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The Viability of Using Remote Controlled Mechanical Chest Compression Devices to Reduce Contamination in Cardiac Arrest Patients during the COVID-19 Pandemic

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Abstract

BACKGROUND: Mechanical chest compression devices play an important role in assisting patients undergoing cardiac arrest. However, this equipment induces an aerosol-generating procedure that could contaminate hospital staff. The development of a remote control system for mechanical chest compression devices may solve the problem; however, there are currently no studies regarding the efficacy of this system.

AIM: This study aims to analyze efficacy of remote control systems for mechanical chest compression devices and compare it with non-remote control systems.

METHODS: This was an analytical cross-sectional study at Srinagarind Hospital, Thailand. Data were collected in two periods of the study. The first period was between January and December 2021 using a non-remote control system to operate the mechanical chest compression device. The second period was from January to April 2022 and collected data on the use of a remote control system.

RESULTS: Sixty-four participants were examined over the 16-month period of the study. A total of 53.1% (n = 34) of participants were male and the mean age of the patients was 52.4 ± 5.1 years old. The number of emergency medical service members (EMS) needed for resuscitation in the remote control group was less than the non-remote control group (3 vs. 5; p = 0.040). The number of emergency department (ED) members needed for resuscitation in the remote control group was four compared with eight in the non-remote control group.

CONCLUSIONS: The remote controlled mechanical chest compression device can effectively reduce the number of staff working both in the EMS and in the ED of the hospital, thus reducing exposure and contamination from aerosol-generating procedure. It was also proven accurate in terms of rate and depth of chest compression according to resuscitation guidelines.

Introduction

Cardiac arrest is a frequent emergency condition in both the emergency department (ED) and for emergency medical services (EMSs) [1], [2]. This condition requires experienced staff and the prompt treatment of patients. Guidelines for resuscitation in patients with cardiac arrest consist of chest compressions and defibrillation in combination with artificial ventilation which results in an aerosol-generating procedure that could contaminate hospital staff [3], [4].

During the coronavirus (COVID-19) pandemic, the study found that the treatment of patients with cardiac arrest changed before the time of the COVID-19 outbreak. The rate of chest compressions pertaining to the general population for cardiac arrest decreased as well as the rate of ventilation in such patients. The cause was the rescuer's fear of contracting COVID-19. In addition, a study found that the tendency to resuscitate in cardiac arrest patients was reduced, leading to an increase in mortality [5], [6].

Mechanical chest compression devices play an important role in assisting patients undergoing cardiac arrest [7]. The devices can control the rate and depth of chest compressions with the time of ventilation according to the resuscitation guidelines. However, the tool requires manual operation of the device near the patient, making it possible for hospital staff to become contaminated with COVID-19.

Therefore, the development of a remote control system for mechanical chest compression devices is needed to solve the problem. This is a technology that was recently developed in 2021 by relying on a wireless network from a control device that through command can remotely set up and operate a chest compression machine. The main advantage is reducing the number of hospital staff needed to resuscitate patients with cardiac arrest. As a result, it significantly reduces the

chances of contracting COVID-19. Furthermore, it also reduces the contamination of some important pathogens such as tuberculosis. This system makes the workforce safer, allowing for increased confidence in the rescue of patients undergoing cardiac arrest. Therefore, studying the use of remote controlled mechanical chest compression devices will be useful in developing resuscitation guidelines with the appropriate technology in the current COVID-19 pandemic situation.

Methods

Study design and setting

This was an analytical cross-sectional study carried out at Srinagarind Hospital, Thailand, in the EMS and ED. This hospital also serves as the medical school for Khon Kaen University and is a tertiary level hospital. The annual number of EMS patients is approximately 1,900-2,100 cases and the ED is visited between 15,000 and 18,000 times per year.

Data were collected in two periods of the study. The first period was between January and December 2021 and was characterized by the use of CORPULS® cardiopulmonary resuscitation (CPR) with no remote control system. The second period from January to April 2022 during which time the software version 4.0 of CORPULS® 3 and software version 1.2 of CORPULS® CPR with Bluetooth connection (remote-control system) was employed in the care of patients.

Ethical considerations

Ethics approval was provided by the Khon Kaen University Ethics Committee for Human Research (HE651051). This study was conducted in accordance with the principles of the Helsinki and Good Clinical Practice guidelines.

Data collection

The sample size was calculated based on the prevalence of the previous studies [7]. To achieve a significance level of 5% and absolute precision 0.12, we determined that a sample size of 64 would be required. The inclusion criteria were patients over 18 years of age who were diagnosed with cardiac arrest by healthcare personnel from the period of the study and used CORPULS® CPR as a mechanical chest compression device. The exclusion criteria were trauma-related cardiac arrest and incomplete data. Data were gathered from the telemedicine system of EMS, electronic medical records, and observation through closed-circuit television.

Data analysis

Statistical analysis was carried out using IBM SPSS for Windows version 27.0 and a Khon Kaen University license (SPSS Inc.; Chicago, Illinois, USA). Continuous variables data are reported as mean and standard deviation (SD), and categorical variables are presented as number (n) or frequency (percent).

