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Original Article

Factor Affecting Survival Outcome among Hospital Cardiac Arrest: a Systematic Review

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Abstract

The aim of this study was to identify factors associated with survival outcomes among hospital cardiac arrest. It was conducted as a systematic reviews on factors associated to survival rate among hospital cardiac arrest. The PRISMA checklist was used to report the review. The electronic databases including PubMed, The Cochran library, and Embase were used for searching on January 11, 2021. The searching was limited to cover the publications during 2000 - 2021, full text, in English and Thai language, of systematic review articles or systematic review and meta-analysis articles, and peer reviews. Thirty six studies were included in the review. Time period of study in the articles was from 1990 to 2020; and the number of samples ranked from 100 - 1,0000. As a result, our systematic literature review identified thirty six studies. We found that the factors associated with survival outcome among hospital cardiac arrest icluded: (1) the use of epinephrine which was associated with improved return of spontaneous circulation (ROSC); and (2) prompt manual cardiopulmonary resuscitation (CPR) which was also effective in increasing ROSC.

Keywords: cardiac arrest; associated factors; systematic review

Introduction

An average global incidence of out-of-hospital cardiac arrest patients (OHCA) is 55 persons per 100,000 per-years which has been a major public health problem for over past decades.[(1)] Consequently, OHCA system has been developed for improving survival rate including return of spontaneous circulation (ROSC), survival to hospital admission, survival

to hospital discharge, survival at 30 days and neurogenic outcomes. Currently, these outcomes that were reported between 0.5-10.4% are still poor.[2-5] In addition, the incidence of OHCA essentially increased when compared with previous years and was associated with high mortality in COVID- 19 pandemic situation.[6-8] Previous studies demonstrated that CPR, location where arrest occurred, time of day on pre-hospital care, response time, scene time, transport time automated external defibrillator (AED) application and IV fluid administration were associated with survival rate.[9-16] However, it is still unclear which factors are associated with such increased incidence, mortality,[17] and especially the survival outcomes. Thus, it is essential to investigate the factors affecting the survival rate in order to decrease the mortality rate.

Systematic review of factors associated with survival rate outcome among OHCA patients existed; and the syntheses of these offer a high quality and practical way to elucidate the reasons for improving survival rate and policy recommendations. Therefore, this systematic review would scope on the evidence of all aspect that related to survival outcome among OHCA patients.

Methods

A systematic review of factors associated to survival rate among hospital cardiac arrest patients was undertaken based on the methodology developed by Smith V, et al.[18] The PRISMA checklist was used to report the reviews.[19]

Review questions

The review question was set as follow: which factors or interventions associated with survival outcomes among hospital cardiac arrest patients across the systematic review evidences?

Eligibility criteria

The inclusion and exclusion criteria using for eligible studies were pre-determined as populations, context, and concepts (PCC). Populations of all age groups who were out-of-hospital cardiac arrest patients receiving resuscitation by medical and non-medical staff. Context was defined as any factors such as chest compression, defibrillation, drug administration as well as age, gender, response time, scene time, witness by a bystander that offering for resuscitation out-of-hospital cardiac arrest patients. Concepts or outcomes were defined as survival rate from out-of-hospital cardiac arrest including primary outcomes: return of spontaneous circulation (ROSC), survival to hospital admission, survival to hospital discharge, survival at 30 days; and secondary outcomes: neurogenic outcome (cerebral performance category 1 and 2). Both systematic reviews with and without meta-analysis were included. The exclusion was composed of people who was cardiac arrest under any disease and study of which investigated outcome after survival from out-of-hospital cardiac arrest.

Searching method

The electronic databases including PubMed, The Cochran library, and Embase were used for searching on January 11, 2021. The searching was limited as 2000 -2021, full text, English and Thai language, systematic reviews articles or systematic review and meta-analysis articles, and peer reviews.

Study selection

Seventy-one studies from three searching databases were exported into EndNoteX9.[20] Five studies were excluded because of duplicating. Sixty-six studies were screened for title and abstract. Forty-four of

full text were scrutinized read by two authors. Ten studies that not relevant were excluded because they did not meet the inclusion criteria. Finally, thirty studies were included for analysis. The flow chart of the study selection process is presented in Figure 1.

