Analysis of Unplanned Extubation Risk Factors in Intensive Care Units

YUAN-CHIA CHENG\textsuperscript{1}, LIANG-CHI KUO\textsuperscript{1}, WEI-CHE LEE\textsuperscript{1}, CHAO-WEN CHEN\textsuperscript{1}, JIUN-NONG LIN\textsuperscript{2}, YEN-KO LIN\textsuperscript{1}, TSUNG-YING LIN\textsuperscript{1}

Background: Unplanned extubation (UEX) has potential risk for critical patients. Information on risk factors for UEX is limited. This study identified factors associated with UEX.

Methods: All critically ill patients admitted between January 1st, 2007, and December 31st, 2008, to the adult surgical and medical intensive care units who had UEX were included in this retrospective study. Patient risk factors and outcomes were retrospectively reviewed from the medical records and compared with those from control patients matched for age, gender and type of intensive care unit (ICU). Analyzed factors included severity of illness, Glasgow Coma Scale (GCS) before intubation, GCS before UEX or weaning and length of mechanical ventilation (MV) support in the ICU. The Acute Physiology and Chronic Health Evaluation II (APACHE II) was used to classify the severity of disease.

Results: Three hundred and seventy-eight patients were enrolled. There were 126 patients with unplanned and 252 with planned extubations. Of those with UEX, 45.2\% needed re-intubation. Student’s t test and multivariate logistic regression were used for each recorded variable. The APACHE II score ($p<0.001$), length of MV support ($p=0.029$), GCS before intubation ($p=0.034$) and GCS before UEX or weaning ($p=0.001$) were predictive of UEX.

Discussion: In this study, the APACHE II score, length of MV in the ICU, GCS before intubation, and GCS before UEX or weaning can be developed as risk assessment tools. Reevaluation of the aforementioned factors will alert the physicians to ICU patients at risk of UEX and possibly decrease the number of UEX.

Key words: unplanned extubation, APACHE II, glasgow coma scale, length of mechanical ventilation

Introduction

Extubation of intubated patients in the intensive care unit (ICU) is an important step in recovery. Unplanned extubation (UEX) sometimes jeopardizes the patient safety. In previous studies, UEX rates ranged from 3\%-14\%\textsuperscript{(1)} and the rates of adverse events following UEX ranged from 5\% to 28\%\textsuperscript{(2)}. There has been very little published on UEX in ICU patients in Taiwan. A variety of studies have been undertaken to identify risk factors for this problem. Previously identified risks include chronic respiratory failure, endotracheal tube fixation with only thin adhesive tape, orotracheal intubation, lack of intravenous sedation in patients with higher consciousness.
levels, medical rather than surgical ICU, use of restraints and long durations of mechanical ventilation (MV)\(^3\)\(^,\)\(^7\). However, research on the determinants of UEX has revealed inconsistent findings. To the authors’ knowledge, only a few of these studies used a case-control design and multivariate analysis to assess independent risk factors for UEX\(^4\)\(^,\)\(^8\)\(^,\)\(^9\). Little is known about the incidence, circumstances, and outcome of UEX in the ICU. Conflicting results on predisposing factors such as the length of MV have been reported.

We began a retrospective evaluation of all intubated patients in our ICU to study factors related to accidental or UEX. Only four parameters were examined here: (1) Acute Physiology and Chronic Health Evaluation II (APACHE II); (2) Glasgow Coma Scale (GCS) before intubation; (3) GCS before UEX or weaning, and (4) length of MV support in the ICU. The aim of this study was to assess risk factors that could be predictors of UEX and analyze the characteristics of patients with UEX.

