Ward Characteristics Associated with Delayed Defibrillator and Doctor Presence in Cardiopulmonary Resuscitation Simulated Survey

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ABSTRACT

Objective: To survey the times to critical actions (defibrillator and doctor presence, initiation of chest compression) of in-hospital simulated cardiopulmonary resuscitation (CPR).

Methods: A 1-year retrospective simulated audit 2009 in a 2,400-bed university hospital in Thailand.

Results: A total of 57 adult wards (around a third of all wards in the hospital), including intensive care units, critical wards, procedural units, general wards and out-patient units were audited. Overall, the median time of initiation of chest compression and defibrillator presence among CPR teams were 1.27 (0.35-7.19) and 1.16 (0.00-26.00) minutes, respectively. The median time of the first doctor presence was 3.45 (0.00-15.15) minutes. However, there were significant differences in time to defibrillator and doctor presence among wards. The longer time of these critical managements were recorded in non-monitored areas (general wards and out-patient units) (p = 0.004 and 0.007, respectively).

Conclusion: In our CPR simulated survey, delayed initiation of critical managements commonly occurred in non-monitored areas. Better management should be concerned for favorable outcomes.

Keywords: Cardiopulmonary resuscitation, simulation, audit, quality improvement

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Cardiopulmonary resuscitation (CPR) is a complex process with highly time-sensitive actions requiring skills and coordination among health care providers.[1-2] To provide the best opportunity of survival, early chest compression, early defibrillation and early advanced care must start promptly and effectively.[1-7]

The Siriraj CPR training center was founded in 1997. The center is responsible for setting and organizing the CPR team services, teaching and training CPR skills for medical students and all levels of healthcare providers. The center has annually surveyed the coordination of the CPR team in each area in the hospital, and subsequently has given feedback to the CPR teams and hospital executives. According to published literatures, audits and feedback clearly encourage the complicated infrastructure hospital to have organized CPR teams, increase the number of emergency supplies such as emergency carts, defibrillator and monitors.[8-9]

The purpose of this study was twofold: first, to evaluate the time management by CPR teams, including time to start chest compression, time to defibrillator and doctor arrival. Second, to identify the ward characteristics which are associated to delay management.

MATERIALS AND METHODS

This retrospective study was approved by the Institutional Review Board (Si.424/2553 (Exempt)). Data for the present study were part of an annual simulated survey

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which was collected in August 2009. This study reported the data related to timing and coordination of CPR.

Study setting and population

The studied hospital is an academic, tertiary care facility with seventeen buildings and approximately 2,400 in-patient beds. The Siriraj training center committee categorized hospital CPR zones according to a risk of cardiac arrest occurrence into five main units, including intensive and cardiac care units (ICU and CCU), critical wards, procedural units, general wards and out-patient units. High risk zones (ICU, CCU, critical wards and procedural areas) were covered by 24-hour available physicians and nurses. We defined a critical ward as a general medical or surgical ward in which a third to a fourth of admitted patients were critically ill patients (patients with mechanical ventilation, hypovolemia or stable angina). Patients were admitted to those wards when ICUs or CCUs could not be provided. Low risk zones (general wards and out-patient units) were covered by an on-call code cardiac arrest teams which covered the rest of the zones in the hospital. These teams were composed of at least one doctor (an internal medicine resident or fellow, an anesthesia resident, a cardiologist or a trauma staff) and trained nurses.

Regarding monitors supplied in each area, ICUs and CCUs hadsufficient numbers of monitors while critical wards, procedural units and out-patient units shared equipment supplies with others.

All first-year residents and nurses in critical care areas were trained in a mandatory advanced cardiac life support (ACLS) course. Around a half of the nurses working in each ward attended a refresher course of basic life support (BLS) and/or advance cardiac life support trained by the Siriraj CPR training center within 3 years during the study period.

Study protocol

The CPR audit period and details of the simulated process were announced on the hospital website and brochure one month in advance. All healthcare providers were expected to know details on a checklist which comprised compulsory actions. The checklist was developed by the Siriraj CPR training center committee in accordance to checklists of the American Heart Association (AHA). There were two main parts in the evaluation. The first part was the evaluation of timing and coordination of CPR and the second part is emphasis on the quality of CPR which is related to individuals and decision making skills of medical personnel performing CPR. Surveyors expected all CPR teams would prepare emergency equipment and organize the CPR team for a favorable result on an audition.

Each survey occurred at an official hour. A simple sampling of a surveyed ward was performed in the morning before they were audited. As soon as surveyors showed up with a manikin, healthcare providers working on that day activated a CPR team and started CPR.

After the scene, surveyors gave a 15-minute feedback to each CPR team and health care providers working in the area.

Data collection

Data collected in the first part included the time and date of an audit, the location in the hospital, the cardiac arrest team who were assigned to cover the area, the number of emergency carts, equipment and defibrillators. Data collected in the second part regarded the times to actions, including the times to emergency cart, defibrillator and a doctor presence at the CPR scene, and the time to initiate chest compression.

