By Kim Curry, PhD, ARNP, Sarah Cobb, RN, MS, Mary Kutash, MSN, ARNP, and Crystal Diggs, RN

**Background**
Unplanned extubations can result in serious complications.

**Objectives**
To determine characteristics of patients and nurses and risk factors that affect extubations.

**Methods**
A retrospective exploratory design was used. Ramsay Sedation Scale scores, need for reintubation, time between intubation and extubation, use of sedation and analgesia in the preceding 48 hours, and use of restraints were collected on 31 patients in a surgical intensive care unit who had unplanned extubations. For nurses, data collected included years’ experience in nursing and as an intensive care nurse, professional credentials, and location at the time of extubation.

**Results**
All unplanned extubations were self-extubations; 15 required reintubation. Most patients had low levels of sedation in the hour preceding the extubation (mean Ramsay score, 2.42; SD, 1.06). Patients who needed reintubation had higher mean Ramsay scores (2.85; SD, 1.14) than patients who did not (2.00; SD, 0.86; \( P = .04 \)). Ramsay scores correlated with need for reintubation (\( r = 0.423; P = .03 \)). Of the 31 patients, 27 (87%) were restrained at the time of extubation (\( \chi^2 = 17.06; df = 1; P < .001 \)). Among the nurses, 32.3% had less than 5 years’ experience in nursing, and 51.6% had less than 5 years’ experience in intensive care; 89% of extubations occurred when the nurse was away from the bedside. Sedative and analgesic doses in the 24 hours before extubation did not differ significantly from those in the 2 hours before extubation.

**Conclusions**
Levels of sedation and use of restraints are associated with unplanned extubations and need for reintubation. (American Journal of Critical Care. 2008;17:45-52)
Patients in critical care units often require endotracheal or tracheal intubation for mechanical ventilation. Unplanned extubations are considered an indicator of quality of care for patients in intensive care units (ICUs) and can result in serious complications, including hypoxia, respiratory insufficiency and failure, and upper airway trauma. Unplanned extubation is defined as “premature removal of the endotracheal tube by action of the patient (self-extubation) or premature removal during care and manipulation of the patient (accidental extubation).”

Incidence rates of unplanned extubation vary; reported rates range from 3% to 14%. A variety of studies have been undertaken to identify risk factors for unplanned extubation. Previously identified risks include being male, trauma diagnosis, and use of restraints. In addition, in several investigations, patients’ agitation and anxiety positively correlated with self-extubation. Finally, research on nurse staffing as a contributing cause has had mixed results.

Reintubation may be necessary and is associated with complications, including upper airway trauma, hypotension or hypertension, new arrhythmia, bradycardia, cardiac arrest, and death. Other complications include difficult laryngoscopy (inability to visualize the glottis), difficult intubation (inability to quickly intubate or 3 or more attempts needed to reintubate), and emergency cricothyrotomy. In addition, reintubation is a costly procedure.

In this study, we examined the characteristics of both patients and nurses and the risk factors that affect extubations. The research questions were as follows:

- Did the patients with unplanned extubation have low levels of sedation (defined as a score <3 on the Ramsay Sedation Scale) within the hour preceding the unplanned extubation?
- Did patients who needed reintubation differ significantly from those who did not on scores on the Ramsay Sedation Scale before the unplanned extubation?
- Did the number of unplanned extubations differ significantly between patients who were restrained and those who were not?
- Did an association exist between unplanned extubation and nurses’ characteristics, including years of experience as a nurse, years of experience in intensive care, professional credentials, and location at the time of unplanned extubation?
- Did rates of unplanned extubation differ according to medication history (defined as use of sedation and/or analgesics within 48 hours of the event, either continuously or as an as-needed bolus)?

Methods

Study Design and Setting

The study was approved under exempt status by the institutional review board. A retrospective exploratory design was used. The study was carried out in an adult, 18-bed, level III surgical ICU at a large tertiary care and level I trauma center. Intubations were performed as needed by attending physicians or senior anesthesia residents under the direct supervision of the attending physician. Nursing personnel administered sedatives, analgesics, and paralytics as prescribed by the physicians. Restraints were used in accordance with the ICU protocol.