**Materials and Methods**

This study used a retrospective case-control design. Subjects were patients admitted to 11 adult ICUs (including two medical, two surgical, two neurosurgical, two neurological, two coronary care and one cardiac surgical ICU) of a medical center in southern Taiwan from January 1\(^\text{st}\), 2007 to December 31\(^\text{st}\), 2008. These ICUs were categorized into medical and surgical groups. The patients were monitored for UEX. For each UEX, two control patients from the same unit were randomly selected. Control subjects were patients who had no UEX and were extubated on schedule. Patients were eligible for the study if they were at least 18 years old at the time of their inclusion and if they had been intubated for at least 12 hours. Because our hospital is a large tertiary referral center, the study population included a fairly varied mix of patients with complicated conditions and patients undergoing routine procedures.

The preferred route of intubation in our institution is oral, and the vast majority of patients were orally intubated and received MV support. After each UEX, a respiratory therapist completed a data collection form that recorded patient characteristics such as age, gender, diagnosis, and whether the patient was in a medical or surgical group, as well as clinical factors that may have contributed to the UEX and subsequent reintubation, if required. Then, a nurse recorded it in the hospital quality improvement database. The following data were recorded: age, gender, main diagnosis, APACHE II score, reason for MV support, and length of ICU stay. In intubated and ventilated patients, the time of intubation and duration of MV were also obtained. For every episode of UEX the following data were also recorded: the day and time; mode of ventilatory support; administration of sedatives or paralyzing drugs; presence of an alert mental status, anxiety, or agitation at every 8 hour interval; use of hand restraints; and level of staff vigilance when the episode occurred. Because UEX is unpredictable, the “GCS before UEX” was considered the last assessment of the GCS recorded during mechanical ventilation support. The “GCS before weaning” was the mental status before starting weaning from ventilator support. Further, the need for reintubation and its characteristics were also documented. Replacement of the endotracheal tube within 48 hours of the UEX was considered reintubation. The usual criteria for reintubation were the development of increased signs of respiratory work, inability to protect the airway, and persistent arterial oxygen saturation less than 90% with a fraction of inspired oxygen 50% or greater.
Statistical Analysis

SPSS for Windows version 14.0 (SPSS, Inc, Chicago, IL, USA) was used for statistical analysis. Descriptive statistics were used when appropriate. Group comparisons were made using the $x^2$ test for categorical variables. The Student $t$ test was used to analyze parametric variables. A $p$ value $\leq 0.05$ was considered statistically significant. Variables with $p$ values $< 0.10$ were then entered into an exploratory logistic regression model to determine independent risk factors for UEX. Logistic regression analysis was then performed to control for possible confounding by any of the aforementioned variables that reached a predetermined significance level.

Results

Three hundred and seventy-eight patients were enrolled over a 2-year period. There were 126 patients with unplanned and 252 with controlled extubations. Patients included 291 men and 87 women, and the mean age was 58.78 (±18.53) years. Of the 126 UEX patients, 57 patients (45.2%) were re-intubated. There were 176 patients in the medical and 202 in the surgical group. The mean APACHE II score and duration of mechanical ventilation were 17.93 (±10.28) and 9.47 (±12.78) days. The groups were similar in all characteristics measured. There were no statistically significant differences between the two groups for age ($p=0.549$), gender ($p=0.980$) and medical or surgical ICU ($p=0.654$). There were significant differences between groups in the APACHE II score, GCS before intubation, GCS before extubation (UEX group) or initiation of weaning (control group), and length of MV (all $p<0.001$). Results for each recorded variable are shown in Table 1.

After examining and controlling for the various significant univariate variables for multicollinearity, the following independent variables were entered into the logistic regression model: APACHE II score, GCS before intubation, GCS before UEX or

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Comparison of variables for the UEX group and the control group</th>
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<tbody>
<tr>
<td></td>
<td>UEX group (n=126)</td>
</tr>
<tr>
<td>Age</td>
<td>58.34±17.54</td>
</tr>
<tr>
<td>Gender (male no./female no.)</td>
<td>97/29</td>
</tr>
<tr>
<td>Medical/surgical ICU (no./no.)</td>
<td>62/64</td>
</tr>
<tr>
<td>APACHE II score</td>
<td>14.94±11.15</td>
</tr>
<tr>
<td>GCS before intubation</td>
<td>8.23±2.89</td>
</tr>
<tr>
<td>GCS before UEX or weaning*</td>
<td>9.30±1.86</td>
</tr>
<tr>
<td>Length of MV support (days)</td>
<td>6.87±6.59</td>
</tr>
</tbody>
</table>

