


The factor influencing the rate of ROSC for nontraumatic OHCA in New Taipei city

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Abstract

Return of spontaneous circulation (ROSC) from out-of-hospital cardiac arrest (OHCA) is critical for the Emergency Medical Services System. When compared to other developed countries, Taiwan has lower rate of ROSC in OHCA patients.

We conducted a retrospective study of cardiac arrest using The Emergency Medical Service Dispatching Center in Northern Taiwan and The Prehospital Care System of New Taipei City Paramedic Service. Patients suffering from nontraumatic OHCA between August of 2019 to February of 2020 were included. We analyzed the cardiopulmonary resuscitation (CPR) quality parameters such as chest compression interruptions, bystander CPR, shockable rhythm, CPR interruption, chest compression fraction (CCF) average, patient transportation in buildings, and adrenaline injection during CPR. Multivariable logistic regression analysis was performed to assess the relationship between potential independent variables and ROSC.

In our study, we involved 1265 subjects suffering from nontraumatic OHCA, among which 587 patients met inclusion criteria. We identified that CCF > 0.8, chest compression interruption greater than 3 times, and patient transportation in the building were the most critical factors influencing ROSC. However, patient transportation in a building was identified as a dependent predictor variable ($P = .4752$).

We concluded that CCF > 0.8 and chest compression interruption greater than 3 times were essential factors affecting the CPR ROSC rate. The most significant reason for suboptimal CCF and CPR interruption is patient transportation in a building. Improving the latter point could facilitate high-quality CPR.

Abbreviations: CCF = chest compression fraction, CPR = cardiopulmonary resuscitation, EMS = emergency medical services, EMT = emergency medical technician, IQR = interquartile range, OHCA = out-of-hospital cardiac arrest, ROSC = return of spontaneous circulation.

Keywords: cardiopulmonary resuscitation interruption, chest compression fraction, out-of-hospital cardiac arrest, patient transportation, prehospital care

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The datasets generated during and/or analyzed during the current study are not publicly available, but are available from the corresponding author on reasonable request.

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1. Introduction

Return of spontaneous circulation (ROSC) from out-of-hospital cardiac arrest (OHCA) represents an ongoing challenge to emergency medical services (EMS) systems among many countries. According to North America's Prehospital Care Response System Report, 33.2% of nontraumatic OHCA patients experienced ROSC from 2011 to 2015.^[1] Jan-Thorsten Gräsner et al^[2] demonstrated that data on the percentage of ROSC for all European countries was 28.6%. The variability of OHCA prehospital ROSC rate ranged from 16% in Italy, 30% in Ireland, up to 37% in Norway.^[3–5] Pan Asian Resuscitation Outcome Study clinical research network reported OHCA prehospital ROSC rate ranged from 3.4% in Malaysia to 21.0% in Thailand between 2009 and 2012.^[6] However, from 2011 to 2013, the ROSC rate of nontraumatic OHCA patients in rural areas in Taiwan was 19.7% and 27.7% in the Great Taipei Area.^[7,8] Based on the above information, the ROSC rates are higher in developed countries than in Taiwan.

Improving survival from OHCA continues to challenge EMS systems.^[9] As it has been highlighted in guidelines and consensus statements published by both the American Heart Association and International Liaison Committee on Resuscitation, providing better cardiopulmonary resuscitation (CPR) quality is a critical factor in improving outcomes from OHCA.^[10,11] CPR quality,

including chest compression fraction (CCF), chest compression rate, chest compression depth, initial shockable rhythm, peri-shock pause, adrenaline injection, and CPR interruption more than 2 times, have all been associated with improved survival to hospital discharge from OHCA.^[12–19]

The EMS Dispatching Center in Northern Taiwan and the Prehospital Care System of New Taipei City Paramedic Service provides emergency care for a population of 4.1 million people in urban and rural settings within a geographic area of 2053 km². Paramedics in these regions respond to over 2000 OHCA per year. The paramedics equate with complete advanced life support skills, a small number of medications, mechanical CPR devices, and automated external defibrillators. Nevertheless, there was no quality control team to monitor New Taipei City EMS efficacy at the OHCA resuscitation mission until 2019.

New Taipei City has lower ROSC rate in OHCA patients than other countries. This study aimed to investigate OHCA events in New Taipei City regarding incidence and features. We further investigated factors that may influence high-quality CPR performance and ROSC rate. Reporting and analyzing those parameters that influence CPR quality (chest compression interruptions and patient transportation in buildings) can identify the best intervention method to improve the services, furthermore, improve the ROSCs rate in New Taipei City.