Statistic analysis

Descriptive statistics were used to examine human, equipment resources and times to actions, including time to emergency cart, defibrillator and a doctor presence, and time to initiation of chest compression. To test the difference in times among 5 ward types, the Kruskal-Wallis test was applied. The Mann-Whitney test was used to compare the times of critical actions among high risk and low risk wards. Statistical analysis was conducted using the software program, SPSS version 17 Inc., Chicago, IL, USA. Data were presented as mean ± standard deviation (SD) (range), median (min, max), number (%) as appropriates. $P < 0.05$ was considered to indicate statistically significant differences.

RESULTS

Characteristics of 57 surveyed wards

The total of 57 sampled wards were around fifty five percent of adult wards in the hospital. These wards included five ICUs, ten critical wards, eleven procedural units, sixteen general wards and fifteen out-patient units. Each CPR team at a simulated scene composed of at least five rescuers, including doctors from a cardiac arrest team, and doctors and nurses working in those areas on the day. Emergency carts were available in every unit while defibrillators were limited. These insufficient resources were shared. Most surveyed wards shared a defibrillator with others, eighteen wards shared a machine with other wards on the same floor, and twelve wards shared a machine with other wards in another floor. Twenty seven wards had a defibrillator located at their wards. (Table 1)

Time to actions of 57 wards

All median times to actions were a skewed right-tail distribution. Overall, median times of equipment arrivals were generally appreciated. An emergency cart arrival median time was only 40 seconds (0-5.30 minutes), and defibrillator arrival median time was only 1.16 minutes (0-26 minutes). Median times to rescuers' performances were also favorable. The median time of an initiation of chest compression performed by any rescuers was 1.27 minutes (0.35 to 7.19 minutes), and the median time of a first doctor arrival was 3.45 minutes (0-15 to 15 minutes) (Table 2).

Timse to critical actions categorized by ward characteristics

Fig 1-3 shows times to critical actions, including initiation of chest compression, defibrillator and a doctor presentation, categorized by types of wards. There were no differences of the median time to initiation of chest compression among high risk and low risk areas (p = 0.357). Interestingly, the median time of defibrillator arrival and first doctor presence were significant different among the five ward-types (p value from Kruskal-Wallis test = 0.007 and 0.018, respectively). As shown in Fig 2-3, the median time of these critical managements were significantly slower in low risk areas than in high risk areas (p value from Mann-Whitney test = 0.004 for time of defibrillator arrival and p value = 0.007 for time of first doctor).

TABLE 1. Staff and equipment for CPR in 57 wards.

	Number of wards (%)
Cardiac arrest team	
Physicians + nurses on ward/ER/ICU/CCU	12 (21.1)
Code A (an internal medical resident or fellow + an anesthetic resident)	28 (49.1)
Code ER (an emergency medical resident + trained nurses)	11 (19.3)
Code Trauma (a surgical trauma resident + trained nurses)	3 (5.3)
Code HMCC (a Cardiologist fellow + trained nurses)	2 (3.5)
Code OR (an anesthesiologist + trained nurses)	1 (1.7)
Emergency cart	57 (100)
Sharing defibrillator	
One machine for one ward	27 (47.4)
Share a machine with wards in the same floor	18 (31.6)
One machine for two wards	13 (22.8)
One machine for three wards	2 (3.5)
One machine for four wards	3 (5.3)
Share a machine with wards in another floor	12 (21.0)
One machine for two wards	1 (1.7)
One machine for three wards	3 (5.3)
One machine for at least four wards	8 (14.0)

DISCUSSION

A complicated infrastructure hospital is a hindrance for effective resuscitation following cardiac arrest. To achieve favorable results, limited human and equipment resources should be organized. The Siriraj CPR center used an audit as tool for indicating some opportunities for quality improvement. Regarding of the Chain of Survival, the key principals of successful resuscitation are composed of rapid presence of rescuers and equipment, and the quality of BLS and ACLS and post- cardiac arrest care. In this study we demonstrated the timing and coordination of CPR in simulated scenes.

Nowadays, the steps of CPR have been changed from A-B-C to C-A-B. The prompt initiation of effective chest compressions is a fundamental aspect of CPR. The high quality of chest compressions improved the victim's chance of survival by providing heart and brain circulation.[1] This action should be performed by all levels of health care providers. Not surprisingly, the median time to start chest compression was favorable, which was 1.27 minutes.

