Cardiopulmonary Resuscitation of Patients with Coronavirus Disease 2019: A One-Year Survey in The West of Iran

Afshin Goodarzi
Hamadan University of Medical Sciences, Hamadan University of Medical Sciences
Masoud Khodaveisi
Hamadan University of Medical Sciences, Hamadan University of Medical Sciences
Alireza Abdi
KUMS: Kermanshah University of Medical Sciences, KUMS: Kermanshah University of Medical Sciences
Rasoul Salimi
Hamadan University of Medical Sciences, Hamadan University of Medical Sciences
Khodayar Oshvandi (oshvandi2005@gmail.com)
Hamadan University of Medical Sciences

Original research

Keywords: Coronavirus disease 2019, Cardiopulmonary resuscitation, Cross-sectional study, Iran

Posted Date: July 9th, 2021

DOI: https://doi.org/10.21203/rs.3.rs-688103/v1

Abstract

Background

The coronavirus disease 2019 (COVID-19) is associated with high risk of cardiac arrest (CA). Therefore, assessing cardiopulmonary resuscitation (CPR) success among patients with COVID-19 and employing effective strategies for its improvement are essential. The present study aimed at assessing the one-year epidemiology and outcomes of CPR among patients with COVID-19.

Methods

This cross-sectional descriptive-analytical study was conducted in January 2021 in the emergency departments of two hospitals in Hamadan and Kermanshah, Iran. Participants were 487 patients with confirmed COVID-19 and CA who had undergone CPR during the one-year period between January 20, 2020 and January 20, 2021. Data were collected using the available CPR documentation forms developed based on the Utstein Style. Data analysis was performed via the Chi-square, Fisher's exact, and Mann-Whitney *U* tests and the logistic regression analysis.

Results

Participants' age was 69.31 ± 14.73 years and most of them were male (61.8%) and suffered from at least one underlying disease (58.1%). The rate of total and in-hospital CA was 9.67% and 9.39%, respectively. The most prevalent first documented rhythm was asystole and the highest responsivity to CPR was for shockable rhythms. The rate of the return of spontaneous circulation was 9% and the rate of survival to hospital discharge was 2%. The significant predictors of CPR success were age, epinephrine administration time interval, and CPR duration.

Conclusion

CPR outcomes among patients with COVID-19 are poor, particularly among those with asystole and bradycardia. Old age and high or low doses of epinephrine can reduce CPR success, while CPR prolongation can improve CPR outcomes.

1. Background

Coronavirus disease 2019 (COVID-19) emerged in December 2019 and rapidly turned into a pandemic. A three-month study conducted from January 23 to March 13, 2020, in 415 sites in 190 countries reported 1908197 cases of COVID-19 and 119257 deaths from the disease. In that study, Iran was the tenth highest ranked country with regard to COVID-19 prevalence (1).

Although COVID-19 is primarily manifested as a severe respiratory infection, different studies reported that it can cause stroke due to cerebrovascular ischemia, pulmonary artery thrombosis, spontaneous pneumothorax, cardiovascular disease, and type II diabetes mellitus due to the dysfunction of the pancreatic beta cells (2–6). Respiratory dysfunction and subsequent alteration of tissue oxygenation in patients with COVID-19 can directly affect the cardiovascular system and cause serious problems such as myocarditis, myocardial injuries, acute myocardial infarction, heart failure, cardiac dysrhythmia, and thromboembolism. These problems can lead to cardiac arrest (CA) (7).

Studies on patients with COVID-19 show the increasing prevalence of in-hospital and out-of-hospital CA. For example, a study reported a two times increase in the rate of out-of-hospital CA and reduced survival during the COVID-19 pandemic (8). A meta-analysis on four studies also indicated a two times increase in the rate of in-hospital CA among patients with COVID-19 (9). Before the COVID-19 pandemic, in the U.S., an average of 292,000 cardiac arrests occurred annually (10, 11).There are no reliable statistics on CA rate in Iran; however, the average rate of CA in the United Arab Emirates and Saudi Arabia was respectively 11.7 and 7.76 cases per 1000 hospitalizations before the pandemic (12, 13). Before COVID-19

The only available technique for CA management is cardiopulmonary resuscitation (CPR). The current CPR technique was first developed sixty years ago and was last updated in 2020 (14, 15). The American Heart Association noted that CPR for patients with COVID-19 is the same as CPR for patients without COVID-19 but recommended the use of personal protective equipment throughout CPR in order to reduce the risk of infection transmission (16, 17).