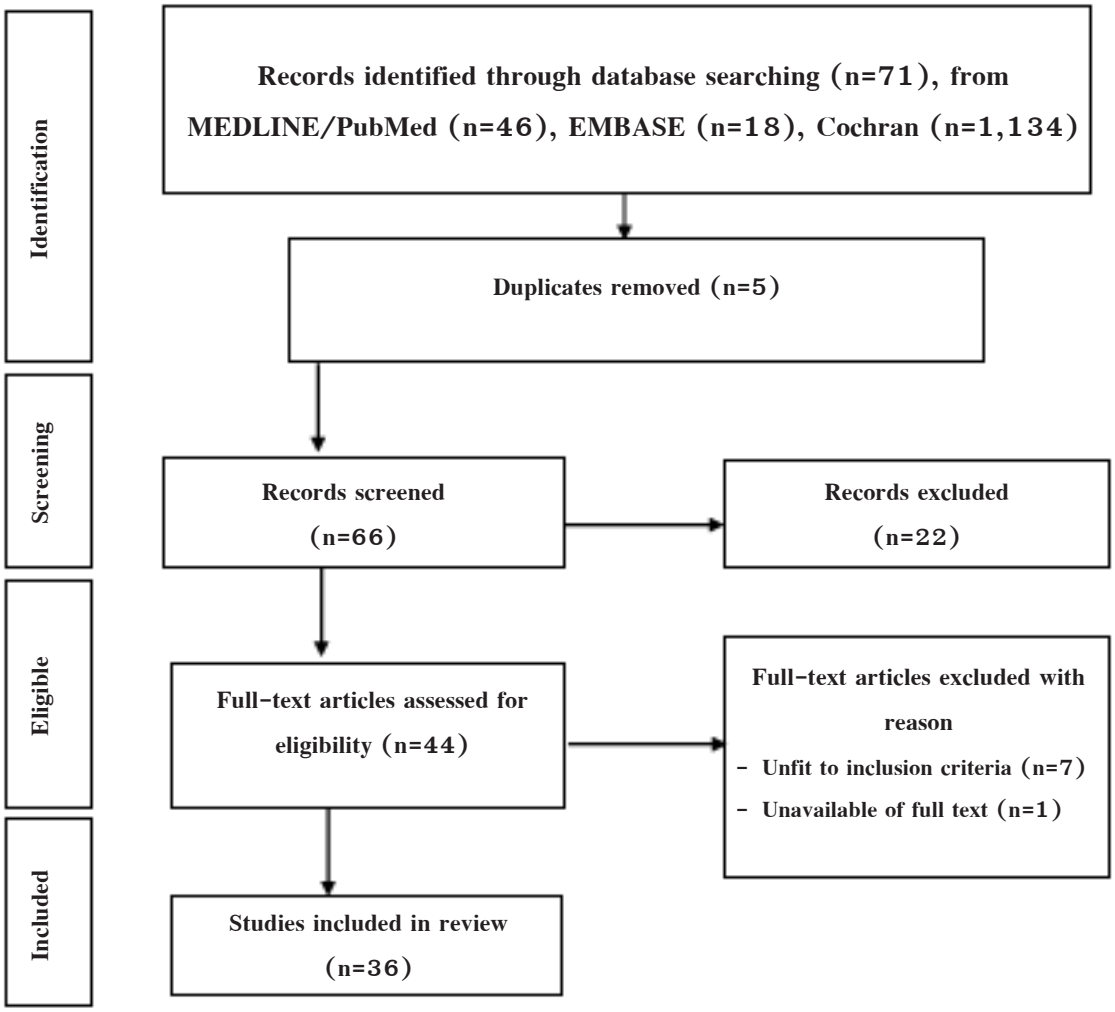
Data extraction

One author extracted following general information of each thirty-seven studies: author, year, outcome, factors or intervention by the Microsoft Excel database. Then, second author verified the extracted information.