Arrival of a doctor in a cardiac arrest scene is crucial in our hospital because the nurses are not allowed to defibrillate. Therefore, the speed of defibrillation, advance airway management and drugs administration depended on the arrival of the cardiac arrest team. Claudio et al,[10] demonstrated patient survival in the wards was significantly higher when the cardiac arrest team arrival time was less than 3 minutes, and no patient survived when the team arrival time was more than 6 minutes. Paul et al[5], also presented the association of delayed defibrillation (>2 minutes) and a significantly lower likelihood of return of spontaneous circulation and survival at 24 hours after the cardiac arrest. Overall, the median times of a doctor and defibrillator presence seemed to be acceptable, which were 1.16 and 3.45 minutes, respectively. However, when we analyzed these times categorized by ward characteristics, the longer time of these critical managements were recorded in non-monitored areas (general wards and outpatient units) ($p = 0.004$ and 0.007, respectively). This was because 50% of non-monitored areas were covered by a code A team. Travel to a scene was not easy because of the complicated infrastructure and there were not enough dedicated elevators. As a result, there were wide ranges of call-to a doctor arrival interval (0 to 15 minutes) and defibrillator presence (0 to 26 minutes) shown in this study. Although the incidence of in-hospital cardiac arrest was only 10% (38/346), according to the report from the Siriraj CPR center, better management should be considered in non-monitored areas.

There are several limitations of this study. Firstly, the times shown were quantity; we do not present the quality of those actions e.g. rate and depth of chest compression

TABLE 2. Time to actions of 57 wards.

Actions	Time of actions* (minute. seconds)
Arrival of emergency cart	0.40 (0.00, 05.30)
Arrival of defibrillator	1.16 (0.00, 26.00)
Initiation of chest compression	1.27 (0.35, 7.19)
Arrival of first doctor	3.45 (0.00, 15.15)
Arrival of primary doctor	3.30 (0.00, 22.30)
Arrival of code A1	5.05 (1.16, 11.56)
Arrival of code A2	7.08 (3.26, 14.30)

*Median (min, max)

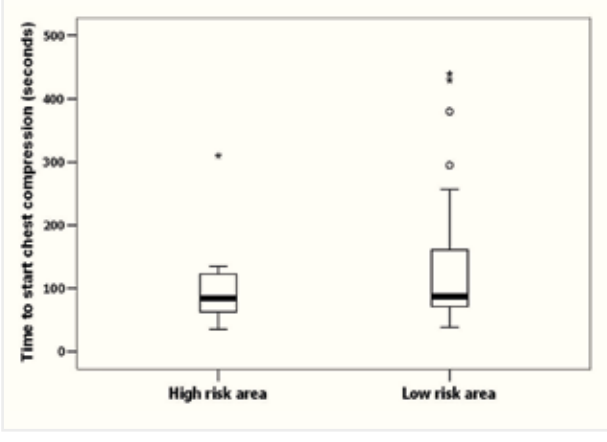

Fig 1. Time to initiation of chest compression

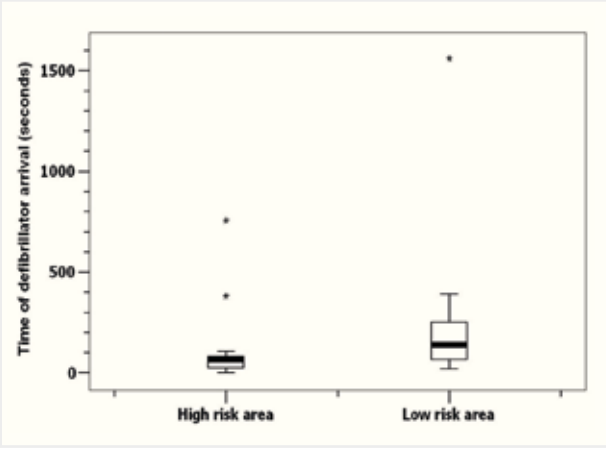

Fig 2. Time to defibrillator arrival

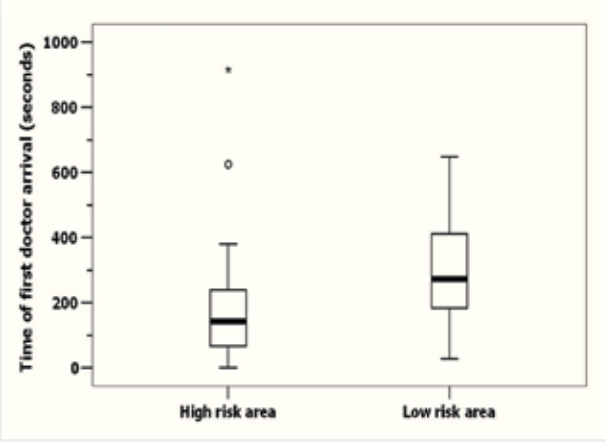

Fig 3. Time to first doctor arrival

in this part of study. In addition, the time of defibrillator arrival does not provide the true link in chain of survival since it is not "time to shock". Secondly, this study prompted checklists and allowances to prepare human and equipment resources which caused the Hawthorne effect.[11] Healthcare providers were motivated to work harder and more effectively by this effect. Time management in in-hospital cardiac arrest should be studied further.

CONCLUSION

Overall, times to critical managements were favorable in this simulated audit. However, delayed initiations of critical actions commonly occurred in non-monitored areas. Better management should be concerned for favorable outcomes.

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