaths by the predicted deaths from the APACHE III database, then multiplying times 100 and reported with a 95% confidence interval (CI). Statistical significance was defined as a two-sided p value < 0.05. All analysis was performed using SAS statistical software version 9.1 (SAS Institute, Cary, NC.).

RESULTS

During the study period, 113 oral tracheal intubations were performed. Two patients presented to the ICU intubated after surgical procedures and self-extubated, thus fulfilling our inclusion criteria. Twenty-five (22%) were considered difficult. The baseline characteristics of DI and EI including the indications for intubation, medications administered, and additional equipment used during ETI is presented in Table 1.

Figure 1

Table 1-Baseline Characteristics of 113 Patients Undergoing ETI*

	Easy (n=88)	Difficult (n=25)
Age, yrs	51 ± 16	56 ± 17
Male gender	60 (68.2)	14 (56)
BMI, kg/m^2	31 ± 11	30 ± 7.5
APS	54 ± 22	53 ± 21
Apache III Score	62 ± 24	62 ± 24
Admission Type		
Medical	52 (59)	18 (72)
Surgical	11 (12.6)	2 (8)
Trauma	12 (13.6)	1 (4)
Neuro/Neurosurgical	13 (14.8)	4 (16)
Indication		
Hypoxemia	47 (53.4)	8 (32)
Hypercapnia	7 (8)	4 (16)
Airway Protection	16 (18)	7 (28)
Shock	13 (14.8)	4 (16)
Procedure	4 (4.5)	1 (4)
Self-extubation	1 (1.1)	1 (4)
No. Attempts	1(1-2)	3(2-5)
Medications		
Etomidate	60 (68)	17 (68)
Propofol	15 (17)	6 (24)
Midazolam	5 (5.7)	2 (8)
Fentanyl	5 (5.7)	2 (8)
Succinylcholine	38 (43)	10 (40)
Rocuronium	13 (14.7)	3 (12)
None	8 (9)	0
Additional equipment		
Eschmann tracheal tube introducer	11 (12.5)	17 (68)
Fiberoptic scope	0	4 (10)
LMA Exchange	0	2 (5)
GlideScope ™	0	1 (2.5)

*Data are presented as No. (%), mean ± SD, or median (range)
p<0.001

Groups were similar in BMI, acute physiology score, APACHE III scores, admission type, and indications for ETI. The most frequently administered medications and airway adjunct used were etomidate and succinylcholine and the eschmann tracheal tube introducer, respectively. An attending anesthesiologist was noted to be present for 3 intubations in the DI group and none in the EI group.

Outcome comparisons are presented in Table 2.

Figure 2

Table 2-Outcomes Comparisons of 113 Patients Undergoing ETI*

	Easy (n=88)	Difficult (n=25)
Mechanical Ventilation, d	5.8 ± 5.2	6.3 ± 6.3
Tracheostomy		
Overall	17 (19)	6 (24)
Medical/Surgical	7 (8)	6 (24)
Actual ICU LOS, d	10 ± 8.6	9.8 ± 8.4
Predicted ICU LOS, d	6.6 ± 2	6.6 ± 1.5
Actual ICU Mortality, %	15.9	28
Predicted ICU Mortality, %	16 ± 17	16 ± 15
SMR	1.01	1.76

*Data are presented as No. (%), mean ± SD
OR=3.7 (95% CI 1.1-12), p=0.03

Days of mechanical ventilation and ICU stay were similar. Observed mortality was higher in the DI group while that predicted by the APACHE system was similar yielding a higher SMR in the DI group (1.76, 1.01). A correlation between the number of airway manipulations (>2) and mortality was found (r^2=0.8, p=0.04). Among general medical and surgical patients, the odds of tracheostomy were higher in DI [OR=3.7 (95% CI 1.1-12), p=0.03]. Severity of illness was not identified as an independent predictor of DI.

DISCUSSION

The main results of our study are that among general medical and surgical patients, DI resulted in greater odds of tracheostomy and we confirmed the higher incidence of DI in the ICU as compared with that reported for elective surgical patients in the OR.