CPR outcome assessments show that the rate of the return of spontaneous circulation (ROSC) is 35–45% in developed countries and 15.3–37.8% in Iran (18–23). Moreover, survival to hospital discharge rate after successful CPR is 25% in the United States and 7.2–13.5% in Iran (21–24). However, CPR outcomes among patients with COVID-19 are poor (9, 25). For instance, a study in China reported that the primary CPR success rate and thirty-day survival rate were 13.2% and 2.9%, respectively (26). Two other studies on out-of-hospital and in-hospital CA among patients with COVID-19 reported a survival to hospital discharge rate of zero percent (25, 27).

CPR outcomes among patients without COVID-19 depend on a wide range of factors. Some of these factors are the cause of CA, underlying disease, the first documented rhythm, age, CA type (witnessed or unwitnessed), CPR duration, response time, call-to-arrival time, and adherence to CPR protocols (18, 22, 28, 29). The lower CPR success rate among patients with COVID-19 has been attributed to factors such as the first documented rhythm (25, 26, 30).

Despite the wide prevalence and the high mortality rate of COVID-19 throughout the world, there are limited reliable data about CPR and its outcomes among afflicted patients. The present study sought to narrow this knowledge gap. The aim of this study was to assess the one-year epidemiology and outcomes of CPR among patients with COVID-19.

2. Methods

2.1. Design

This cross-sectional descriptive-analytical study was conducted in January 2021 on CPRs performed for patients with confirmed COVID-19 during the one-year period between January 20, 2020 and January 20, 2021.

2.2. Setting and participants

Study setting was all emergency departments of Besat hospital, Hamadan, Iran, and Imam Reza hospital complex, Kermanshah, Iran. As a specialty and subspecialty center, Besat hospital is the largest hospital in Hamadan province in the west of Iran and has 581 hospitalization beds. This hospital is a referral center for patients with COVID-19. Imam Reza hospital complex has 1000 hospitalization beds and is the largest hospital in the west of Iran. This hospital includes the Golestan hospital which is a referral center for patients with COVID-19. Study population consisted of all patients with confirmed COVID-19 hospitalized in these two hospitals who had undergone out-of-hospital or in-hospital CPR. Inclusion criteria were age over eighteen years, definite diagnosis of COVID-19, and out-of-hospital or in-hospital CA based on the Utstein Style criteria (31, 32). Patients with CA and no indication of CPR (i.e., those with rigor mortis or labor mortis) were not included. Patients with out-of-hospital CA and ROSC before hospital arrival who experienced another CA in emergency department were considered as out-of-hospital CA.

2.3. Data collection

Based on the Utstein Style, the core CPR success outcomes are ROSC, post-CPR survival up to hospital discharge or for thirty days, and optimum neurological function up to hospital discharge or for thirty days. Complementary outcome based on this style is one-year survival after successful CPR (33). In this study, ROSC was considered as the primary outcome of CPR and post-CPR survival to hospital discharge was considered as the final outcome of CPR.

The data collection instrument was the standard national CPR forms which had been developed based on the Utstein Style and were routinely used for CPR documentation by CPR nurses in the study setting. The items of these forms are on demographic characteristics, underlying disease, initial and final diagnoses, consciousness at arrival, CA type (in-hospital or out-of-hospital),

out-of-hospital CPR, the first documented cardiac rhythms, use of defibrillation, necessary time for intravenous (IV) cannulation, administered medications during CPR, CPR duration, and CPR success. We defined the adrenaline average dosing interval as the time between the first adrenaline dose and the resuscitation endpoint, divided by the total number of adrenaline doses received after the first dose. Besides, supplementary data were collected from patients' medical records. Hospital discharge status (dead or alive) was also assessed using the electronic medical record system of the study setting.

2.4. Data analysis

Data were analyzed using the SPSS software (v. 20.0). The normality of the age and the CPR duration variables was tested via the Kolmogorov-Smirnov test. The Chi-square, Fisher's exact, and Mann-Whitney *U* tests were used to assess the relationship of CPR outcomes with demographic characteristics, CPR time, CPR duration, epinephrine administration intervals, and IV cannulation time. Moreover, the logistic regression analysis was performed to predict CPR outcomes. Variables with significant relationship with CPR outcomes in univariable analysis were entered into the logistic regression model.