2. Method

We conducted a retrospective study of cardiac arrest using the data of The Emergency Medical Service Dispatching Center in Northern Taiwan and the Prehospital Care System of New Taipei City Paramedic Service. A digital video and audio-recording camera was set up in every emergency medical technician (EMT) helmet combined with data extracted from the Zoll X Series defibrillator to assess the effectiveness of CPR performance. EMTs recorded each patient's general data and resuscitation parameters (including prehospital CPR timing, equipment use, automated external defibrillator rhythm, and intervention, etc) uploaded CPR performance parameters to New Taipei City Paramedic Service databank. The exclusion criteria were: patients less than 18 years old; patients with missing data of general characteristics; patients with missing CPR data. We extracted their data and calculated the percentage of patients with ROSC and analyzed the subgroups with chest compression interruptions, bystander CPR, shockable rhythm, CPR interruption, CCF average, patient transportation in a building, and adrenaline injection during CPR. CCF is defined as the proportion of time spent providing chest compression while the patient is pulseless and in cardiac arrest. The CPR interruption is defined as CPR interruption of more than 3 times for more than 10 seconds.

The ethics committee approved this study of the Institutional Review Board of Taipei Medical University in Taipei City, Taiwan (TMU-JIRB No. 201909006).

2.1. The goal of the study

The primary goal was to indicate the rate of ROSC in OHCA and determine the crucial parameters that influence the ROSC rate in New Taipei City. Then, based on the results, we could seek the best solution to improve the EMTs performance in New Taipei City.

2.2. Statistical analysis

Continuous variables were expressed as means and Standard Deviation (SD) or medians and the interquartile range (IQR). The categorical variables were summarized by using descriptive statistics with frequencies (percentages) or count. Differences between groups were analyzed for significance by the Chi-square test. Multivariable logistic regression analyses were performed to assess the relationship between potential independent variables and ROSC. Variables significant in Chi-square analysis were included in the multiple logistic regression analysis to identify independent predictors. Statistical tests were 2-sided, and *P* values less than .05 were considered statistically significant. Statistical analysis of the study's data was made using R 3.2.4 software (R Foundation for Statistical Computing, Vienna, Austria).

3. Result

Data from 1265 individuals were collected from The Emergency Medical Service Dispatching Center in Northern Taiwan and the Prehospital Care System of New Taipei City Paramedic Service. We excluded 678 patients due to one of the following selection criteria: age < 18 years old (*n*=14), missing data of general patient's characteristic (*n*=332), or missing CPR data (*n*=332) (Fig. 1).

Results are also summarized according to the Utstein style template (Fig. 2).

Our analysis includes 587 patients presenting with OHCA from the selected study sites. There were 211 women and 376 men with a mean age of 65.3 ± 16.9 years. Two hundred eighty-eight out of 587 (49%) patients had a witnessed arrest, of which only 16% (47 out of 88) of cases were witnessed by the paramedic. Overall, 185 patients had ROSC, of which 35% (65 out of 185) survived to be admitted to hospital. When these survivors were followed till the end of hospital stay, only 20% (13 out of 65) of patients survived and were later discharged. Most of the patients having a ROSC died within a few hours of the event and the likely cause of death was hemodynamic instability rather than neurologic sequelae. Upon the arrival of emergency service personnel, shockable rhythm can be detected in 17.7% (104 out of 587) of OHCA patients, of which 50% (52 out of 104) of cases received bystander CPR. Asystole rhythm was the most common form of presentation and could be detected in 72.5% OHCA patients (426 out of 587), of which 45% (192 out of 426) of cases received bystander CPR.

Ultimately, 587 prehospital OHCA patients were selected for further analysis, in which 185 cases experienced ROSC (31.51%). Patient baseline characteristics for the sample population are described in Table 1. The mean age of the study population was 65.3 years old (standard deviation: 16.97, IQR: 56–79), and 376 (64.05%) cases were male. The most common comorbidities were a history of hypertension (32.20%), diabetes mellitus (25.21%), heart disease (21.47%), and malignancy (8.01%).

In our study, 47.36% of the subjects received bystander CPR, and the initial shockable rhythms were 17.72%. The mean CPR duration time and interruption duration time were 1275 seconds and 331.5 seconds, respectively. The mean CCF were 0.74 (IQR 0.54–0.85) and CCF > 0.8 was 40.37%. Epinephrine injection was found in 39.01% of OHCA patients. Additional details of the patients' CPR characteristics are presented in Table 2.

