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The effect of the number and level of emergency medical technicians on patient outcomes following out of hospital cardiac arrest in Taipei☆

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ABSTRACT

Aim: The effect of the number and level of on-scene emergency medical technicians (EMTs) on the outcomes of patients with out-of-hospital cardiac arrest (OHCA) remains unclear. We aimed to test the association between the number and level of EMTs and the outcomes of patients with OHCA.
Methods: We analysed Utstein-based registry data on OHCA in Taipei from 2011 to 2015. The eligible patients were adults, aged ≥20 years, with non-traumatic OHCA who underwent resuscitation attempts. The exposures were the total number of EMTs or the EMT-Paramedic (EMT-P) ratio >50%. The outcome of interest was survival to discharge.
Results: During study period, total 8262 OHCA cases were included, of which 1085 (13.1%) were approached by crews with an EMT-P ratio >50%. While an increase in the number of EMTs on-scene was not associated with better chances of survival (adjusted odds ratio [aOR] 0.98, 95% confidence interval [CI] 0.89–1.08), an EMT-P ratio >50% was significantly associated with improved outcome (aOR 1.36, 95% CI 1.06–1.76). Subgroup analyses showed that EMT-P >50% significantly benefited survival in witnessed OHCA cases with non-shockable rhythm (aOR 1.69, 95% CI 1.01–2.58). Survival was the highest among cases seen by four EMTs with an EMT-P ratio >50% (aOR 2.54, 95% CI 1.43–4.50).
Conclusion: An on-scene EMT-P ratio >50% was associated with improved survival to discharge of OHCA cases, especially in those with witnessed, non-shockable rhythm. The presence of four EMTs with an EMT-P ratio >50% at the scene of OHCA was associated with the best outcome.

Introduction

Out of hospital cardiac arrest (OHCA) is a problem of paramount importance worldwide. Although resuscitation science has made significant progress in the past decades, survival following OHCA remains unresolved [1]. In the United States, over 176,100 OHCA patients are treated annually by emergency medical service (EMS) teams [2]. In Taiwan, the incidence of OHCA was reported as 51.1 per 100,000 people from 2000 to 2012, or an average of 9815 cases per year; the survival rate among these cases was 9.8% at 180 days [3]. On-scene emergency medical technicians (EMTs) are the first-line health care providers for OHCA patients in many countries.

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Therefore, the number and level of EMTs in the field are considered to influence the outcomes of patients with OHCA [4–7].

The number and level of EMTs on the scene for OHCA resuscitation is one of possible modifiable factors in OHCA treatment. However, their effects on outcomes of OHCA patients remain controversial [4–6,8]. In a single-tiered system, Kajino et al. found that the presence of three paramedics (100% paramedic ratio) in resuscitation team was associated with improved favourable neurologic outcomes in the witnessed OHCA group, although there was no difference in the 30-day survival [4]. However, Hagiwara et al. showed the opposite, reporting no significant favourable neurological outcomes in the resuscitation group with more than two paramedics (i.e. 66.7–100% paramedic ratio) [8] In a two-tiered system, Eschmann et al. revealed no significant survival benefits in the group treated by the advanced life support (ALS) team with an increasing number of paramedics, but the study did not investigate the influence of the total number of EMTs [6]. Another study conducted by Warren et al. showed a positive association between the total number of EMTs and survival of OHCA patients, but they did not consider the number of on-scene paramedics in the resuscitation team [5].

Taking both number and level of on-scene EMTs into consideration is important in evaluating the effect of EMTs on the survival of OHCA patients because there might be interactions between them, such as workload or leadership. A sufficient number of EMTs is essential for the management of OHCA patients. For example, two EMTs may not be able to perform many treatments and simultaneously maintain a high quality of cardiopulmonary resuscitation (CPR). Paramedics are usually more skilful and confident in performing OHCA as they have more experience and training, and theoretically could be team leaders for on-scene resuscitation. However, too many paramedics might lead to ambiguous leadership, thus threatening the team performance [9]. Proper paramedic ratios could be an important component of EMS configuration. Many EMS teams comprise different levels of EMTs, such as EMT-intermediate (EMT-I) and paramedics, but the best paramedic ratio in prehospital resuscitation is still unknown in both single-tiered and-two-tiered systems [4,8].