Data Collection

The existing hospital quality improvement database was reviewed. Data on patients included scores on the Ramsay Sedation Scale, need for reintubation, days elapsed between time of intubation and time of unplanned extubation, history of sedation and analgesia in the 48 hours preceding the extubation, and use of restraints. The Ramsay score was obtained by using a commonly used scale. A score of at least 3 indicates sedation and calmness; a score of at least 4 indicates sleep. Reintubation was defined as a procedure to replace an airway after premature removal of the airway.

About the Authors

Kim Curry is an assistant professor of nursing at the University of Tampa, Tampa, Florida. Sarah Cobb is an assistant professor at the University of South Florida in Tampa. Mary Kutash is coordinator of nursing research and Crystal Diggs is a staff nurse at Tampa General Hospital in Tampa.

Corresponding author: Dr Kim Curry, 401 W Kennedy Blvd, Box 10F, Tampa FL 33606 (e-mail: kcurry@ut.edu).
Nurses’ characteristics included years of experience in nursing, years of experience in intensive care, educational credentials, and location at the time of the unplanned extubation. No identifiers such as medical record numbers or patients’ names were used on the data collection instrument.

Data were collected by using a tool we developed (Table 2). Data were collected from September 2005 through April 2006, providing a sample size of 31 patients, exceeding the minimum sample size of 30 patients desired for this pilot study. The sample consisted of all adult patients in the trauma surgical ICU who had experienced an unplanned extubation. The patients were identified through an in-house quality improvement database used to amass information on unplanned extubations. Patients with intentional extubations were excluded from the database.

Unintentional extubation was defined as either spontaneous self-extubation or accidental premature discontinuation of use of the endotracheal or tracheal tube. Spontaneous self-extubations were defined as the intentional premature removal of an airway (endotracheal or tracheal) by a patient. Accidental extubations were defined as the unintentional removal of an airway by healthcare staff or a patient (eg, while a patient was being turned).

Additionally, information was sought on the costs associated with intubation and reintubation. The hospital calculated a bundled charge of $1000 per reintubation event, which included costs for the time required for a physician or anesthetist to reintubate the patient, nurses’ time, other staff members’ time, equipment (trays, cannulas, other), medications, laboratory tests, and other costs. This figure was used as an indirect measure of the cost of reintubation; a full cost analysis was not feasible because of the limited data available.

Data Analysis

Data were coded and analyzed by using SPSS, version 11.4 (SPSS Inc, Chicago, Illinois). Descriptive statistics were calculated for all variables. The patients were divided into groups on the basis of their reintubation status, use of restraints, and medication history. The nurses were divided into groups on the basis of years of experience in nursing. For categorical variables, χ² tests were used to determine significant differences between groups. The Pearson product moment correlation was used to assess the direction and magnitude of relationships among interval level data. The Spearman rank correlation ρ or the Kendall τ-b rank correlation was used to assess relationships between categorical or mixed data. A 2-tailed t test was used to analyze differences between group means of interval level data. The α level of significance was set a priori at $P = .05$ for all analyses.

Results

All unplanned extubations that occurred were self-extubations. A total of 26 patients who self-extubated were men (84%); 86% of the patients were restrained at the time of extubation. Of the 31 patients included in the study, 20 (64.5%) were admitted to the trauma surgery service. An additional 11 patients were admitted to a variety of elective and surgical specialty services. The majority of the trauma service patients had been involved in
The mean Ramsey scores of patients who needed reintubation differed significantly from the scores of patients who did not (t = 2.71; df = 24; P = .04). Patients who needed reintubation had higher mean Ramsey scores (2.85; SD, 1.14) than patients who did not (2.00; SD, 0.86). A related finding was a significant positive correlation between Ramsey scores and the need for reintubation (r = 0.423; P = .03).

**Use of Restraints**

The number of patients who were restrained was significantly higher than the number who were not restrained. Of the 31 patients in the sample, 27 (87%) were restrained at the time of extubation (χ² = 17.06; df = 1; P < .001). The most common type of restraint used was soft wrist restraints. In 3 instances, patients had more than 1 type of restraint in place at the time of the self-extubation.