Although mortality associated with ETI in critically ill adults has been previously identified, no severity of illness-adjusted mortality has been reported. Thus, actual differences may have been overlooked. Schwartz et al. reported an overall mortality of 2.6% in patients intubated for reasons other than cardiac arrest (1). Many, but not all intubations in their report took place in critical care areas. Benedetto and colleagues reported a much higher mortality of 48% when ETI took place on the medical wards (5). Two recent ICU-specific studies reported mortalities of 46% and 15.4%, respectively (2-3). The disparate report of mortality among ETI studies likely reflects varying case mix, severity of illness, and indication for intubation. Our observed ICU mortality of 18.5% (15.9% in the EI group and 28% in the DI group) is commensurate with these reports and is in close agreement with the report of Griesdale et al (3). After adjustment for predicted mortality, we noted a higher than expected death rate among patients who were difficult to intubate. Except severe hypoxia leading to brain injury or cardiopulmonary arrest secondary to airway catastrophe, we are unable to provide a concrete biologically plausible explanation for this finding. Inconsistency in the medical record severely limited our ability to collect data pertaining to airway management complications. Severe hypotension and/or hypoxia related to airway management could have resulted in worsened organ function in a group of patients with already limited physiologic reserve and been reflected in a higher SMR. However, we acknowledge that our data in this regard can only be interpreted as supposition and hypothesis generating. Further, we are unaware of a statistical method, which can assign significance to a SMR and therefore, we are uncertain as to whether the higher than expected mortality in the DI group represents a statistically significant result. However, any lack of statistical differences in mortality would just as likely reflect of our small sample size as a lack of clinical effect. For example, a hypothetical group of patients similar to ours, but two-and-a-half times as large (283 patients), would have shown a significantly higher mortality in DI group (p-value=0.043) even before adjusting for APACHE-predicted mortality. Furthermore, the denominator in our SMR calculation, predicted mortality, was derived from the APACHE III database, which derives mortality predictions from data collected on 17,440 patients from 40 institutions between 1988 and 1989 (6). Because of treatment advances, the quality of care in ICUs has improved since this model was developed (7-10) and our predicted mortality is likely to have been overestimated. If this is indeed the case, our calculated SMRs would be even higher than what we are reporting, increasing the likelihood that a clinically and statistically relevant increase in mortality resulted from unanticipated DI.

General medical and surgical patients in our study had almost a four-fold increase in odds of tracheostomy after DI. To our knowledge, this is the first report of these phenomena. Insofar as healthcare providers may be more reluctant to remove the tracheal tube if they feel it is likely that difficulty will be encountered when attempting to replace it and, rather, elect to have a tracheostomy placed, is not surprising. However, this deserves closer inspection, as our data did not allow us to examine whether patient or operator-related factors led to the determination of difficulty, only that difficulty was indeed encountered.

It is generally acknowledged that airway management outside of the OR, in general, and in the critically ill, in particular, is more difficult than routine intubations in the

OR. Termed the "critical airway," the ability to achieve a functional airway is dependent not only on the expertise or experience of the operator, but all personnel involved, the patient characteristics, available equipment and resources, and the time available to complete the task (11). Suboptimal conditions in any of these areas may result in difficulty in obtaining a functional airway. Subsequently, no consistent definition of what constitutes a DI is available. Our DI rate of 22% is higher than previous reports. Had we defined DI intubation as one requiring ≥ 3 attempts or one lasting > 10 minutes by an experienced operator as published in the American Society of Anesthesiologist's 1993 guidelines, the rate would have been 12% (12). However, the ASA difficult airway algorithm is predicated upon the ability to anticipate a difficult airway and the decision to secure the airway before induction of general anesthesia in the setting of the elective airway management. Management of the elective airway is customized to avoid a crisis that does not exist at the beginning of the airway instrumentation. This is in contrast to the ICU where airway management in not elective and the crisis already exists. Furthermore, ≥ 2 attempts at ETI in the critical care setting are associated with increased complications independent of operator experience (3-4). Therefore, we believe defining DI as one requiring ≥2 attempts by DL with the use of an airway adjunct such as an eschmann tracheal tube introducer is more relevant and applicable to ETI taking place in the ICU.

The supervision of anesthesia trainees by an attending anesthesiologist was rarely noted in our series, which could have impacted our DI rates. Our study used data collected prior to changes in practice resulting from to reports showing associations between the presence of a second experienced airway manager and lower complication rates. Indeed, Jaber et al. reported that supervision of junior intubators by a more senior physician was associated with fewer complications in ICU patients undergoing ETI (2). Recently, Schmidt et al. also reported that the presence of a supervising attending anesthesiologist during ETI decreased the incidence of complications (13). The number of intubation attempts was unaffected by the oversight, however, and the authors hypothesized that the greater proportion of patients receiving neuromuscular blocking drugs (NMBD) in the supervised group may have accounted for the difference. In our series, NMBDs were administered to 56.6% of patients, 58% of the EI and 52% of the DI compared with 46% and 17% of patients who received NMBDs with and without the supervision of an attending anesthesiologist as reported by Schmidt and colleagues. The administration of NMBDs alone does not appear to explain the difference in DI rates. We can only speculate that the presence of more experienced staff may have directed more appropriate selection of those who may have benefited from such therapy or that the presence of a second experienced operator would have decreased DI rates.