2.5. Ethical considerations

The Institutional Review Board and the Ethics Committee of Hamadan University of Medical Sciences, Hamadan, Iran, approved this study (codes: 9909186284 and IR.UMSHA.REC.1399.689). Necessary permissions for entering the study setting and performing data collection were obtained from the Research Administration of Hamadan and Kermanshah Universities of Medical Sciences, Hamadan and Kermanshah, Iran, and provided to the authorities of the study setting. Patients' data were managed confidentially. It is noteworthy that in the study setting, consents for using patient data for research purposes were routinely obtained from patients and their family members at the time of hospital admission and were available in-patient medical records.

3. Results

During the one-year assessment period of the study, 5034 patients with COVID-19 had been hospitalized in the study setting and 487 of them had experienced out-of-hospital or in-hospital CA. The total rate of CA among patients with COVID-19 was 9.67% and the total rate of in-hospital CA was 9.39%. Mean age among patients with CA was 69.31 ± 14.73 years and most of them were male (61.8%) and suffered from at least one underlying disease (58.1%). The most prevalent underlying diseases were diabetes mellitus and hypertension (31.2%) which were observed either separately, as comorbidity, or together with cardiovascular disease or cancer (Table 1).

Most patients with CA had experienced in-hospital CA (96.7%). Among patients with out-of-hospital CA, only 12.5% had been taken to hospital by the emergency medical services and had received CPR before hospital arrival. The most prevalent cardiac dysrhythmia was asystole (67.9%) and the mean of CPR duration was 41.98 ± 8.98 minutes. The time interval between each two epinephrine administrations was 9.02 ± 4.31 minutes and in most cases (95.3 %) IV cannulation had been performed in less than one minute. The total rates of ROSC and survival to hospital discharge were 9% and 2%, respectively (Table 2).

The ROSC outcome had significant relationship with participants' age, the first documented rhythm, epinephrine administration time interval, and CPR duration but survival to hospital discharge had significant relationship just with first documented rhythm ($P < 0.05$; Tables 3 and 4).

Therefore, these variables were entered into the logistic regression analysis. The results of the regression analysis showed age, epinephrine administration time interval, and CPR duration as the significant predictors of ROSC ($P < 0.05$). The amount of variance explained by these variables was 0.9–1.9% for age, 7.3–15.9% for epinephrine administration time interval, and 25.6–56.3% for CPR duration (Table 5).

4. Discussion

This study assessed the one-year epidemiology and outcomes of CPR among patients with COVID-19. Findings showed that the total rate of in-hospital CA was 9.39%. In line with this finding, a former study reported that the rate of in-hospital CA among patients with COVID-19 was 10% (9).

Most participants suffered from at least one underlying disease, particularly diabetes mellitus, hypertension, cardiovascular disease, and cancer. A meta-analysis also reported the prevalence of different underlying diseases among patients with COVID-19 (34). Affliction by underlying diseases increases mortality rate among patients with COVID-19 (34, 35). Compromised immunity due to diabetes mellitus, decreased inflammatory cytokines among patients with cardiovascular disease, or chemotherapy among patients with cancer is considered as a major risk factor for affliction by COVID-19 (36, 37). On the other hand, findings showed that 41.9% of participants had no underlying disease, denoting the high prevalence of COVID-19 among people with no underlying disease. These finding questions the widespread belief that COVID-19 less frequently affects people with no underlying disease. The high transmissibility of the virus is a significant factor contributing to the high prevalence of COVID-19 even among people with no underlying disease.