* Analyzed by using the $\chi^2$ test;
$^b$ Analyzed by using the Student-$t$ test;

* GCS before UEX indicates the last assessment of GCS level during mechanical ventilator support before patient unplanned extubation in UEX group; GCS before weaning is the mental status before starting the weaning from ventilator support.
Table 2  Independent Risk Factors Associated With UEX

<table>
<thead>
<tr>
<th>Factor</th>
<th>Odds ratios (95% Confidence intervals)</th>
<th>p value</th>
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<tbody>
<tr>
<td>APACHE II score</td>
<td>0.932 (0.898-0.957)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>GCS before intubation</td>
<td>1.164 (1.046-1.395)</td>
<td>0.034</td>
</tr>
<tr>
<td>GCS before UEX or weaning</td>
<td>1.324 (1.153-1.629)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Length of MV</td>
<td>0.870 (0.835-0.907)</td>
<td>0.029</td>
</tr>
</tbody>
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Plus-minus values are mean±SD. The risk factors included in the logistic regression model were APACHE II score, intubation and pre-extubation GCS, and length of mechanical ventilation.

weaning, and length of MV support. Multivariate logistic regression analysis showed a statistically significant association between UEX and the control group for the APACHE II score, GCS before intubation, GCS before UEX or weaning, and length of MV, with corresponding odds ratios of 0.932, 1.164, 1.324 and 0.870, respectively. The important factors for UEX included the APACHE II score (p<0.001), GCS before intubation (p=0.034), GCS before UEX or weaning (p<0.001), and length of MV support (p=0.029) (Table 2).

Discussion

UEX is a frequent problem in the ICU. Only a few studies have examined patient predictive factors associated with UEX\(^{(4,10-12)}\). GCS before intubation and GCS before UEX or weaning have not been well studied previously. This retrospective case-control study was conducted to further extend previous work in this area. There is also controversy on the effect of the length of MV on UEX. The results of this retrospective study could be used to determine predictors of UEX.

Patients with higher levels of consciousness are at high risk for self-extubation\(^{(10)}\). Usually, the GCS is recorded before intubation. Use of this parameter could help in predicting UEX. However, it may not be practical because the time interval between intubation and UEX is longer than that between the last assessment of GCS before UEX and UEX. The GCS before UEX or weaning may be better in predicting UEX (Table 2).

In a previous study, episodes of UEX were associated with longer stays in the ICU\(^{(11)}\). UEX was found to be associated with longer durations of MV support and length of stay in patients in the pediatric ICU\(^{(6)}\). However, in our study, the duration of ventilation support was 6.87±6.59 days in UEX patients, and 10.69±13.36 days in the control patients. Therefore, we found longer durations of ventilation were associated with a higher rate of scheduled extubations. This could have occurred because patients who needed prolonged intubation had more severe disease and were more heavily sedated than those with less severe conditions.

UEX can result in serious complications; however, 54.8% of our patients who had UEX did not need immediate reintubation, suggesting the need to closely evaluate early weaning for these patients.

An important strength of our study is the large number of patients with UEX evaluated. Furthermore, each UEX patient was matched closely with two corresponding control patients, creating statistically equivalent groups in regards to age and gender, and whether they were medical or surgical patients. Case-control methodology is the most powerful tool available to provide outcome analysis and analysis of risk factors in clinical contexts that do not allow randomized, controlled prospective trials. The comprehensive nature of the ICU database used for this study allowed detailed comparisons between the UEX and control.
populations.