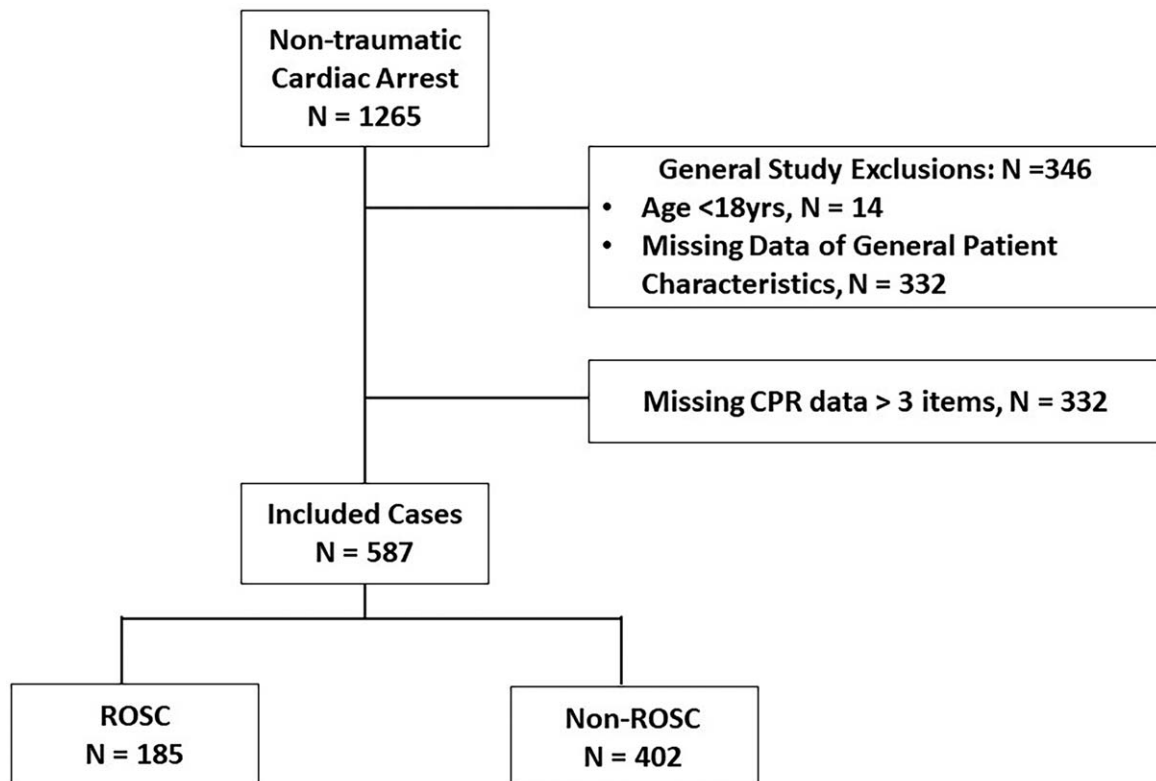


Figure 1. Study scheme.

This study identified that $CCF > 0.8$, chest compression interruption greater than 3 times, and patient transportation in the building were the most critical factors influencing ROSC (Table 3). We further employed multivariate analysis to verify the independent predictors of ROSC, the CCF ($P < 1 \times 10^{-10}$), chest compression interruption ($P < .001$), and patient transportation in a building ($P = .4752$). In contrast, patient transportation in a building was a dependent predictor variable (Table 4).

4. Discussion

In this study, 185 out of 587 subjects experienced prehospital ROSC (31.51%) in New Taipei City during our study period. For CPR quality analysis, we further analyzed several factors affecting CPR quality. In our data set, the crucial factors influencing the ROSC rate were $CCF > 0.8$, chest compression interruption greater than 3 times, and patient transportation in the building. Furthermore, we identified that patient transportation in a building is not an independent factor affecting the CPR ROSC rate. In New Taipei City, it is common for EMT to transport OHCA patients in small apartment buildings, which results in poor CPR performance. These small apartments usually have no elevators, and OHCA victims could only be transported via extremely narrow stairs where the mechanical chest compression system (ex: LUCAS or autopause) hardly worked. As a result, EMTs could only perform manual chest compression intermittently while reaching the stairway platform, which caused frequent CPR interruption (Fig. 3).