Primary CPR success, i.e., ROSC, was observed among only 9% of the patients with COVID-19 who had experienced CA. CPR success rate among patients with in-hospital CPR was also higher than patients with out-of-hospital CPR. A former study in this area reported that the rate of ROSC after CPR was 25.9% for out-of-hospital CA and 30.6% for in-hospital CA (25). Moreover, a meta-analysis on four studies on 621 patients with COVID-19 showed that the pooled prevalence of primary CPR success was 39% (95% CI: 21.0–59.0%) (9). The rate of primary CPR success in these two studies are much better than the rate in our study. Comparison of the findings of the present study with the findings of two former studies in Iran before the COVID-19 pandemic also reveals the lower CPR success rate among patients with COVID-19 (21, 29). This lower CPR success rate can be attributed to the higher prevalence of asystole in the present study compared with former studies on patients with and without COVID-19 (21, 25, 27, 38). Asystole is less responsive to CPR than other shockable dysrhythmias. Another reason for the lower CPR success rate in the present study may be non-adherence to epinephrine administration protocols. Some studies also reported that poor CPR outcomes among patients with COVID-19 may be due to the employment of novice staff for CPR during the COVID-19 pandemic, delayed CPR onset due to the need for using personal protective equipment, and CPR staff's concern over affliction by COVID-19 during CPR (39, 40). Delayed or slow CPR onset and subsequent CPR prolongation have significant negative relationships with CPR outcomes (41–43). The lower rate of CPR success rate among patients with out-of-hospital CA in the present study may also be due to the fact that only 12.5% of them had been taken to hospital by emergency medical services and the others had been taken by private vehicles or taxi and hence, had not received out-of-hospital CPR. A former study also reported the same finding (44).

Study findings showed that only 2% of patients had survival to hospital discharge. All these patients had experienced in-hospital CA. A meta-analysis on patients with COVID-19 and in-hospital CA also reported that the cumulative prevalence of survival to discharge rate was 3% (9), while none of the patients with COVID-19 and in-hospital CA in two other studies had survived to hospital discharge (25, 38). COVID-19 significantly affects different body organs and hence, CA among afflicted patients is mostly fatal. Therefore, preventive measures, timely treatments, and careful monitoring of critically-ill patients with COVID-19 are necessary to prevent the occurrence of CA.

Findings revealed that primary CPR success had significant relationship with age, the first documented rhythm, epinephrine administration interval, and CPR duration, while final CPR success had significant relationship only with the first documented rhythm. The logistic regression analysis revealed age, epinephrine administration interval, and CPR duration as the significant predictors of primary CPR success. The mean of CPR duration was 24 minutes (with an interquartile range of 15–30) for patients with successful primary CPR and 43 minutes for unsuccessful CPR. The mean of CPR duration was six minutes (with an interquartile range of 4–14) among patients with successful primary CPR and in-hospital CA in a former study (30) and eight minutes (with an interquartile range of 4–10) in another study (27). The longer CPR duration in the present study compared with former studies may be due to the fact that the study included patients with out-of-hospital CA. A study reported that there is no maximum time for CPR efforts, while longer CPRs were associated with greater survival to discharge rate (45).

Although the mean of CPR duration among survived patients in the present study was shorter, 6.8% of successful CPRs had lasted more than 45 minutes, denoting that CPR prolongation can be a determining factor in CPR success.

The mean of participants' age in the present study was 69 years and the mean age among participants with successful CPR was significantly less than those with unsuccessful CPR. The results of a meta-analysis on more than half a million patients with COVID-19 from different countries also reported age as a significant predictor of mortality (46). These findings highlight the importance of timely preventive measures for older patients to improve treatment outcomes among them because they are less responsive to treatments in critical conditions such as CA.

Epinephrine administration interval was one of the significant predictors of primary CPR success in the present study. This interval was 5.41 ± 1.74 minutes for patients with successful primary CPR. The rates of primary CPR success and survival to hospital discharge were respectively 34.85% and 9.09% for patients who had received epinephrine every 3–5 minutes and 5.07% and 0.97% for patients who had received it in intervals longer than five minutes. Moreover, none of patients who had received extra high doses of epinephrine (i.e., with intervals less than three minutes) had experienced successful primary CPR and survived to hospital discharge. The standard dose of epinephrine for adults is 1 milligram every 3–5 minutes throughout CPR (15). Our findings showed that CPR success among patients who had received high doses of epinephrine was less than those who had received it with doses less than the recommended standard dose. Although poor CPR outcomes among patients with COVID-19 can be attributed to COVID-19 severity, the role of high doses of epinephrine in causing cytokine storms should be taken into account. Further studies are needed to assess this role and the necessity to use safer medications instead of epinephrine for the CPR of patients with COVID-19.

The most prevalent first documented cardiac rhythms among study participants were respectively asystole and bradycardia and the prevalence of shockable dysrhythmias was 1.24%. The prevalence of shockable dysrhythmias in five earlier studies on patients with COVID-19 was 3.7–13%, which is less than the rate among patients without COVID-19 (25–27, 30, 38). Pulmonary involvement and its associated hypoxia may be a reason for the lower rate of shockable dysrhythmias among patients with COVID-19.

