



## Clinical Paper

# The clinical significance of a failed initial intubation attempt during emergency department resuscitation of out-of-hospital cardiac arrest patients



Joonghee Kim<sup>a</sup>, Kyuseok Kim<sup>a,\*</sup>, Taeyun Kim<sup>a</sup>, Joong Eui Rhee<sup>a</sup>, You Hwan Jo<sup>a</sup>,  
Jae Hyuk Lee<sup>a</sup>, Yu Jin Kim<sup>a</sup>, Chan Jong Park<sup>a</sup>, Hea-jin Chung<sup>a</sup>, Seung Sik Hwang<sup>b</sup>

<sup>a</sup> Department of Emergency Medicine, Seoul National University Bundang Hospital, 166 Gumi-ro, Bundang-gu, Seongnam-si, Gyeonggi-do 463-707, Republic of Korea

<sup>b</sup> Department of Social and Preventive Medicine, Inha University School of Medicine, 100 Inharo, Nam-gu, Incheon 402-751, Republic of Korea

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## ABSTRACT

**Objective:** Advanced airway management is one of the fundamental skills of advanced cardiac life support (ACLS). A failed initial intubation attempt (FIIA) is common and has shown to be associated with adverse events. We analysed the association between FIIA and the overall effectiveness of ACLS.

**Methods:** Using emergency department (ED) out-of-hospital cardiac arrest (OHCA) registry data from 2008 to 2012, non-traumatic ED-resuscitated adult OHCA patients on whom endotracheal intubation was initially tried were identified. Prehospital and demographic factors and patient outcomes were retrieved from the registry. The presence of a FIIA was determined by reviewing nurse-documented CPR records. The primary outcome was achieving a return of spontaneous circulation (ROSC). The secondary outcomes were time to ROSC and the ROSC rate during the first 30 min of ED resuscitation.

**Results:** The study population ( $n=512$ ) was divided into two groups based on the presence of a FIIA ( $N=77$ ). Both groups were comparable without significant differences in demographic or prehospital factors. In the FIIA group, the unadjusted and adjusted odds ratios (ORs) for achieving a ROSC were 0.50 (95% confidence interval [CI], 0.31–0.81) and 0.40 (95% CI, 0.23–0.71), respectively. Multivariable median regression analysis revealed that FIIA was associated with an average delay of 3 min in the time to ROSC (3.08; 95% CI, 0.08–5.80). Competing risk regression analysis revealed a significantly slower ROSC rate during the first 15 min (adjusted subhazard ratio, 0.52; 95% CI, 0.35–0.79) in the FIIA group.

**Conclusion:** FIIA is an independent risk factor for the decreased effectiveness of ACLS.

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## 1. Introduction

Advanced airway management is one of the fundamental skills of advanced cardiac life support (ACLS).<sup>1,2</sup> Endotracheal intubation is commonly employed to secure an airway during the emergency department (ED) resuscitation of out-of-hospital cardiac arrest (OHCA) patients. However, intubation is difficult to master and requires frequent repetition to maintain the skill.<sup>3–7</sup> The failure rate of first ED or first in-hospital emergency intubation attempts varies from 20% to 32%,<sup>8–10</sup> and repeated intubation attempts are associated with various adverse events.<sup>8–11</sup> Similar findings might be expected in ED OHCA patients undergoing ACLS; however, information about the incidence and its association with outcomes in ED OHCA patients is currently unavailable.

The purpose of this study was to analyse the association between a failed initial intubation attempt (FIIA) event and the incidence of ROSC during CPR. We hypothesised that a FIIA may impair the overall effectiveness of ACLS, thus causing significant delay in ROSC as well as slower ROSC rate.

## 2. Materials and methods

This is a retrospective study of all OHCA patients from 2008 to 2012 on whom an endotracheal intubation was attempted as the initial choice of advanced airway during ED ACLS. The OHCA ED registry was the primary source of data for this study. The institutional review board at the study site approved the analysis and provided a waiver of informed consent.