In conclusion, a lower APACHE II score, higher level of consciousness before intubation and before UEX or weaning, and shorter duration of MV support were independent risk factors for UEX. Evaluation of the aforementioned factors will alert physicians to ICU patients at risk of UEX and possibly decrease the number of UEX.

Limitations of the Study

Our study had the limitations of a case-control study. One limitation was the method used to complete the data collection sheet. All nursing and respiratory therapy staff were required to understand the use of the tool and use it appropriately. Each time a UEX occurred, the staff person involved was required to complete an incident report and a collection tool. At times the tool was not completed but an incident report was generated. Inconsistent data collection required a review of the medical chart to find missing data. If documentation was not complete, it was difficult for the collector to find retrospective data in the chart.

Another limitation of this study was the quantity and quality of the recorded data. For example, we were unable to determine the time of initiation of weaning. The sample of 126 patients with UEX may not be representative of the entire population of patients who had UEX. The identified cases were only those patients for whom nursing staff voluntarily reported the UEX event. It is likely that only 126 patients had reports of UEX during the study period and that those for whom no reports were made may have differed from the described cases. In order to highlight the examined parameters, the APACHE-II score, GCS before intubation, GCS before UEX or weaning, and length of MV, we did not analyze other UEX factors, such as mode of MV, sedatives or paralyzing drugs, staff vigilance and use of hand restraints. Although a control group was selected to match the case group, we only matched the patient’s age, gender and type of ICU. Other variables were controlled by logistic regression.

Acknowledgements

We acknowledge and thank the respiratory care practitioners in the Department of Critical Care Support Services and the nurses in the ICUs for assistance in the data collection required for this study. This study was supported by a grant from the Kaohsiung Medical University Hospital (KMUH98-8G29)

References


對在加護病房的非計劃性拔管風險因素的分析

鄭淵家1 郭良基1 李維哲1 陳昭文1
林俊農2 林彥克1 林聰穎1

背景：非計劃性拔管(Unplanned extubation, UEX)對患者有重要的潛在風險。關於可造成UEX的風險因素的信息是有限的。我們想要辨別與UEX相關的因素。

方法：所有危急病患在2007年1月1日和2008年12月31日之間，被收治到成人外科和內科加護病房有發生UEX皆包括在這項回顧控制研究中。在加護病房(intensive care unit, ICU)的病患風險因子和預後從病歴中回溯性地與控制組病患匹配比較其年齡、性別、疾病嚴重度，插管前與非計劃性拔管或脫離機械通輸前的格拉斯哥昏迷指數(GCS)，機械通輸支持的時間長度。APACHE II是作為疾病嚴重度指標。

結果：共有378名患者。其中有126位是非計劃性拔管，另外252位是計劃性拔管患者。45.2%非計劃性拔管患者需要再插管。經由Student t檢定和多維分佈的回歸分析下列可預測UEX的變項：APACHE II (p＜0.001)，機械通輸支持的時間長度(p=0.029)，插管前與非計劃性拔管或脫離機械通輸前的GCS (分別為p=0.034與p＜0.001)

討論：在這項研究中，根據所辨明出來的風險因素，例如APACHE II評估，於ICU中機械通輸支持的時間長度，插管前與非計劃性拔管或脫離機械通輸前的GCS，可以被發展為風險評估工具。反覆評估前述風險因素能提醒醫師找出在ICU期間的非計劃性拔管危險病患，藉以減少UEX的發生。

關鍵詞：非計畫性拔管，APACHE II，格拉斯哥昏迷指數，機械通輸時間長度

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收件：98年9月11日 接受刊載：98年12月29日
1高雄醫學大學，高雄醫學大學附設中和紀念醫院外科部 2義守大學，義大醫院內科部感染科
通訊及郵寄地址：林聰穎醫師 高雄醫學大學附設中和紀念醫院外科部
高雄市807三民區自由一路100號
電話：(07)3121101轉7555 傳真：(07)3208255
E-mail: 960090@ms.kmuhs.org.tw