The highest successful primary CPR rate and survival to discharge rate were among patients with pulseless ventricular tachycardia. Although the first documented rhythm was not a significant predictor of CPR outcome in the present study, it had significant relationship with primary CPR success and survival to discharge rate. Studies on patients without COVID-19 (20, 47) and a meta-analysis on patients with COVID-19 found poorer CPR outcomes for patients with non-shockable dysrhythmias (9). Despite the lower prevalence of shockable dysrhythmias among patients with COVID-19, these dysrhythmias have better prognosis than non-shockable dysrhythmias.

5. Conclusion

This study concludes that CPR outcomes among patients with COVID-19 are poorer than patients without COVID-19. The prevalence of shockable dysrhythmias among patients with COVID-19 is also much lower than patients without COVID-19, resulting in lower responsiveness to CPR among patients with COVID-19. Old age and high doses of epinephrine are factors which can negatively affect CPR outcomes, particularly primary CPR success, among patients with COVID-19. Further studies are needed to assess the effects of epinephrine administration on CPR outcomes among these patients. The present study also suggests that although shorter CPR duration can be associated with primary CPR success, CPR prolongation can result in better long-term CPR outcomes such as greater survival to discharge rate among patients with COVID-19. Poor CPR outcomes among patients with COVID-19 highlight the importance of exploring CPR staff's experiences and the effects of their concerns over affliction by COVID-19 on CPR quality and outcomes.

6. List Of Abbreviations

IHCA

In-Hospital Cardiac Arrest, OHCA:Out of Hospital Cardiac Arrest, CPR:Cardio Pulmonary Resuscitation, CA:Cardiopulmonary Arrest, IV:Intravenous, ROSC:Return of Spontaneous Circulation

7. Declarations

7.1. Ethics approval and consent to participate

The Institutional Review Board and the Ethics Committee of Hamadan University of Medical Sciences, Hamadan, Iran, approved this study (codes: 9909186284 and IR.UMSHA.REC.1399.689). Necessary permissions for entering the study setting and performing data collection were obtained from the Research Administration of Hamadan and Kermanshah Universities of Medical Sciences, Hamadan and Kermanshah, Iran, and provided to the authorities of the study setting. Patients' data were managed confidentially. It is noteworthy that in the study setting, consents for using patient data for research purposes were routinely obtained from patients and their family members at the time of hospital admission and were available in-patient medical records.

7.2. Consent for publication

Not applicable.

7.3. Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

7.4. Competing interests

The authors declare that they have no competing interests

7.5. Funding

Financial resources for the design of the present study and collection, analysis, and interpretation of data and in writing the manuscript provided by Hamadan University of Medical Sciences.

7.6. Authors' contributions

Study design: AG, KO; Data gathering: AG, RS; Analysis: AG, ARA; Interpreting: AG, , MK, ARA; Drafting: AG, KO; Critically revised the paper: All authors.

7.7. Acknowledgement

We would like to thank the Research Administration of Hamadan University of Medical Sciences, Hamadan, Iran, as well as the authorities, nurses, and medical records staff of the study setting who helped us conduct this study.

References

1. Guo C, Bo Y, Lin C, Li HB, Zeng Y, Zhang Y, et al. Meteorological factors and COVID-19 incidence in 190 countries: an observational study. Sci Total Environ. 2021;757:143783. https://doi.org/10.1016/j.scitotenv.2020.143783.
2. y Galán JTG. Stroke as a complication and prognostic factor of COVID-19. Neurología (English Edition). 2020. https://doi.org/10.1016/j.nrleng.2020.04.013.
3. Ekanem E, Podder S, Donthi N, Bakhshi H, Stodghill J, Khandhar S, et al. Spontaneous pneumothorax: An emerging complication of COVID-19 pneumonia. Heart Lung. 2021;50(3):437–40. https://doi.org/10.1016/j.hrtlng.2021.01.020.

