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Original Contribution

Prevalence and outcomes of endotracheal intubation–related cardiac arrest in the ED☆

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ABSTRACT

Background: Emergency endotracheal intubation–related cardiac arrest (CA) is not well documented. This study compares the clinical features and outcomes of intubation-related CA and other causes of inhospital CA.
Methods: All study patients were consecutive adults (≥18 years) who developed CA in the emergency department between January 2007 and December 2011. Emergent endotracheal intubation–related CA was defined as occurring within 20 minutes after successful intubation. Clinical variables were compared between patients with intubation-related CA and intubation-unrelated CA. The primary outcome was a good neurologic outcome defined as a Cerebral Performance Category score of 1 to 2. The secondary outcome was survival to hospital discharge.
Results: Of the 251 patients who developed CA, 41 were excluded due to trauma-related CA or "do-not-resuscitate" protocols, thereby leaving 210 patients. The prevalence of intubation-related CA was 23.3%, and the median duration between successful intubation and CA was 5.0 minutes (interquartile range, 2.0-9.5). Pulseless electrical activity was more commonly noted as the first arrest rhythm in the intubation-related CA group (75.5% vs 59.0%; $P = .03$) compared with patients with other causes of CA. However, the rates of good neurologic outcomes (14.3% vs 21.1%) and survival to discharge (34.7% vs 35.4%) were not significantly higher in intubation-related CA group (both $P > .05$).
Conclusion: Endotracheal intubation–related CA occurred higher than commonly recognized, and patient outcomes were not better than other causes of CA. These data highlight the importance of efforts to prevent intubation-related CA. However, further prospective larger study will be required to generalize this result.

1. Introduction

Determining the prognosis according to the cause of cardiac arrest (CA) can be challenging in many cases [1]. However, more accurate information regarding the prognosis of CA could help guide patient management and the goals of care [2].

Emergency endotracheal intubation to critically ill patients can be fraught with severe life-threatening complications, including hypoxemia, hypotension, arrhythmia, and even CA [3-10]. Nonetheless, physicians seem to have underestimated prognosis of intubation-related CA, and literatures have not been interested in such a serious complication [11]. One study has reported that the incidence of intubation-related CA may be higher than commonly appreciated and is associated with hospital deaths [12]. However, the clinical features and prognosis of intubation-related CA in comparison with other causes of inhospital CA remain unclear. This study describes and compares the clinical features and outcomes of patients with emergency endotracheal intubation–related CA and other causes of inhospital CA that developed in the emergency department (ED).

2. Methods

2.1. Study design and population

This retrospective, single-center cohort study was conducted at Asan Medical Center, a 2800-bed, university-affiliated, tertiary referral center in Seoul, Korea. We included consecutive adult patients (≥18 years) who developed CA in the ED between January 2007 and December 2011. Exclusion criteria included age younger than 18 years, trauma-related CA, and patients with "do-not-resuscitate" protocols. This study was approved by the ethics committee of institution, and informed consent was waived because of its retrospective design.

2.2. Definitions and data collection

We consecutively collected patients who required cardiopulmonary resuscitation during study period in the ED. Medical chart review was performed by 2 coauthors who underwent a training program. A

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random sample of 10% of chart was collected and compared by other 2 authors to assess lack of variation. The clinical and demographic characteristics of all study patients, including age, sex, medical history, and vital signs at admission to ED, were retrieved from electronic medical records. Emergent endotracheal intubation–related CA was defined as occurring within 20 minutes after successful intubation in the ED. The sustained return of spontaneous circulation (ROSC) was defined as the restoration of a palpable pulse for greater than or equal to 20 minutes [13]. The neurologic status of all patients who survived to discharge was classified according to the Cerebral Performance Category (CPC), which was measured at hospital discharge [14]. Cerebral Performance Category scores were graded as 1 (no significant impairment), 2 (moderate impairment but able to complete daily living activities), 3 (severe impairment but conscious), 4 (vegetative state or coma), or 5 (death). A good neurologic outcome was defined as a CPC score of 1 to 2 [12].

2.3. Statistical analysis

Data in this study are presented as the mean ± SD, median with interquartile range for continuous variables, or absolute or relative frequencies for categorical variables. Patients who developed CA within 20 minutes of intubation were compared with patients who developed intubation-unrelated CA. The χ^2 test was used to assess categorical variables, the Student *t* test was used to assess normally distributed continuous variables, and the Mann-Whitney *U* test was used to assess continuous variables with a skewed distribution. In this study, $P \le .05$ was considered statistically significant. All statistical analyses were performed using SPSS for Windows (version 18.0; SPSS, Inc, Chicago, IL).