**Nurses’ Characteristics**

The majority of the attending nurses had a bachelor’s degree (52%; χ² = 7.72; df = 2; P = .02). Among the nurses whose educational levels were known, 15 had baccalaureate degrees, 12 had associate degrees, and 1 had a diploma in nursing. These findings were consistent with the educational levels of the ICU nurses as a whole at the hospital.

The mean number of years of nursing experience among the attending nurses was 8.81 (SD, 7.32); however, 32.3% had less than 5 years of experience (χ² = 20.26; df = 6; P = .002; Table 3). Similarly, the mean number of years of ICU experience was 6.01 (SD, 6.11), but 51.6% had less than 5 years of ICU experience (χ² = 27.87; df = 4; P < .001). Data on the staffing patterns such as nurse to patient ratio on the days of the unplanned extubations were not collected. The number of unplanned extubations that occurred on 12-hour night shifts did not differ significantly from the number that occurred on 12-hour day shifts.

A total of 89% of the attending nurses were not at the patients’ bedside at the time of extubation (χ² = 10.78; df = 3; P = .01). In 11 instances, the nurse was at the nurses’ station at the time of the unplanned extubation. The physical layout of the ICU allows patients to be viewed from the nurses’ station. In another 11 instances, the nurse was elsewhere in the ICU. In 3 instances, the nurse was at the patient’s bedside. In 2 instances, the nurses were on break at the time of the event, and in 4 instances, the nurse’s location was not noted.
Doses of Sedatives or Analgesics 24 and 2 Hours Before Extubation

The most common medications ordered that were associated with mechanical ventilation in this study were fentanyl (n = 21, 67.7%) and propofol (n = 14, 45.2%). Two other agents were used in several patients in the sample: lorazepam, a medium-acting benzodiazepine, and morphine, an opioid narcotic used for analgesia. Haloperidol was used to control agitation in 1 patient who had been receiving ventilatory support for 2 days. Lorazepam and fentanyl were given to 1 patient, but no propofol was ordered. Finally, 1 patient was given diazepam only.

Pain management was an important issue in the patients in this study. A total of 3 patients had no sedative or analgesic medication ordered. An additional 3 had been given a sedative but no analgesic. Fentanyl doses ordered ranged from 25 to 300 µg/h. The mean fentanyl doses at 24 hours (52 µg/h) and at 2 hours (57 µg/h) before extubation did not differ significantly. The Pearson correlation between the doses was significant (r = 0.509, P = .02). The propofol doses ranged from 0 to 150 mg/h. The mean propofol doses at 24 hours (29.85 mg/h) and at 2 hours (19.19 mg/h) before extubation did not differ significantly.

Discussion

We found that a low level of sedation (mean Ramsay score, 2.42) was associated with unplanned extubation. This finding is consistent with the results of other recent studies. In an evaluation of similar patient characteristics by Yeh et al,91% of patients were able to communicate and 78.2% were alert at the time of unplanned extubation. In that study, 57% of the patients able to communicate about the event indicated that they removed the tube because it was uncomfortable.

Moons et al12 conducted a nested case control study to develop a risk stratification scheme for unplanned extubation in ICU patients. In their study, the incidence rate of unplanned extubation was 4.2%, and the rate in medical ICUs (9.5%) was higher than that in surgical ICUs (2.6%). In addition, the risk for an unplanned extubation was higher in patients with low levels of sedation and higher levels of consciousness.

In a prospective cohort study, Woods et al13 examined the frequency, characteristics, and clinical outcomes of severely agitated patients receiving ventilatory support. Of the patients who self-extubated, 26% were agitated at the time of the unplanned extubation, and 6% were not.

The number of patients who were restrained was significantly higher than the number who were not restrained. This finding could mean that use of restraints was a function of inadequate sedation and analgesia. However, restraints also may be used during intubation when weaning is an option that is not being exercised. Our finding was consistent with the results of Mort,9 who noted that use of restraints does not tend to prevent unplanned extubation.

Clinical guidelines11 have been developed for use of restraining therapies in the ICU. These guidelines address the need to use analgesics and anxiolytics to mitigate the need for restraining therapies.

