Original Article

The Role of Mechanical Cardiopulmonary Resuscitation Devices in Emergency Medical Services

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Background: Mechanical cardiopulmonary resuscitation (CPR) devices were developed over 60 years ago to help with chest compressions in patients suffering from cardiac arrest. However, no studies examining mechanical CPR devices have been conducted in EMS patients at Srinagarind Hospital.

Objective: To compare the effectiveness of mechanical and manual CPR.

Materials and Methods: This was a retrospective descriptive study. The sample consisted of 73 patients over 18 years of age who were diagnosed with out-of-hospital cardiac arrest (OHCA) by EMS personnel from January 2016 to December 2019. Data were collected from the Srinagarind Hospital EMS operation database and hospital information database system.

Results: There were a total of 9,670 operations conducted by Srinagarind Hospital EMS during the study period. One hundred sixteen subjects were diagnosed with OHCA, of whom 73 were examined. Just over half (52.2%) of the patients who received mechanical CPR were over 65 years of age. The average on-scene time for mechanical and manual CPR was 10.20 minutes and 15.30 minutes, respectively (p = 0.020), and chest compression time was 6.32 minutes and 4.20 minutes, respectively (p = 0.014).

Conclusion: Use of mechanical CPR devices on OHCA patients did not improve activation or response time but significantly decreased on-scene time and increased chest compression time.

Keywords: Cardiopulmonary resuscitation, CPR, Emergency mobile units, Ambulances

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Mechanical cardiopulmonary resuscitation (CPR) devices were developed over 60 years ago to help with chest compressions in patients suffering from cardiac arrest. Modern devices allow the operator to adjust the depth and rate of compression based on the individual needs of the patient. There are approximately 40 models that have been approved for use, and many are compact enough to be used on an ambulance[1].

Previous studies have found that survival rates in patients who undergo CPR via mechanical devices do not differ from those who undergo manual chest compression[2-5]. However, an advantage of these devices is that they can be used in confined spaces and with limited personnel. Because of this, the 2015 American Heart Association (AHA) guidelines on advanced cardiovascular life support (ACLS) recommend that the mechanical CPR devices be used to perform CPR in ambulances[12]. According to the ACLS guidelines for resuscitation, because mechanical CPR devices allow the operator to set the rate of chest compression, they also allow for more stable and continuous compression than manual methods[6-11]. Mechanical CPR devices have been used by Srinagarind Hospital emergency medical services (EMS) since January 2019. However, there have yet been no studies conducted regarding the effectiveness of these devices in this setting. The objective of this study was thus to compare the effectiveness of mechanical CPR devices and manual methods.

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Materials and Methods

This was a retrospective descriptive study. The sample consisted of 73 patients over 18 years of age who were diagnosed with out-of-hospital cardiac arrest (OHCA) by EMS personnel from January 2016 to December 2019. The exclusion criteria were trauma-related OHCA and incomplete data. Ethics approval was provided by the Khon Kaen University Ethics Committee for Human Research (HE631171). Data were collected from the Srinagarind Hospital (Khon Kaen University Faculty of Medicine, Thailand) EMS operation database and hospital information database system.

The sample size was calculated based on the prevalence of OHCA reported in a previous study. In order to achieve a significance level of 5% and power of test of 0.8,

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we determined that a sample size of 73 would be required. Statistical analysis was performed using SPSS for Windows version 16.0 (SPSS Inc., Chicago, IL, USA). Categorical data were presented as percentages, and continuous data were presented using mean and standard deviation. Univariable analysis was performed using a two-sample t-test for numerical data and a Pearson's correlation for data relationships between the two groups.

The patients were classified into two groups: (1) the mechanical CPR group, consisting of patients who underwent chest compression using mechanical CPR devices (CORPULS® CPR, Germany) and (2) the manual CPR group, consisting of patients who underwent manual chest compression conducted by EMS personnel.

Results

There were a total of 9,670 operations conducted by Srinagarind Hospital EMS during the study period. One hundred sixteen patients were identified as suffering from OHCA by EMS personnel, 73 of whom remained after excluding cases of trauma-related OHCA and those with incomplete data. The study flowchart is shown in Figure 1. Patient characteristics are shown in Table 1. Just over half (52.2%; n = 12) of patients in the mechanical CPR group were over 65 years of age, and 50.0% of the manual CPR group were between 19 to 64 years of age. The subjects in both groups were mostly male. The most common place where care occurred was in the patient's home (52.2% and 52.0%). Operations were most commonly performed between night shifts (0.00 AM to 8.00 AM).