Quality appraisal

Although quality appraisal was not essential in scoping review, it was recommended. Included studies were independently assess for quality using R-AMSTAR (Assessing the Methodological Quality of Systematic Reviews)[21] by both authors. For each of the 11 items on the R-AMSTAR checklist, a score of 0 was given if they did not meet the criteria or if information was unavailable, a score of 1 if the criteria was met. Any studies which scored less than 5 (out of the possible total: 11) were not considered to be included in studies. A score as 6 or more was high quality, it would be included. If it included in studies were disagreed, they would be rated and discussed until reaching consensus.

Figure 1 PRISMA flow chart of the study selection process



Results

Searching and selecting the included studies

Thirty-six studies were included in the review. Twenty of studies were systematic review and sixteen studies were systematic review with meta-analysis The period of the studies was between 1990-2020. Number of samples in the studies ranked from 100 to 1,0000 samples. The characteristics including authors, year, outcome and factors or interventions were extracted and presented in Table 1.

Quality of the included studies

The quality of selected studies varied from low to high by the R-AMSTAR checklist. A cross-sectional study of which score was 3 (total of 8) (low quality) was excluded. Consequently, 25 studies included in the review were composed of 12 quantitative studies (48%) scored as a high quality, 11 quantitative studies (44%) scored as a moderate quality, and 2 qualitative studies (8%) scored as a moderate quality. Overall kappa's statistic was 0.70, the acceptable value.

Discussion

Our systematic literature review identified thirty-six studies. Twenty of them were systematic review and the other sixteen were systematic review with meta-analysis. Timing of the studies was between 1990-2020. The factors associated with survival outcome among out-of-hospital cardiac arrest were identified as follow (Table 2):

1) The living in urban areas had higher survival rate than the living in rural areas. Living in urban area

Table 1 Characteristics of the included studies

Author (years)	Outcome	Intervention or factors
Alanazy ARM, et al. (201)[22]	Survival rates	Living in urban areas had higher survival rate than rural areas. Living in urban area had faster response time, less on scene time and reduce transport time.
Atiksawedparit P, et al. (2014)[23]	Return of spontaneous circulation Survival to hospital admission Survival to discharge Discharge with cerebral performance	Prehospital adrenaline administration increase Return of spontaneous circulation.
Aves T, et al. (2020)[24]	Return of spontaneous circulation (ROSC) Survival to hospital admission survival to discharge survival at 30 days	Standard dose of epinephrine increase return of spontaneous circulation, survival to hospital admission, survival to discharge, and survival at 30 days and 3 months.
Böttiger BW, et al. (2016)[25]	Return of spontaneous circulation Survival to hospital admission Survival to hospital discharge survival at 30 days	CPR guided by EMS physicians Return of spontaneous circulation Survival to hospital admission Survival to hospital discharge
Descatha A, et al. (2015)[26]	Admission alive at hospital (Survival to hospital admission) Discharge alive from hospital (Survival to hospital discharge) Good neurological outcome	Resuscitation at workplace compare with another place

Table 1 Characteristics of the included studies (continued)