Balon determined the incidence and variables associated with unplanned extubation in a 412-bed teaching hospital. Variables included date and time of unplanned extubation, amount of pulmonary secretions, agitation and level of consciousness, analgesics and sedatives ordered and given, and nurse staffing patterns. In that investigation, at the time of the unplanned extubation, 79% of the patients were restrained and 53% were agitated. Within 2 hours of the event, 24% of the patients had received analgesics and 25% had received sedatives.

Reintubation after an unplanned extubation is expensive, and unplanned extubation can be physically traumatic to the patient. Our hospital estimated an additional $15 000 in patient charges just for the 15 reintubation procedures that were performed. Reintubation rates vary according to the type of unplanned extubation; other investigators have noted that rates of reintubation were higher in patients who were accidentally extubated than in those who self-extubated.

In an earlier prospective study, Christie et al determined the frequency, outcomes, and factors associated with unplanned extubations in ICU patients. Self-extubations accounted for 85% of unplanned extubations; accidental extubations accounted for 15%. However, the patients who had accidental unplanned extubations experienced more complications and had a higher reintubation rate than did the patients who had unplanned extubations that were self-extubations. A total of 80% of the patients with accidental extubations and 48% of those who self-extubated had reintubation.

Eighty-seven percent of patients who self-extubated were restrained and 84% were male; half were reintubated.

As level of sedation deepened, the need for reintubation increased.
None of the unplanned extubations in our study were accidental; all were self-extubations. Therefore, the estimate of $15,000 may be conservative compared with other hospitals’ estimates of costs of reintubation. However, many other factors should be considered. Cost analyses that account for differences in lengths of stay, complication rates, comorbid conditions, and diagnoses are warranted, not just for costs of reintubation but also for costs of unplanned extubation events even if reintubation was not needed.

In a study of 100 patients who had unplanned extubation, Krinsley and Barone found 44 instances of unplanned extubation that required reintubation and 56 that did not. ICU and hospital lengths of stay and pharmacy, laboratory, and diagnostic imaging charges were higher in the patients who required reintubation. Patients who did not require reintubation had better outcomes. Krinsley and Barone concluded that care protocols should be instituted to identify those patients “ready to be liberated from mechanical ventilation.”

In our study, 72.3% of the nurses had less than 5 years of nursing experience, and 51.6% had less than 5 years of experience in intensive care. However, this finding may have been a function of the small sample size. The roles of nurses and patients’ risk factors related to unplanned extubation have been examined in other studies. In research on nurse-related factors, among the primary nurses caring for a patient at the time of unplanned extubation, 72.9% had 2 to 4 years of experience and 2.3% had more than 4 years experience. Of note, 79.1% of the unplanned extubations occurred when a nurse was not at the bedside.2

Nurse education specific to knowledge of intubated patients has been the focus of previous studies.3,10 Several have addressed educational methods to decrease the occurrence of unplanned extubation. Richmond et al described a project that included use of improved equipment (endotracheal tube holders) along with education of nurses and respiratory therapists to reduce the rate of unplanned extubations. This project resulted in a statistically significant decrease in the number of unplanned extubations. Fentanyl is an opioid agonist. It acts by binding to opioid receptors, producing analgesia and sedation. It is typically used for analgesia in the ICU but also may be used as an adjunct to anesthesia. Propofol is a hypnotic agent used to induce and maintain anesthesia. Typically, in the surgical ICU, fentanyl is used for analgesia and propofol is used for sedation. Our finding that the fentanyl and propofol doses in the 24 hours before extubation did not differ significantly from the doses in the 2 hours preceding the extubation was interesting and warrants further investigation.

Finally, benzodiazepines were associated with greater agitation in one study of sedation in intubated patients. In our study, in the 4 patients who were receiving as-needed boluses of benzodiazepines before the unplanned extubation, the mean Ramsay score was 2.25 (SD, 0.96). Of the 4, one patient was being weaned and remained extubated; however, the other 3 patients were reintubated, 2 within 1 hour and 1 within 5 hours.