In the mechanical CPR group, the average time from dispatch to resources being en route (activation time) was 1.40±0.43 minutes, and the time from 1669 call receipt to unit arrival on scene (response time) was 11.26±3.24 minutes (Table 2). The average on-scene time for mechanical and manual CPR was 10.20 minutes and 15.30 minutes, respectively (p = 0.020), and chest compression time was 6.32 minutes and 4.20 minutes, respectively (p = 0.014). Overall, 84.9% (n = 62) of OHCA patients were transferred by EMS to the hospital for further treatment, and 4.1% (n = 3) died and CPR was discontinued during transfer (Table 3).

Discussion

In the present study, the authors examined Srinagarind Hospital EMS data of OHCA patients from January 2016 through December 2019. The use of mechanical CPR devices by Srinagarind Hospital EMS began in January 2019, before which manual or hand chest compression was performed. The use of mechanical CPR devices did not improve activation or response time due to the fact that the devices were placed on the ambulance and could, thus, not reach the patient before EMS

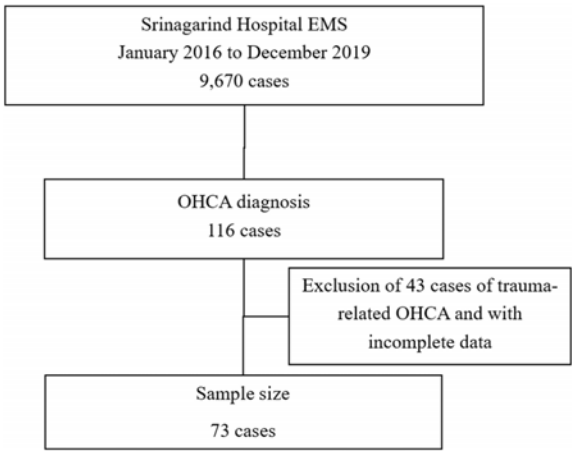

Figure 1. Flowchart of the study.

Table 1. Characteristics of the subjects

Characteristics	Mechanical CPR n = 23, (%)	Manual CPR n = 50, (%)	p-value
Age (years)			0.820
≤18	1 (4.3)	1 (2.0)	
≥19 to 64	10 (43.5)	25 (50.0)	
65	12 (52.2)	24 (48.0)	
Sex			0.724
Male	15 (65.2)	31 (62.0)	
Female	8 (34.8)	19 (38.0)	
EMS dispatch destination			0.650
Private residence	12 (52.2)	26 (52.0)	
Healthcare/nursing facility	8 (34.8)	15 (30.0)	
Public street	2 (8.7)	5 (10.0)	
No data	1 (4.3)	4 (8.0)	
Operation time			0.764
8.00 AM to 4.00 PM	4 (17.4)	9 (18.0)	
4.00 PM to 0.00 AM	8 (34.8)	15 (30.0)	
0.00 AM to 8.00 AM	11 (47.8)	26 (52.0)	

Table 2. EMS operation time in OHCA patients

EMS operation	Mechanical CPR n = 23	Manual CPR n = 50	*p*-value
EMS operation time ±SD (minute)			
Activation	1.40±0.43	1.32±0.21	0.320
Response	11.26±3.24	10.56±4.20	0.422
On-scene	10.20±4.42	15.30±5.02	0.020*
Chest compression ±SD (minute)	6.32±2.20	4.20±1.12	0.014*

* Statistical significance

Table 3. Patient outcomes

Patient outcomes	Mechanical CPR n = 23, (%)	Manual CPR n = 50, (%)	*p*-value
Transferred to hospital	20 (87.1)	42 (84.0)	0.420
Died on the ambulance	1 (4.3)	2 (4.0)	0.440
Transferred to another location	1 (4.3)	1 (2.0)	0.520
No data available	1 (4.3)	5 (10.0)	0.202

personnel[13-15].