Author (years)	Outcome	Intervention or factors
Faddy SC, et al. (2016)[27]	Return of spontaneous circulation	Biphasic defibrillation waveforms
Finn J, et al. (2019)[28]	Survival to hospital admission Survival to hospital discharge	Standard-dose adrenaline improves return of spontaneous circulation
Fouche, et al. (2014)[29]	Return of spontaneous circulation Survival to hospital admission Survival to hospital discharge survival at 30 days	Advance airway intervention (AAI) (endotracheal intubation: ETI and supraglottic airways: SGA) decrease return of spontaneous circulation and survival to hospital admission.
Gates, et al. (2015)[30]	survival with good neurological outcome Survival to discharge survival at 30 days	Mechanical chest compression devices do not improve outcome when compared to manual chest compression.
Huan, et al. (2019)[31]	Return of spontaneous circulation Survival to hospital discharge Survival to hospital admission Neurogenic outcome (Cerebral performance category 1 and 2: CPC)	Use of epinephrine increase return of spontaneous circulation, survival to hospital discharge but not increase of neurogenic outcome and Survival to hospital admission.
Li H, et al. (2016)[32]	Neurogenic outcome (Cerebral performance category: CPC) Survival to admission Survival to discharge ROSC	Manual cardiopulmonary resuscitation (CPR) was more increase ROSC. Manual cardiopulmonary resuscitation (CPR) was not difference of mechanical CPR in survival to admission, survival to discharge, and CPC.
Liao X, et al. (2018)[33]	Neurogenic outcome (Cerebral performance category: CPC) Survival to discharge ROSC	Chest-compression only CPR (CCPR) was not less than standard CPR (SCPR) in improving ROSC, CPC, and survival to discharge rate. CCPR was more advantageous in learning and the willingness of bystanders to implement
Lim ZJ, et al. (2020)[34]	(Collection data during COVID -19 pandemic) Mortality	COVID-19 pandemic increase OHCA mortality, supraglottic airway use. Increase time for call to ambulance, reduce frequency of unwitnessed events, bystander CPR and AED use effect to mortality during COVID-19 pandemic.
Liu M, et al. (2019)[35]	Return of spontaneous circulation Survival to hospital discharge Survival to hospital admission Survival to 30 days	Mechanical chest compression with LUCAS device does not improve survival outcome.
Liu Y, et al. (2020)[36]	ROSC	High mean regional cerebral oxygen saturation (rSO2) level associated with ROSC
Loomba RS, et al. (2015)[37]	ROSC Survival to hospital discharge Survival to 30 days	Use of epinephrine before arrival to the hospital was increase ROSC. But increase poor neurologic outcome at the time of discharge.
Majewsk D, et al. (2019)[38]	Survival to hospital discharge Survival to 30 days	Comorbidity reduce survival to hospital discharge and poorer neurological outcomes

Table 1 Characteristics of the included studies (continued)

Author (years)	Outcome	Intervention or factors
Meier P, et al. (2010)[39]	ROSC Survival to hospital discharge Neurologic outcome	Chest compression first and defibrillation first were not different in all outcome. But chest compression first be beneficial for cardiac arrest with a prolong response time.
Morales-Cané I, et al. (2016)[40]	Neurologic outcome (CPC) ROSC Survival to hospital admission	Standard dose of epinephrine improved ROSC and survival to hospital admission.
Ong ME, et al. (2012)[41]	Neurologic outcome (CPC) ROSC Survival to hospital admission Survival to hospital discharge	Mechanical CPR decrease survival outcome and neurologic outcome.
Pan J (2015)[42]	ROSC Survival to hospital admission Survival to hospital discharge	Performance of uninterrupted chest compressions and simple airway management procedures, and real-time feedback devices during bystander CPR improve survival rate. Epinephrine improve ROSC.
Ran L, et al. (2020)[43]	Survival to discharge Survival to hospital admission ROSC Neurologic outcome (CPC)	Early pre-hospital administration of adrenaline increase the survival to discharge, return of spontaneous circulation, and favorable neurological outcomes.
Scquizzato T, et al. (2020)[17]	Survival to discharge ROSC	During the COVID-19 pandemic, witnessed cases, bystander-initiated cardiopulmonary resuscitation and resuscitation attempted by emergency medical services were reduced and ambulance response times were delays effect to increase ROSC and survival to hospital discharge.
Shao H & Li CS (2017)[44]	ROSC Survival to hospital discharge Neurological outcome	Epinephrine was associated with improved ROSC.
Tiah, L, et al. (2014)[45]	Survival to hospital discharge Survival to hospital admission Neurological outcome	Endotracheal intubation (ETI) and supraglottic airway devices (SGA) not significant differences for survival to hospital admission or discharge and neurological outcome.
van de Glind, EM, et al. (2013)[46]	Survival to hospital discharge	Aged over 70 years, elderly at nursing home residency and comorbidities decrease survival to discharge.
van Nieuwenhuizen, B.P, et al. (2019)[47]	Receiving bystander CPR Survival rate	Low SES decrease chance of receiving bystander CPR and survival rate. (But study was not determined specific SES)
Wang CH, et al. (2013)[48]	ROSC Survival to hospital discharge	Biphasic waveforms did not seem superior to monophasic ones with respect to Vf termination, ROSC, or survival to hospital discharge in OHCA patients with initial Vf rhythm under the context of current guidelines.
Wang GN, et al. (2017)[49]	Survival rate to discharge Long-term neurological outcome	Extracorporeal cardiopulmonary resuscitation (ECPR) improved survival rate to discharge and long-term neurological outcome over conventional cardiopulmonary resuscitation (CCPR)