3. Results

3.1. Characteristics of the study population

A total of 251 adult patients developed CA in the ED during the study period. Of these, authors excluded 35 patients with trauma-related CA and 6 patients who had "do-not-resuscitate" protocols in place, thereby leaving a total of 210 patients for analysis (Figure). The affected patients ranged in age from 26 to 90 (64.0) years, and 129 patients (61.4%) were male. A total of 49 cases of intubation-related CA occurred in the emergency ward, demonstrating an overall prevalence of 23.3%. The most common cause of intubation-unrelated CA was cardiac in origin, and additional causes of CA are outlined in Table 1. The median time from successful intubation to CA was 5.0 minutes (interquartile range, 2.0-9.5).

Acute respiratory failure was the most common reason for emergency airway management in patients with intubation-related CA (51.0%).

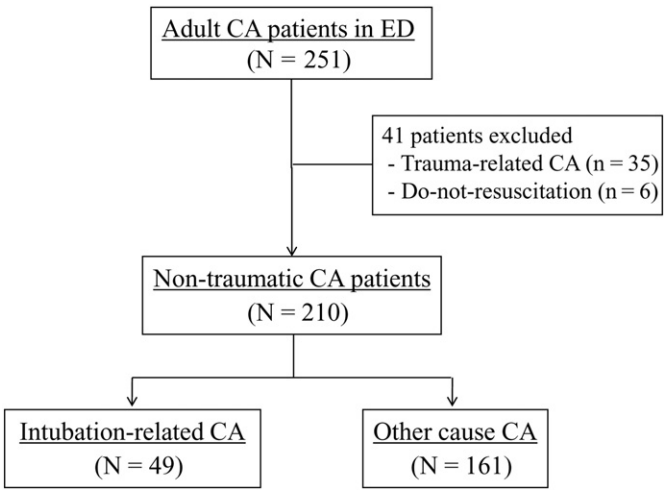

Figure. Flow chart for the selection of patient.

Table 1
Causes of cardiac arrest

Causes	n (%)
Intubation-related CA	49 (23.3)
Intubation-unrelated CA	161 (76.7)
Cardiac	44 (20.6)
Sepsis	37 (17.6)
Bleeding(nontrauma)	26 (12.4)
Pulmonary	18 (8.6)
Aortic dissection/rupture	14 (6.7)
Metabolic	9 (4.3)
Cerebral	7 (3.3)
Intoxication	1 (0.5)
Unknown	5 (2.4)

The types of opioid and sedative drugs used are shown in Table 2. Nearly all of the patients (93.9%) received sedative medications, including etomidate in 37 patients, midazolam in 7 patients, and other types in 2 patients.

3.2. Intubation-related CA vs intubation-unrelated CA

Demographic characteristics and comorbidities were not significantly different between intubation-related and intubation-unrelated CA patients. However, the intubation-related CA group demonstrated a significantly lower respiratory rate (20 [19-24] vs 24 [20-31]) and oxygen saturation (92.0 [83.5-96.0] vs 97.0 [91.0-98.0]; both $P = .03$) than the intubation-unrelated CA group, and pulseless electrical activity was more frequently noted as the first arrest rhythm in the intubation-related CA group (75.5% vs 59.0%; $P = .03$). Additional demographic characteristics and clinical features of each group are summarized in Table 3. There were no significant differences in the rate of sustained ROSC or percentage of patients who were discharged from the hospital (Table 4). There was no difference in favorable neurologic outcomes between the 2 groups, with a trend toward lower rates of good recovery in the intubation-related CA group (14.3% vs 21.1%; $P = .29$).

4. Discussion

This is the first observational study to evaluate the clinical features and outcomes of intubation-related and intubation-unrelated CA. Intubation-related CA was found not to be uncommon (23% of inhospital cases of CA), and its outcomes were not significantly different than other causes of CA. Emergency endotracheal intubation in the ED is not rare, and its complications can be mild to severe (eg, dental injury, aspiration, cardiac arrhythmia, esophageal intubation, serious hypoxemia, severe collapse, CA, and death) [6]. There are several studies on the complications of endotracheal intubation and risk factors associated with intubation-related CA, but there have been no studies that compared outcomes between intubation-associated CA and other causes of inhospital CA. Here, the authors identify differences in the characteristics

Table 2
Reasons for emergency airway management and the administered drugs

	n (%)
Reasons for intubation	
Acute respiratory failure	25 (51.0)
Shock	12 (24.5)
Altered mental status	6 (12.2)
others	6 (12.2)
Administered drugs for intubation	
Fentanyl	34 (69.4)
Hypnotics	
Etomidate	37 (75.5)
Midazolam	7 (14.3)
Others	2 (4.1)