Mechanical chest compression devices (Figures 1 and 2)

The CORPULS® CPR, Germany, was the tool employed as the mechanical chest compression device in this study. The display was a 2.4 inch LED color display, illuminated. The operating volume was 70 decibels with a weight of 5.5 kg. The dimensions of the device were 43 cm (h), 45 cm (w), and 9 cm (d). The frequency of chest compression was adjusted 80–120 compressions/min and pressure depth ranged from 2 to 6 cm.

The remote control system of the mechanical chest compression device utilized a Bluetooth connection with the software version 4.0 of CORPULS® 3 and software version 1.2 of CORPULS® CPR. The health-care provider who controls the rate and depth of the chest compression device can adjust from the monitor of CORPULS® 3. The distance between the monitor and chest compression device is within 5–10 m.

Results

The 64 participants were examined over a period of 16 months for the study. The characteristics of participants are shown in Table 1. A total of 53.1% (n = 34) of participants were male and the mean age of the patients was 52.4 ± 5.1 years. EMS operation times were most commonly performed during the night shift (00.00 am–8.00 am).

Table 1: Characteristic of participants (n = 64)

Characteristics	Number (%)
Gender	
Male	34 (53.1)
Female	30 (46.9)
Age (years) mean ± SD	52.4 ± 5.1
EMS operation time	
Morning shift	22 (34.4)
Afternoon shift	19 (29.7)
Night shift	23 (35.9)
Response time (min) mean ± SD	9.4 ± 4.2
Scene time (min) mean ± SD	18.6 ± 8.4
Transport time (min) mean ± SD	14.1 ± 6.5

The cardiac arrest participants who used the mechanical chest compression device were divided into two groups (non-remote control group and remote control group). The number of EMS members required for resuscitation in the remote control group was less than the non-remote control group (3 vs. 5; p = 0.040). The number of ED members needed for resuscitation in

the remote control group was four compared with eight in the non-remote control group (Table 2).

Table 2: Comparison of mechanical chest compression device

Characteristics	Non-remote control group (n = 42)	Remote control group (n = 22)	p-value
Number of EMS members in each case, mean (IQR)	5 (4−5)	3 (2−3)	0.040*
Number of ED members in each case, mean (IQR)	8 (6−9)	4 (3−5)	0.032*
Percentage of chest compression rates that followed the guidelines, (%) mean ± SD	95.4 ± 3.2	95.8 ± 3.0	0.614
Percentage of chest compression depth that followed the guidelines, (%) mean ± SD	97.2 ± 2.5	97.1 ± 2.6	0.528
Hands-off chest compression time, (sec) Mean ± SD	2.1 ± 0.8	2.0 ± 0.7	0.442

*Statistical significance, Abbreviation: EMS: Emergency Medical Service, IQR: Interquartile range, ED: Emergency Department, SD: Standard Deviation, sec: Second

Figure 1: Mechanical chest compression device

Discussion

The primary objective of this study was to evaluate the benefits of developing a resuscitation model which utilizes a remote control mechanical chest compressions device to reduce contamination of staff operating in ED and for EMS. The study found that using a remote control can effectively reduce the number of staff working, thus it can be seen as useful in reducing contamination through a number of respiratory pathogens.

Of the 64 cardiac arrest participants, ratios were similar in the number of males and females, consistent with the previous studies [8], [9]. However, in terms of operating time for EMS, the vast majority of patients with cardiac arrest occurred on night shift, this is unlike previous studies where the incidence of out-of-hospital cardiac arrest was more associated with the afternoon shift [7], [10]. In terms of response time, it was found that in the study units close to the standards of Thailand that EMS must reach a patient in cardiac arrest in less than 8 or 10 min.

From the study, it was found that using a remote control device in the treatment of cardiac arrest patients, the number of medical personnel required was greatly reduced. This was due to the fact that the device can be controlled at a distance of 5–10 m, putting the controller operating the machine at a safe distance outside of the radius of most likely to spread pathogens. In addition, control of the device requires only one individual. In addition to making the operation more efficient, it also reduces possible communication errors [11], [12], [13].

In terms of accuracy, the rate and depth of chest compressions in patients with cardiac arrest through a mechanical chest compression device using both the remote control and non-remote control have similar accuracy, a high percentage is close to the resuscitation guidelines [14], [15]. In addition, it was found that the hands-off time for chest compression was less than ten seconds by guideline standards.

The further development of remote control systems in medical devices is a challenge that arises under the limiting circumstances of the COVID-19 outbreak. However, these devices that can be remotely controlled are needed now more than ever before as they will increase the safety of operators as well as reduce the chance of contamination and the spread of infection. Finally, it is important for the developers of systems to be able to develop remote control abilities to put on the necessary basic medical equipment such as blood pressure monitors or oxygen saturation monitoring.

Figure 2: Remote control system of mechanical chest compression device

There are two main limitations to the study. First, the study was from a single hospital, which may not be representative of the population in other areas. Second, it can also be noted that only one type of chest compression device was enrolled in this study which may be different with other brands of equipment resulting in different prescribed times for the study.

Conclusions

Using a mechanical chest compression device with remote control can reduce the number of staff working both in the EMS and in the ED of the hospital,

thus reducing exposure and contamination from aerosol-generating procedure. It is also accurate in terms of rate and depth of chest compression according to resuscitation guidelines.

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