Table 1 Characteristics of the included studies (continued)

Author (years)	Outcome	Intervention or factors
Yan S, et al. (2020)[1]	Survival to hospital discharge	Witnessed by a bystander or emergency medical services (EMS) who received bystander CPR who were living in Europe and North America
Yang Z, et al. (2019)[50]	ROSC Survival to hospital discharge Survival to hospital admission	Endotracheal intubation as early as possible improve ROSC, survival to admission rate and discharge
Yao L, et al. (2014)[51]	Survival to hospital discharge ROSC	Chest compression CPR similar was improved survival to hospital discharge and ROSC
Yu Y, et al. (2020)[52]	30-day survival or survival to hospital discharge Rate of bystander CPR	Interventions that include both a community based component and health service component appeared to be associated with improved bystander CPR greater than that of community-only intervention. **Community based program** Public CPR skills training (standard basic life support courses or compression-only CPR), distribution of self-instruction CPR kits to public schools or school students, broadcasting resuscitation training on television or other media, mandatory CPR training for school students, when acquiring a driver's license or for some occupations (eg, firefighters, policemen, and rescue squads), and messaging trained laypersons or first responders to encourage attendance at cardiac arrest sites **Program components at the level of health systems** Include strengthening of EMS systems and implementing advanced life support protocols in hospitals, increasing numbers of ambulances, and training of EMS and hospital staff in high-performance CPR skills, early emergency cardiac catheterization, and use of therapeutic hypothermia.
Zhan L, et al. (2017)[53]	Surviving to hospital discharge	CPR was performed by untrained bystanders who were assisted via telephone by emergency services, continuous chest compression-only CPR led to more people surviving to hospital discharge.
Zhang Q, et al. (2018)[54]	ROSC Neurological outcome at discharge or at 30 days Long term survival (≥6 months) Rate of initial shockable rhythm	Gasping or agonal respirations increase in ROSC, neurological outcomes, long-term survival, and initial shockable rhythm
Zhu N, et al. (2019)[55]	ROSC rate, the rate of survival to hospital admission survival to hospital discharge neurological function	There were no significant differences in resuscitative effects between mechanical and manual chest compression in OHCA patients.
Zwingmann J, et al. (2012)[56]	Mortality neurological outcome at discharge.	Children have a higher chance of survival after resuscitation of an out-of-hospital traumatic cardiac arrest compared to adults but tend to have a poorer neurological outcome at discharge.

had faster response time, less on scene time and reduce transport time.

2) Prehospital adrenaline administration increase Return of spontaneous circulation.

3) Standard dose of epinephrine increase return of spontaneous circulation, survival to hospital admission, survival to discharge, and survival at 30 days and 3 months.

4) CPR guided by EMS physicians return of spontaneous circulation.

5) Biphasic defibrillation wave forms standard dose adrenaline improves return of spontaneous circulation.

6) Advance airway intervention (AAI) (endotracheal intubation: ETI and supraglottic airways: SGA) decrease return of spontaneous circulation and survival to hospital admission.

7) Mechanical chest compression devices do not improve outcome when compared to manual chest compression.

8) Use of epinephrine increase return of spontaneous circulation, survival to hospital discharge but not increase of neurogenic outcome and Survival to hospital admission.

9) Manual cardiopulmonary resuscitation (CPR) was more increase ROSC.

10) Increase time for call to ambulance, reduce frequency of unwitnessed events, bystander CPR and AED use effect to mortality during COVID-19 pandemic.