Since our study was completed, the surgical ICU has instituted use of the Motor Activity Assessment Scale. This scale contains 7 domains, whereas the Ramsay scale has 6 domains. Use of the Motor Activity Assessment Scale was selected in an attempt to improve the accuracy of assessing patients’ behaviors and sedation levels.17 The American Association of Critical-Care Nurses also has published a sedation assessment scale18 that addresses 5 different domains to assist clinicians in achieving clinical goals of sedation therapy in critically ill patients.

Limitations of our study include the size of the sample. The small sample may have affected the ability to detect findings of significance in some instances. In addition, the type and location of the facility in which the study was conducted limit the generalizability of the results. We analyzed data on patients in a surgical ICU; other investigators have reported differences between medical and surgical patients in rates of unplanned extubation. Finally, researchers in hospitals that use sedation scales other than the Ramsay Sedation Scale may not obtain comparable data when assessing patients’ sedation.

Conclusion

Unplanned extubations are a concern in critical care. Our results on unplanned extubations and patients’ demographics were fairly consistent with those of previous studies. Further research is needed to explore unplanned extubations in other settings, including nonsurgical units and longer term care settings. Development of a sedation protocol for the medical staff to ensure adequate medication management of patients may be useful. In addition, timing of weaning from ventilatory support is critical. Staffing available for weaning patients should be
explored to ensure that unplanned extubation is avoided when possible.

Finally, proper medication management, particularly pain management, is an issue in maintaining endotracheal intubation. In our study, the majority of patients did not require reintubation, thus timing of weaning from ventilatory support may have been a factor in the occurrence of unplanned extubation.

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None reported.

REFERENCES

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1. Which of the following is not a risk for unplanned extubation?
   a. Male gender
   b. Use of restraints
   c. Unit without 24-hour coverage by an intensivist
   d. Patient’s anxiety and agitation

2. Which of the following was not a research question in this study?
   a. Did rates of unplanned extubations correlate with length of stay?
   b. Did the patients with unplanned extubations have low levels of sedation?
   c. Did the number of unplanned extubations differ significantly between patients who were restrained and those who were not?
   d. Did rates of unplanned extubation differ according to medication history?

3. Which type of research design was used in this study?
   a. Double-blind
   b. Qualitative
   c. Quantitative
   d. Retrospective exploratory

4. Which score on the Ramsey Sedation Scale indicates sedation and calmness?
   a. 4
   b. 3
   c. 6
   d. 5

5. Which of the following was not one of the nursing characteristics used in this study?
   a. Years of critical care experience
   b. Years of nursing experience
   c. Age
   d. Educational credentials

6. Which definition best describes unintentional extubation?
   a. Either spontaneous self-extubation or accidental premature discontinuation of the endotracheal tube
   b. Premature removal of an airway by a patient
   c. Removal of an endotracheal tube by staff re-taping their endotracheal tube
   d. Removal of an airway by a respiratory therapist while he or she re-tapes the patient’s endotracheal tube

7. What percentage of patients who self-extubated were men?
   a. 12%
   b. 45%
   c. 84%
   d. 68%

8. What was the mean Ramsay score for patients who self-extubated?
   a. 3.14
   b. 2.42
   c. 1.89
   d. 3.85

9. What percentage of patients were restrained at the time of self-extubation?
   a. 87%
   b. 56%
   c. 34%
   d. 73%

10. What percentage of nurses were not at the patient’s bedside during self-extubation?
    a. 12%
    b. 48%
    c. 25%
    d. 89%

11. What was the estimated cost of reintubation for the 15 patients in this study?
    a. $5000
    b. $15 000
    c. $2500
    d. $35 000

12. Which type of patients experienced the most complications in a trauma intensive care unit since completion of this study?
    a. Motor Activity Assessment Scale
    b. Modified Ramsey score
    c. SASS score
    d. Checklist of Nonverbal Pain Indicators

13. What new assessment scale has been implemented in the surgical trauma intensive care unit since completion of this study?
    a. Motor Activity Assessment Scale
    b. Modified Ramsey score
    c. SASS score
    d. Checklist of Nonverbal Pain Indicators

Program evaluation

Objective 1 was met Yes No
Objective 2 was met Yes No
Objective 3 was met Yes No
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