The study from Canada reported that the median CCF was 0.89^[20]; however, in our study, the median of CCF was only

0.74. Moreover, the mean CPR Interruption duration was 222 seconds in Denmark,^[21] whereas our CPR mean interruption duration was 331.5 seconds. Based on our results, we believe that patient transportation in the building may substantially influence CCF and chest compression interruption in New Taipei City.

According to previous research, a higher post-OHCA survival rate is more likely in patients who received bystander CPR,^[22] which contrasts with our result. The explanation is that compared with North America and Europe, the popularization of bystander CPR has been relatively delayed in Asia; thus, bystander CPR's quality might be lower in this region. In addition, 1 study showed that the threshold of EMS protocols for initiating resuscitation is lower in Asian countries,^[23] which was likely to contribute to the difference in the survival rates. Therefore, improved BLS education for laypeople to obtain the skills necessary to recognize OHCA and early CPR with ongoing medical dispatcher training would provide better dispatcher-assisted CPR and ensure high-quality bystander CPR.

Our data demonstrated that shockable rhythm does not affect the survival rate. We further surveyed the EMS resuscitation effect by analyzing the video recorder and noticed that some EMT did not stop chest compression while automated external defibrillator analyzed rhythm, leading to possible false interpretation as shockable rhythm and then conducting ineffective DC shock. Furthermore, AL Hallstrom et al^[24] observed that the ROSC rate had no significant difference between OHCA patients initially found in PEA or Asystole, subsequently received defibrillation and OHCA patients remained in a non-shockable rhythm, they concluded that for initially non-shockable rhythm patients, ALS providers should focus less on the defibrillator and