11) Use of epinephrine before arrival to the hospital was increase ROSC.

12) Chest compression first and defibrillation first were not different in all outcome. But chest compression first be beneficial for cardiac arrest with a prolong response time.

13) Standard dose of epinephrine improved ROSC and survival to hospital admission.

14) Epinephrine improve ROSC.

Therefore, from all the factors mentioned above it was found that if operators in the emergency medical system pay attention to there factors, the patients' survival rate could be improved.

Table 2 Factors related to survival outcome among out-of-hospital cardiac arrest patients

Factors/ Interventions	Author (year)	Outcome						
		ROSC	Survival to hospital admission	Survival to hospital discharge	Survival at 30 days	Survival at 3 months	Neurological outcome (CPC)	Mortality
Individual level								
Children receive CPR	Zwingmann J, et al.[56]						-(O)	-(O)
Comorbidity receive CPR	Majewsk D, et al.[38], van de Glind EM, et al.[46]			-(O)			-(O)	
Age over 70 years receive CPR	van de Glind EM, et al.[46]			-(O)				
Elderly at nursing home	van de Glind EM, et al.[46]			-(O)				
Low SES	van Nieuwenhuizen, BP, et al.[47]	-(O)	-(O)	-(O)				

Table 2 Factors related to survival outcome among out-of-hospital cardiac arrest patients (continued)

Factors/ Interventions	Author (year)	Outcome						
		ROSC	Survival to hospital admission	Survival to hospital discharge	Survival at 30 days	Survival at 3 months	Neurological outcome (CPC)	Mortality
Individual level								
Living in Europe and North America	Yan S, et al.[1]			+(O)				
Drug administration								
Prehospital adrenaline administration (standard dose)	Atiksawedparit P, et al.[23], Finn J, et al.[28], Aves T, et al.[24], Huan L, et al.[31], Loomba RS, et al.[37], Morales-Cané I, et al.[40], Pan J[42], Ran L, et al.[43], Shao H & Li CS[44]	+(O)	+(O), -(O)	+(O)	+(O)	+(O)	-(O), +(O)	
CPR guided by EMS physicians	Böttiger BW, et al.[25]	+(O)	+(O)	+(O)				
Time administration								
Witnessed by a bystander or emergency medical services (EMS)	Yan S, et al.[1],			+(O)				
Received bystander CPR	Yan S, et al.[1], Zhan L, et al.[53]			+(O)				
EMS operating in urban area	Alanazy ARM, et al.[22], Zhan L, et al. [53]		+(O)	+(O)				
Organization administration								
Resuscitation at workplace	Descatha A, et al.[26]		+(O)	+(O)			+(O)	
Community based intervention	Yu Y, et al.[52]							
Community based program with health system	Yu Y, et al.[52]							
Real-time feedback devices during bystander CPR	Pan J[42], Zhan L, et al.[53]	+(O)	+(O)	+(O)				
CPR technique								
Biphasic defibrillation waveforms	Faddy SC, et al.[27]	+(O)						
Manual chest compression	Gates, et al.[30]			+(O)	+(O)		+(O)	
Chest-compression only CPR (CCPR)	Liao X, et al.[33], Pan J[42], Yao L, et al.[51], Zhan L, et al.[53]	+(O)	+(O)	+(O)			+(O)	

Table 2 Factors related to survival outcome among out-of-hospital cardiac arrest patients (continued)