We are unaware of previous reports attempting to link severity of illness in the critically ill with difficulty in intubation. Certainly, individual components the severity of illness score, which are used to calculate LOS, ventilator days, and mortality predictions are associated with higher likelihood of difficult intubation. For example, hyperglycemia from diabetes mellitus would increase the acute physiology score (APS) and the presence of cancer metastatic to the cervical spine would increase chronic health points. The presence of shock and hypoxemia, which were present in 64% of all intubations in our group, along with any associated metabolic derangements further increases the calculated APS. These indications for intubation would also present a greater urgency and severely limit the time for preparation and assessment. Thus, we hypothesized that overall severity of illness might better predict difficult intubations than its individual components. As a general rule, there must be at least 10 outcomes for each independent variable that is to be included in a multivariable statistical model (14). We observed only 25 events (difficult intubations) allowing sufficient power to include only 2 variables. Thus, our analysis was underpowered to adequately perform such an analysis and we cannot comment with any certainty of the effects of severity of illness on difficulty of intubation. Attempts at predicting difficult intubation based upon a clinical airway exam in the elective surgical population are of dubious utility. In the classic report of Rose and Cohen (15), difficult intubation, defined as ≥ 3 attempts by DL, occurred in only 1.8% of 18, 205 patients. Failure to intubate by DL alone or failure to intubate by any means resulting in postponement of the surgery occurred in only 0.3% and 0.05% of patients, respectively. Because of the low incidence of DI in this setting, the clinical exam has a poor positive and negative predictive value leading one author to call it a pointless ritual (16). This may be true in the ICU as well and the clinician would be better served to simply treat all airways as potential difficult intubations (17).

We acknowledge our study has important limitations. First, approximately 25% of intubations in our ICU are performed by fellows from the Department of Medicine; Section of Pulmonary, Allergy, and Critical Care or trainees from the departments of medicine, surgery, or anesthesiology under the supervision of the attending critical care physician. Over 30% of the time, the attending critical care staff has primary board certification in Anesthesiology. Thus we are unable to report on approximately an additional 28 intubations. However, even if all of these were performed easily, our DI rate would still have been 17.7%. Second, our review is retrospective and thus the actual events surrounding the ETI, including vital signs and those in attendance are subject to reporting bias and could not be sufficiently reconstructed with adequate fidelity. Vital signs before and after intubation attempts were not charted on many of the anesthesia records and the exact times of medication administration and individual intubation attempts were difficult to accurately reconstruct from nursing and respiratory notes. Thus, we lack the ability to report on complications of ETI that were encountered. Also, anesthesiology and critical care staff or a more senior trainee may have been supervising, but their presence not recorded. This omission did not allow us to examine any potential confounding effects of operator experience on outcomes. No current study of ETI in the ICU has reported an associative or causal link between complications of ETI and increased length of stay, days of mechanical ventilation, or mortality. Although we confirmed the previously reported correlation between higher numbers of airway manipulations and increasing mortality (4), our primary goal was to examine any effect of DI on severity-adjusted outcomes. Our study was small, but comparable in numbers to those of Griesdale and Benedetto (3,5). The difference in standardized mortality we report may be clinically relevant despite a lack of a statistically significant difference. Had we been able to record complications and they were higher in the DI group, this would have strengthened the possible link between DI and ICU mortality.

In summary, we conclude that DI among critically ill adult patients is common and occurs in more than one in every five patients in our series. In addition, more than two attempts at ETI were associated with increasing mortality. Every effort should be made to limit the number of airway manipulations and secure the airway as quickly as possible in order to avoid the possibility of increased mortality related to airway management. This includes avoiding multiple laryngoscopies and earlier use of airway adjuncts such as the Eschmann tracheal tube introducer and supraglottic airways such as the laryngeal mask as a dedicated airway and a conduit for fiberoptic intubation. The possible link between difficult intubation and higher than predicted mortality in this group deserves further evaluation.

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