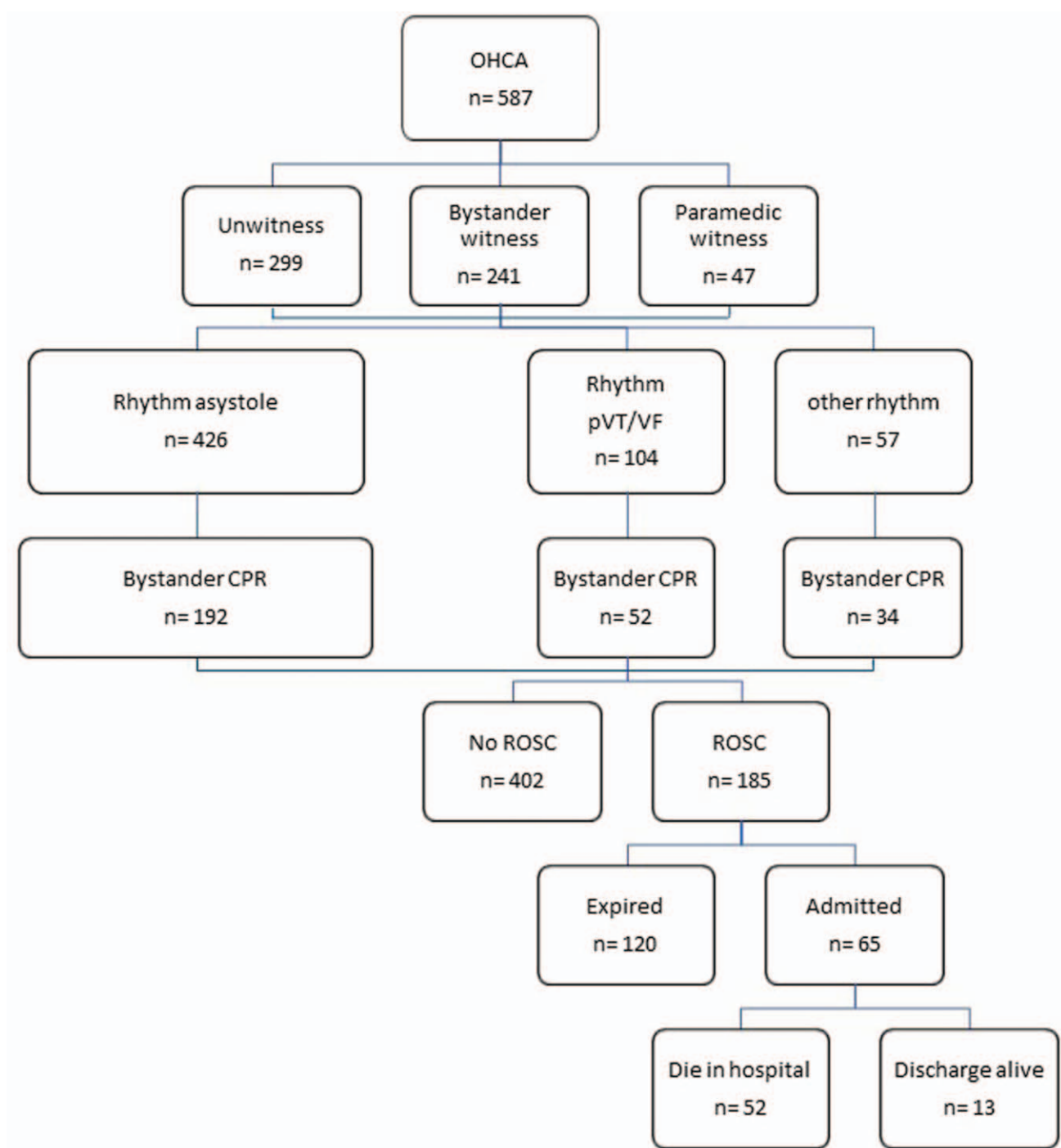


Figure 2. The Utstein template.

more on other treatment methods such as high-quality CPR with minimal interruption, appropriated ventilation, and identification and treatment of reversible causes.

Administration of epinephrine seems not to affect the ROSC rate in our study group. One previous study indicated that repeated doses of adrenaline are associated with decreasing chances of survival.^[25] Attaran^[26] 2010 pointed out that epinephrine could be either a curse or a cure in cardiac arrest. Moreover, its value depends on the dosage, the administration's timing, and the cardiac arrest's initiating factor. Nevertheless,

earlier administration of epinephrine is not the cure by itself. Its effect on OHCA patients should be integrated into a series of essential steps, including cardio cerebral resuscitation and post-resuscitation care.

Our results confirmed a trend of poor survival rate of frequent chest compression interruption and low CCF ratio, which is an independent predictor variable indicated by statistical analysis. Additionally, our study suggests that patient transportation in a building is a dependent predictor variable of chest compression interruption and CCF. Therefore, we believe that modifying our

Table 1
Patient baseline characteristics.

	All patients n=587	Patients with ROSC n=185	Patients without ROSC n=402	P value
Age: mean (SD)	65.3 (16.97)	64 (15.7)	66.81 (17.47)	.1406
Male: n (%)	376 (64.05)	125 (67.57)	251 (62.44)	.3546
Comorbidities				
Heart disease: n (%)	126 (21.47)	40 (21.62)	86 (21.39)	.9272
Diabetes mellitus: n (%)	148 (25.21)	43 (23.24)	105 (26.12)	.3979
Hypertension: n (%)	189 (32.20)	64 (34.59)	125 (31.09)	.3877
Malignancy: n (%)	47 (8.01)	18 (9.73)	29 (7.21)	.1105

ROSC=return of spontaneous circulation, SD=standard deviation.

current method of patient transportation in a building could increase CCF and minimize chest compression interruption.

We currently suggest that EMS should introduce the evacuation chair plus Mechanical CPR to facilitate CPR performance and minimize chest compression interruption during patient transportation, especially when EMTs have to resuscitate OHCA patients in a limited working space environment.

New Taipei city belongs to Taipei metropolitan area, thus the data can apply to other metropolitan cities in Taiwan. We pointed out the unique problem of patient transportation impact on chest compression quality which eventually influences resuscitation outcome. This finding can apply to other Asia metropolitan areas with a crowded living environment and many old buildings interfering resuscitation mission such as New Taipei City. We hope that our study's findings can be helpful to other areas that face similar scenario and remind them to re-evaluate their resuscitation mission, facilitate CPR performance, and improve OHCA patient outcomes.

4.1. Limitation of the study

Firstly, although we provided staff training in reporting sheet completion at the designated emergency departments and EMSs, some data were missing. We believe that it may influence the overall OHCA data interpretation. Secondly, we also attempted and failed to identify possible initial cardiac collapse cases at the beginning of the study. Therefore, this variable was removed from our analysis. We set up a quality control team to monitor and evaluate New Taipei City EMS efficacy at the OHCA

Table 2
Patient demographics.