However, the authors found that the use of mechanical CPR devices significantly decreased on-scene time and increased chest compression time. This is because manual CPR requires sufficient available personnel to prepare both the equipment and perform chest compression; there are typically only three to four personnel available on an EMS operation. The use of mechanical CPR devices reduces the number of personnel required, allowing those available to prepare the patient for transfer or manual procedures and resulting in reduced on-scene time[13,14].

In Thailand, mechanical CPR devices have only been used in EMS for a few years, and there have been no studies conducted to demonstrate the clinical benefits of this method compared to manual CPR. However, the use of mechanical CPR devices in Western countries has increased more than 4-fold from 2010 to 2016[1]. One reason for the late adoption of these devices in Thailand may be their high cost (>25,000 USD per unit).

The present study was limited in that it did not collect data of patients with trauma-related OHCA due to hospital management protocol, resulting in small population size. In addition, the study design was retrospective, which may have resulted in incomplete data collection.

Conclusion

Use of mechanical CPR devices in OHCA patients did not improve activation or response time but significantly decreased on-scene time and increased chest compression time.

What is already known on this topic?

Mechanical CPR devices have been available for over 60 years to help with chest compression in patients suffering from cardiac arrest.

What this study adds?

The use of mechanical CPR devices significantly decreased on-scene time and increased chest compression time.

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Potential conflicts of interest

The authors declare no conflict of interest.

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บทบาทของเครื่องนวดหัวใจอัตโนมัติในระบบการแพทย์ฉุกเฉิน

กรกฎ อภิรัตน์วรากุล, วิสาลินี ส่งเสริม, กมลวรรณ เอี้ยงฮง, ปริวัฒน์ ภู่เงิน, คนุ เกษรศิริ, วัชรพงศ์ พุทธิสวัสดิ์

ภูมิหลัง: เครื่องนวดหัวใจอัตโนมัติถูกพัฒนามากว่า 60 ปี เพื่อช่วยในกดหน้าอกในผู้ป่วยที่หัวใจหยุดเต้น อย่างไรก็ตามยังไม่มีการศึกษาในหน่วยการแพทย์ฉุกเฉิน โรงพยาบาลศรีนครินทร์

วัตถุประสงค์: เพื่อเปรียบเทียบประสิทธิภาพการกดหน้าอกระหว่างเครื่องนวดหัวใจอัตโนมัติและมือในผู้ป่วยที่หัวใจหยุดเต้น

วัสดุและวิธีการ: การศึกษาแบบย้อนหลังในผู้ที่อายุมากกว่า 18 ปี และมีภาวะหัวใจหยุดเต้นนอกโรงพยาบาลจำนวน 73 ราย ระหว่างเดือนมกราคม พ.ศ. 2559 ถึงเดือนธันวาคม พ.ศ. 2562 ข้อมูลการศึกษาได้จากฐานข้อมูลด้านการแพทย์ฉุกเฉินและฐานข้อมูลผู้ป่วย โรงพยาบาลศรีนครินทร์

ผลการศึกษา: มีการปฏิบัติการทั้งสิ้น 9,670 ครั้งในช่วงที่ทำการศึกษา มีผู้ที่ได้รับการวินิจฉัยว่ามีภาวะหัวใจหยุดเต้นนอกโรงพยาบาลจำนวน 116 ราย นำข้อมูลมาศึกษา 73 ราย ในกลุ่มที่ใช้เครื่องนวดหัวใจอัตโนมัติมีอายุมากกว่า 65 ปี ร้อยละ 52.2 เวลาเฉลี่ยในที่เกิดเหตุในกลุ่มที่ใช้เครื่องนวดหัวใจอัตโนมัติ 10.20 นาทีและในกลุ่มที่ใช้มือกดหน้าอก 15.30 นาที ช่วงเวลาที่ใช้ในการกดหน้าอกในกลุ่มที่ใช้เครื่องนวดหัวใจอัตโนมัติ 6.32 นาทีและ 4.20 นาทีในกลุ่มที่ใช้มือกดหน้าอก

สรุป: การใช้เครื่องนวดหัวใจอัตโนมัติในผู้ที่มีภาวะหัวใจหยุดเต้นนอกโรงพยาบาล สามารถลดเวลาเฉลี่ยในที่เกิดเหตุและเพิ่มช่วงเวลาที่ใช้ในการกดหน้าอก