This study aimed to evaluate the effect of the number and level of on-scene EMTs on the outcomes of OHCA patients. We hypothesized that more than two EMTs and a paramedic ratio >50% for the resuscitation team would be associated with improved survival among OHCA patients in Taipei City, Taiwan.

Materials and methods

Study design and setting

We conducted a 5-year retrospective cohort study using prospectively collected Utstein-based registry data from the Taipei EMS to investigate the association between the number of EMTs and the paramedic ratio with OHCA patient outcomes [10]. The study protocol was approved by the Institutional Review Board of the National Taiwan University Hospital.

Taipei City is a metropolitan area with 2.65 million registered residents; this number fluctuates to 3.0 million during working hours due to the inflow of workers within 272 km^2. Taiwanese people comprise the majority of the population. Taipei city has a one fire-based EMS system with a two-tiered response consisting of a basic life support plus defibrillator (BLS-D) team and an ALS team. The BLS-D team is capable of performing defibrillation and placing laryngeal mask airway (LMA). Taipei city has 45 prehospital BLS-D stations with 1020 EMT intermediate staff, who have finished at least 264 h of training and constitute the fire base crews. One BLS-D station has two BLS-D ambulances. One BLS ambulance is teamed with two EMTs-I, although sometimes there is a third staff member (usually a volunteer EMT) in the ambulance.

The ALS team providers are authorised to perform endotracheal tube intubation and intravenous injections of resuscitation medications, like adrenaline, atropine, and amiodarone, as per protocol [10]. The ALS providers conduct OHCA re-training for ALS treatment every year. There are four ALS stations staffed by 120 EMT paramedics who have completed 1280 h of training as per the requirements of the Taiwanese Ministry of Health and Welfare. One ALS station has three ALS ambulances. One ALS ambulance is usually teamed up with two paramedics, while one BLS ambulance is teamed with two EMTs-I, although sometimes there is a third staff member (usually a volunteer EMT) in the ambulance. Taipei has a single central dispatch centre to process all incoming EMS calls; all dispatchers are required to complete 40 h of training on priority dispatch. BLS-D is the universal response for all dispatch calls. For cases that meet the ALS dispatch criteria, additional ALS teams would be dispatched to the scene together with BLS-D teams. For an ALS case that occurs in an area close to an ALS squad, the nearby ALS team would be the first response team to dispatch, and an additional ALS team, as opposed to the BLS-D, would be activated if available.

Study population

From 1st January 2011, to 31st December 2015, non-traumatic adult (age $\geq$ 20) patients with OHCA that activated the EMS teams were included in the study. We excluded patients if they were not transported to the hospital due to obvious death signs, such as rigor mortis, or if the family requested a do-not-resuscitate (DNR) or the patient had given pre-existing consent for DNR.

Definition of exposures

The exposures in our study were defined as EMT configuration including the total number of EMTs and a paramedic ratio >50%, defined as paramedic proportion among all on-scene EMTs. For the paramedic ratio, we divided the ratio into two categories (>50% vs $\leq$50%) because this was more practically applied by the dispatch centre.

Outcome measurements

The primary outcome was defined as survival to hospital discharge. The secondary outcome was favourable neurologic status at discharge defined as cerebral performance category level 1 and level 2 (CPC $\leq$2) [11].

Our data were extracted from the Utstein-based OHCA registry system in the Taipei EMS. This registry system was initially developed for OHCA quality control [10]. The rates of missing data ranged from 0% (most data) to 2.6% (mainly “prehospital times”). The registry system collected data on dispatch records, modes and timing of prehospital care, patient demographics (age, sex), arrest characteristics (witness status, bystander CPR, initial rhythm on cardiac monitor), records on automated external defibrillator (AED) availability, prehospital ALS treatment including airway and medication used, patient records from the EMS-receiving hospitals, and patient outcomes (survival to hospital discharge, and neurologic status at discharge) [12,13].

We conducted a subgroup analysis using the new Utstein template, with methods suggested by the International Liaison Committee on Resuscitation (ILCOR) in 2014 to explore the effect of a paramedic ratio >50% among different subgroup patients with OHCA [11]. For this analysis, we stratified the data by shockable bystander CPR groups, shockable bystander witness groups, and non-shockable witness groups.