Factors/ Interventions	Author (year)	Outcome						
		ROSC	Survival to hospital admission	Survival to hospital discharge	Survival at 30 days	Survival at 3 months	Neurological outcome (CPC)	Mortality
CPR technique								
Mechanical chest compression with LUCAS device or mechanical CPR	Liu M, et al.[35], Ong ME, et al.[41]	-(O)	-(O)	-(O)	-(O)		-(O)	
Endotracheal intuba -tion as early as possible	Yang Z, et al.[50]	+(O)	+(O)	+(O)				
Gasping or agonal respirations	Zhang Q, et al.[53]	+(O)					+(O)	
COVID 19 situation								
COVID-19 pandemics	Lim ZJ, et al.[34]							+(O)
Time for call to ambulance	Lim ZJ, et al.[34], Scquizzato T, et al.[17]	-(O)		-(O)				+(O)
Reduce frequency of unwitnessed events	Lim ZJ, et al.[34]							+(O)
Reduce bystander CPR	Lim ZJ, et al.[34]							+(O)
Reduce witnessed cases	Scquizzato T, et al.[17]	-(O)		-(O)				
Reduce bystander-initiated CPR	Scquizzato T, et al.[17]	-(O)		-(O)				
Resuscitation attempted by emergency medical services								
Reduce AED use	Lim ZJ, et al.[34]							+(O)

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บทคัดย่อ

ปัจจัยทีมีผลต่อการรอดชีวิตจากภาวะหัวใจหยุดเต้นนอกโรงพยาบาล: การทบทวนวรรณกรรมอย่างเป็นระบบ

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วารสารการแพทย์ฉุกเฉินแห่งประเทศไทย 2564;1(2):184-97.

การสังเคราะห์งานวิจัยด้วยการทบทวนวรรณกรรมอย่างเป็นระบบครั้งนี้ มีจุดมุ่งหมายเพื่อรวบรวมงานวิจัยและสังเคราะห์ปัจจัยที่มีผลต่อการรอดชีวิตจากภาวะหัวใจหยุดเต้นนอกโรงพยาบาล วิธีดำเนินการวิจัย ผู้วิจัยได้ทบทวนอย่างเป็นระบบเกี่ยวกับปัจจัยที่เกี่ยวข้องกับอัตราการรอดชีวิตในภาวะหัวใจหยุดเต้นนอกโรงพยาบาล ตามรูปแบบของสมิทธิ์และคณะ โดยมีการตรวจสอบตามเกณฑ์ของ PRISMA ผลการสังเคราะห์แก่นเรื่อง จากการสืบค้นในฐานข้อมูลอิเล็กทรอนิกส์ ได้แก่ PubMed, The Cochran library และ Embase เมื่อวันที่ 11 มกราคม พ.ศ. 2564 จำกัดช่วงเวลาที่ตีพิมพ์เผยแพร่ในปี พ.ศ. 2543-2564 โดยคัดเลือกงานเอกสารฉบับเต็มทั้งภาษาอังกฤษและภาษาไทย ได้แก่ เอกสารการทบทวนวรรณกรรมอย่างเป็นระบบ การวิเคราะห์อภิมาน และบทความวิเคราะห์และวิจารณ์ จากการศึกษาทั้ง 36 เรื่องที่ผ่านเกณฑ์การคัดเลือก ช่วงเวลาของการศึกษาวิจัยตั้งแต่ปี ค.ศ. 1990 ถึง 2020 สรุปผลการวิจัย จากกระบวนการทบทวนวรรณกรรมอย่างเป็นระบบ มีการศึกษาที่ผ่านเกณฑ์การคัดเลือกจำนวนทั้งหมด 36 เรื่อง พบว่า ปัจจัยที่เกี่ยวข้องกับการอยู่รอดของภาวะหัวใจหยุดเต้นนอกโรงพยาบาลที่ส่งผลมากที่สุด 2 อันดับแรก ได้แก่ ผู้ป่วยที่ได้รับยา epinephrine ขณะได้รับการช่วยชีวิตขณะอยู่นอกโรงพยาบาล ซึ่งสัมพันธ์กับการกลับมาของการไหลเวียนเลือดได้เองของ ผู้ป่วย และการช่วยฟื้นคืนชีพ (CPR) อย่างรวดเร็ว ก็ช่วยเพิ่มการกลับมาของการไหลเวียนเลือดได้เองของผู้ป่วยมากขึ้นเช่นเดียวกัน

คำสำคัญ: **ภาวะหัวใจหยุดเต้นเฉียบพลัน; ปัจจัยที่เกี่ยวข้อง; การทบทวนวรรณกรรมอย่างเป็นระบบ**
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