### 2.1. Study setting

The study was conducted at a 950-bed tertiary hospital that was located in a city with an estimated population of 1,000,000.

\* Corresponding author.

E-mail address: [dremkks@snuh.org](mailto:dremkks@snuh.org) (K. Kim).

Prehospital emergency care in the city is provided by government-run fire service.<sup>12</sup> The level of prehospital care is primarily basic life support, and ED transfer is required for ACLS in most cases. Upon arrival to the ED, ACLS commences: chest compressions are immediately provided by duty EMTs, and airway management is provided by ED physicians. ED nurses primarily take care of inserting lines, administering drugs and logging CPR events. We follow the most up-to-date American Heart Association CPR guidelines, which were last updated in 2010.<sup>2</sup> Therefore, any interruption of chest compressions for advanced airway management is not allowed unless absolutely required. Any supraglottic airway placed during the prehospital course is routinely changed to an endotracheal tube at the beginning of ED resuscitation.

## 2.2. Participants, data collection and outcome measures

Using ED OHCA registry data<sup>13,14</sup> from 2008 to 2012, adult (aged  $\geq 18$ ) patients presenting with a non-traumatic OHCA who were resuscitated upon ED arrival because of prehospital resuscitation failure were identified. Patients without an initial intubation attempt in ED were excluded. Prehospital and demographic factors and patient outcomes were retrieved from the registry. The detailed definitions of the prehospital variables and the patient outcome measures are described in supplementary Table 1 (available online at the RESUSCITATION journal website). The presence of a FIIA was determined by reviewing nurse-documented CPR log sheets. The review process was done by a resuscitation researcher who was blinded to the patient long-term outcomes. The criteria for a FIIA were (1) any extubation after the first pass of the endotracheal tube during resuscitation, (2) any repeated advanced airway attempt regardless of its method after first intubation attempt or (3) any first intubation attempt described as “failure” in the CPR log sheets. The primary outcome was the overall chance of achieving a ROSC. Secondary outcomes were the time to ROSC and the ROSC rate during the first 30 min of ED resuscitation.

## 2.3. Statistical analysis

Student's *t*-test, Mann–Whitney test, Chi-square test and Fisher's exact test were performed, as appropriate, for comparisons between patient groups with and without a FIIA. Univariable and multivariable logistic regression analyses were performed to assess the unadjusted and adjusted associations between a FIIA and attaining a ROSC. Multivariable quantile regression analyses at 25th, 50th and 75th percentiles were conducted to determine the possible association between FIIA and time to ROSC during ED resuscitation. An analysis of the Fine and Gray regression models, accounting for the competing risk of resuscitation termination, was conducted to assess the association between a FIIA and the ROSC rate during the first and second 15 min of ED resuscitation.<sup>15</sup> The proportional hazards assumptions of the models were confirmed by examining plots of Schoenfeld residuals. The results of the logistic regression, quantile regression and Fine and Gray regression analyses were presented as odd ratios (ORs), regression coefficients (min/unit) and subhazard ratios (SHR), respectively, and their 95% confidence intervals (CIs) were also presented. *P*-values  $< 0.05$  were considered significant. All analyses were performed using STATA 12 (StataCorp 113 LP, TX, USA).

## 3. Results

Among the 636 adult ED OHCA patients during the study period, 608 patients without a prehospital ROSC underwent ACLS upon ED arrival. After excluding patients with a traumatic cardiac arrest ( $n = 69$ , 11.3%) and cases without an initial intubation attempt ( $n = 31$ , 5.1%), 512 adult patients with a non-traumatic OHCA and an