	All patients n=587	Patients with ROSC n=185	Patients without ROSC n=402
Bystander CPR: n (%)	278 (47.36)	85 (45.95)	193 (48.01)
Shockable rhythm: n (%)	104 (17.72)	42 (22.70)	62 (15.42)
CPR duration: s	1275	1250	1289
interruption duration: s	331.5	212	425
CCF average: median (IQR)	0.74 (0.85-0.54)	0.83 (0.89-0.71)	0.67 (0.81-0.51)
CCF > 80%: n (%)	237 (40.37)	123 (66.49)	114 (28.36)
Epinephrine: n (%)	229 (39.01)	65 (35.14)	164 (40.80)

CCF=chest compression fraction, CPR=cardiopulmonary resuscitation, IQR=interquartile range, ROSC=return of spontaneous circulation.

Table 3
Characteristics of patients.

	Non-ROSC	ROSC	P value
Age			
≥65	223	92	.2273
<65	179	93	
Sex			
Male	252	124	.3546
Female	150	61	
CCF			
≥80%	113	124	<.00001
<80%	289	61	
Bystander CPR			
Yes	192	86	.7598
No	206	99	
Shockable rhythms			
Yes	59	29	.7902
No	345	154	
Epinephrine			
Yes	163	66	.1827
No	218	115	
Chest compression interruption			
≥3	139	24	<.00001
<3	263	161	
Patient transportation in building			
Yes	207	69	<.0019
No	195	116	

CCF=chest compression fraction, CPR=cardiopulmonary resuscitation, ROSC=return of spontaneous circulation.

Table 4
Logistic regression analysis.

	OR	95% CI	P value
CCF	3.654	2.485-5.431	< 1 × 10 ⁻¹⁰
Chest compression interruption	0.406	0.237-0.675	<.001
Patient transportation in building	0.864	0.578-1.290	.4752

CCF=chest compression fraction, CI=confidence interval, OR=odds ratio.

resuscitation mission since August 2019. The further investigation will focus on EMS OHCA data quality control and the CPR quality evaluation. Finally, the lack of long-term outcomes and the small number of subjects weakens the evidence in this study. Because the determination of the 12-month survival status and quality of life has been emphasized in the newly revised Utstein survey,^[27] we have started to process this modification to the registry system to include these variables in future studies.

5. Conclusion

We concluded that CCF > 0.8 and chest compression interruption greater than 3 times were essential factors affecting the ROSC rate. The most significant reasons for suboptimal CCF and CPR interruption are patient transportation in a building. This study determines that minimizing patient transportation in a building may facilitate high-quality CPR.

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Figure 3. Patient transportation in Taipei Metropolitan areas.

Taipei City Paramedic Service. Their commitment and accomplishments improved prehospital care.

Author contributions

All authors have read and agreed to published version of the manuscript.

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Writing – review & editing: J.L.C.