**Table 1**  
Patient characteristics of study population.

Age, years, median (IQR)	70 (54–79)
Sex, male, no. (%)	311 (60.7)
Witnessed, no. (%)	343 (67.0)
Public place, no. (%)	75 (14.6)
Shockable rhythm, no. (%)	63 (12.4)
Presumed cardiac aetiology, no. (%)	238 (46.5)
Bystander CPR, no. (%)	177 (34.6)
No-flow time, minutes, median (IQR)	6 (0–12)
Prehospital low-flow time, minutes, median (IQR)	16 (9–23)
Prehospital advanced airway <sup>a</sup>	
No advanced airway, no. (%)	498 (97.3)
LMA, no. (%)	8 (1.6)
E-tube, no. (%)	1 (0.2)
Unknown, no. (%)	5 (1.0)
Return of spontaneous circulation, no. (%)	293 (57.23)
Survival discharge, no. (%)	50 (9.8)
Good neurologic outcome <sup>b</sup> , no. (%)	24 (4.7)

IQR, interquartile range; CPR, cardiopulmonary resuscitation; LMA, laryngeal mask airway; E-tube, endotracheal tube.

<sup>a</sup> Among the eight patients with prehospital LMA, seven patients were successfully changed to E-tube without any failed attempt at the beginning of ED resuscitation. The patient with prehospital E-tube was first intubated in a private clinic before his cardiac arrest which occurred during his transfer to study ED. He was successfully reintubated after one failed attempt.

<sup>b</sup> Cerebral performance criteria score 1 or 2.

initial ED intubation attempt were included as the study population (Supplementary Fig. 1, available online at the RESUSCITATION journal website). Among the study population, 293 (57.23%, Table 1) patients had a ROSC. A total of 50 (9.8%) patients survived until discharge to home or a nursing care facility, and 24 (4.7%) patients had a favourable neurologic outcome (based on 6-month cerebral performance criteria 1 or 2).

Patients were divided into two groups according to whether a FIIA was present (FIIA group,  $n = 77$ , 15.0%; non-FIIA group,  $n = 435$ , 85.0%). The groups were comparable in their baseline characteristics, with no significant differences in their demographic and prehospital factors (Table 2). There was an absolute difference of 16.9% between the groups in achieving a ROSC (42.9% for the FIIA group vs. 59.8% for the non-FIIA group,  $p = 0.006$ ). The difference between the groups in time to ROSC was almost significant (12 min for the FIIA group vs. 10 min for the non-FIIA group,  $p = 0.053$ ), and there was no significant difference in the duration of ED resuscitation until CPR was terminated (30 min for the FIIA group vs. 30 min for the non-FIIA group,  $p = 0.981$ ). There was no significant difference in the long-term outcomes, including patient survival to discharge (7.8% for FIIA group vs. 10.1% for non-FIIA group,  $p = 0.527$ ) and the proportion of patients with good neurologic outcomes (6.5% for FIIA group vs. 4.4% for non-FIIA group,  $p = 0.416$ ).

We conducted univariable and multivariable logistic regression analysis to investigate the association between a FIIA and attaining a ROSC (Table 3). With a FIIA, the unadjusted OR for a ROSC was 0.50 (95% CI, 0.31–0.81;  $p = 0.006$ ). Multivariable logistic regression analysis revealed that a FIIA was independently associated with a decreased chance of a ROSC, with an OR of 0.40 (95% CI, 0.23–0.71;  $p = 0.002$ ). Other significantly associated variables in the model were witnessed cardiac arrest (OR, 3.78; 95% CI, 2.46–5.79;  $p < 0.001$ ), shockable initial rhythm (OR, 1.91; 95% CI, 1.01–3.63;  $p = 0.047$ ), presumed cardiac aetiology (OR, 0.38; 95% CI, 0.25–0.58;  $p < 0.001$ ), no-flow time (OR, 0.98 per 1 min; 95% CI, 0.96–1.00;  $p = 0.023$ ) and prehospital low-flow time (OR, 0.97 per 1 min; 95% CI, 0.94–0.98;  $p < 0.001$ ).

Fig. 1 depicts the incidence of ROSC in both groups during the first 30 min of ED resuscitation. In the figure, the divergence of the two incidence curves is observed during earlier ACLS period which rather suddenly decreases by the midpoint of this 30-min period. However, competing events of resuscitation termination

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