References

- [1] Kurz MC, Schmicker RH, Leroux B, et al. Advanced vs. basic life support in the treatment of out-of-hospital cardiopulmonary arrest in the resuscitation outcomes consortium. *Resuscitation* 2018;128:132–7.
- [2] Gräsner JT, Lefering R, Koster RW, et al. EuReCa ONE—27 Nations, ONE Europe, ONE Registry: a prospective one month analysis of out-of-hospital cardiac arrest outcomes in 27 countries in Europe. *Resuscitation* 2016;105:188–95.
- [3] Danielis M, Chittaro M, DeMonte A, et al. A five-year retrospective study of out-of-hospital cardiac arrest in a north-east Italian urban area. *Eur J Cardiovasc Nurs* 2019;18:67–74.
- [4] Barry T, Heaton M, Glynn R, et al. Ten years of cardiac arrest resuscitation in Irish general practice. *Resuscitation* 2018;126:43–8.
- [5] Mathiesen WT, Bjørshol CA, Kvaløy JT, et al. Effects of modifiable prehospital factors on survival after out-of-hospital cardiac arrest in rural versus urban areas. *Crit Care* 2018;22:1–9.
- [6] Ong MEH, Shin SDo, DeSouza NNA, et al. Outcomes for out-of-hospital cardiac arrests across 7 countries in Asia: the Pan Asian Resuscitation Outcomes Study (PAROS). *Resuscitation* 2015;96:100–8.
- [7] Hung SC, Mou CY, Hung HC, et al. Non-traumatic out-of-hospital cardiac arrest in rural Taiwan: a retrospective study. *Aust J Rural Health* 2017;25:354–61.
- [8] Sun JT, Chiang WC, Hsieh MJ, et al. The effect of the number and level of emergency medical technicians on patient outcomes following out of hospital cardiac arrest in Taipei. *Resuscitation* 2018;122:48–53.
- [9] Nichol G, Thomas E, Callaway CW, et al. Regional variation in out-of-hospital cardiac arrest incidence and outcome. *JAMA - J Am Med Assoc* 2008;300:1423–31.
- [10] Meaney PA, Bobrow BJ, Mancini ME, et al. Cardiopulmonary resuscitation quality: improving cardiac resuscitation outcomes both inside and outside the hospital: a consensus statement from the American heart association. *Circulation* 2013;128:417–35.
- [11] Hazinski MF, Nolan JP, Billi JE, et al. Part 1: executive summary: 2010 international consensus on cardiopulmonary resuscitation and emergency cardiovascular care science with treatment recommendations. *Circulation* 2010;122(16 SUPPL. 2):S250–75.
- [12] Idris AH, Guffey D, Aufderheide TP, et al. Relationship between chest compression rates and outcomes from cardiac arrest. *Circulation* 2012;125:3004–12.
- [13] Cheskes S, Schmicker RH, Verbeek PR, et al. The impact of peri-shock pause on survival from out-of-hospital shockable cardiac arrest during the Resuscitation Outcomes Consortium PRIMED trial. *Resuscitation* 2014;85:336–42.
- [14] Han KS, Lee SW, Lee EJ, et al. Prognostic value of the conversion to a shockable rhythm in out-of-hospital cardiac arrest patients with initial non-shockable rhythm. *J Clin Med* 2019;8:644.
- [15] Kragholm K, Wissenberg M, Mortensen RN, et al. Bystander efforts and 1-year outcomes in out-of-hospital cardiac arrest. *N Engl J Med* 2017;376:1737–47.
- [16] Lundin A, Rylander C, Karlsson T, et al. Adrenaline, ROSC and survival in patients resuscitated from in-hospital cardiac arrest. *Resuscitation* 2019;140:64–71.
- [17] Kurz MC, Prince DK, Christenson J, et al. Association of advanced airway device with chest compression fraction during out-of-hospital cardiopulmonary arrest. *Resuscitation* 2016;98:35–40.
- [18] Brouwer TF, Walker RG, Chapman FW, et al. Association between chest compression interruptions and clinical outcomes of ventricular fibrillation out-of-hospital cardiac arrest. *Circulation* 2015;132:1030–7.
- [19] Gallagher E, Lombardi G, Gennis P. Effectiveness of bystander cardiopulmonary resuscitation and survival of following out-of-hospital cardiac arrest. *Resuscitation* 1996;32:77.

- [20] Cheskes S, Byers A, Zhan C, et al. CPR quality during out-of-hospital cardiac arrest transport. *Resuscitation* 2017;114:34–9.
- [21] Krarup NH, Terkelsen CJ, Johnsen SP, et al. Quality of cardiopulmonary resuscitation in out-of-hospital cardiac arrest is hampered by interruptions in chest compressions—a nationwide prospective feasibility study. *Resuscitation* 2011;82:263–9.
- [22] Yan S, Gan Y, Jiang N, et al. The global survival rate among adult out-of-hospital cardiac arrest patients who received cardiopulmonary resuscitation: a systematic review and meta-analysis. *Crit Care* 2020;24:8–13.
- [23] Berdowski J, Berg RA, Tijssen JGP, et al. Global incidences of out-of-hospital cardiac arrest and survival rates: systematic review of 67 prospective studies. *Resuscitation* 2010;81:1479–87.
- [24] Hallstrom A, Rea TD, Mosesso VN, et al. The relationship between shocks and survival in out-of-hospital cardiac arrest patients initially found in PEA or asystole. *Resuscitation* 2007;74:418–26.
- [25] Fothergill RT, Emmerson AC, Iyer R, et al. Repeated adrenaline doses and survival from an out-of-hospital cardiac arrest. *Resuscitation* 2019;138:316–21.
- [26] Attaran RR, Ewy GA. Epinephrine in resuscitation: curse or cure? *Future Cardiol* 2010;6:473–82.
- [27] Idris AH, Bierens JJLM, Perkins GD, et al. 2015 revised Utstein-style recommended guidelines for uniform reporting of data from drowning-related resuscitation: an ILCOR advisory statement. *Resuscitation* 2017;118:147–58.