4. Akel T, Qaqa F, Abuarqoub A, Shamoon F. Pulmonary embolism: a complication of COVID 19 infection. Thrombosis research. 2020;193:79–82. https://doi.org/10.1016/j.thromres.2020.05.033.
5. Hayden MR. An immediate and long-term complication of COVID-19 may be type 2 diabetes mellitus: the central role of β-cell dysfunction, apoptosis and exploration of possible mechanisms. Cells. 2020;9(11):2475. https://doi.org/10.3390/cells9112475.
6. Guo T, Fan Y, Chen M, Wu X, Zhang L, He T, et al. Cardiovascular implications of fatal outcomes of patients with coronavirus disease 2019 (COVID-19). JAMA cardiology. 2020;5(7):811–8.
7. Long B, Brady WJ, Koyfman A, Gottlieb M. Cardiovascular complications in COVID-19. The American journal of emergency medicine. 2020. https://doi.org/10.1016/j.ajem.2020.04.048.
8. Marijon E, Karam N, Jost D, Perrot D, Frattini B, Derkenne C, et al. Out-of-hospital cardiac arrest during the COVID-19 pandemic in Paris, France: a population-based, observational study. The Lancet Public Health. 2020;5(8):e437-e43. https://doi.org/10.1016/S2468-2667(20)30117-1.
9. Mir T, Sattar Y, Ahmad J, Ullah W, Shanah L, Alraies MC, et al. Outcomes of in-hospital cardiac arrest in COVID-19 patients: A proportional prevalence meta-analysis. Catheter Cardiovasc Interv. 2021. https://doi.org/10.1002/ccd.29525.
10. Holmberg MJ, Ross CE, Fitzmaurice GM, Chan PS, Duval-Arnould J, Grossestreuer AV, et al. Annual incidence of adult and pediatric in-hospital cardiac arrest in the United States. Circulation: Cardiovascular Quality and Outcomes. https://doi.org/10.1161/CIRCOUTCOMES.119.005580.
11. Atkins DL. Sudden cardiac arrest in a young population: not so unpredictable. Journal of the American Heart Association. 2019;8(2):e011700. https://doi.org/10.1161/JAHA.118.011700.
12. Aziz F, Paulo MS, Dababneh EH, Loney T. Epidemiology of in-hospital cardiac arrest in Abu Dhabi, United Arab Emirates, 2013–2015. Heart Asia. 2018;10(2). http://dx.doi.org/10.1136/heartasia-2018-011029.
13. Alzahrani AH, Alnajjar MF, Alshamarni HM, Alshamrani HM, Bakhsh AA. Prevalence and outcomes of sudden cardiac arrest in a university hospital in the Western Region, Saudi Arabia. Saudi journal of medicine medical sciences. 2019;7(3):156. https://dx.doi.org/10.4103%2Fsjmms.sjmms_256_18.
14. Safar P, Brown TC, Holtey WJ, Wilder RJ. Ventilation and circulation with closed-chest cardiac massage in man. Jama. 1961;176(7):574–6.
15. Panchal AR, Bartos JA, Cabañas JG, Donnino MW, Drennan IR, Hirsch KG, et al. Part 3: Adult Basic and Advanced Life Support: 2020 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation. 2020;142(16_Suppl_2):366–468. https://doi.org/10.1161/CIR.0000000000000916.
16. Koester RJ. Review of Search and Rescue Response Guidelines to COVID-19. JournalofSAR com. 2020;4(2):ISSN 2230–5734. 214.
17. Edelson DP, Sasson C, Chan PS, Atkins DL, Aziz K, Becker LB, et al. Interim guidance for basic and advanced life support in adults, children, and neonates with suspected or confirmed COVID-19: from the emergency cardiovascular care committee and get with the guidelines-resuscitation adult and pediatric task forces of the American Heart Association. Circulation. 2020;141(25):e933-e43. https://doi.org/10.1161/CIRCULATIONAHA.120.047463.
18. Shao F, Li CS, Liang LR, Qin J, Ding N, Fu Y, et al. Incidence and outcome of adult in-hospital cardiac arrest in Beijing, China. Resuscitation. 2016;102:51–6. https://doi.org/10.1016/j.resuscitation.2016.02.002.
19. Yingying H, Jun X, Zhu H, Zhang G, Sun F, Zhang Y, et al. Profile and outcome of cardiopulmonary resuscitation after sudden cardiac arrests in the emergency department: a multicenter prospective observational study. Chinese Critical Care Medicine. 2018;30(3):234–9.
20. Nolan JP, Soar J, Smith GB, Gwinnutt C, Parrott F, Power S, et al. Incidence and outcome of in-hospital cardiac arrest in the United Kingdom National Cardiac Arrest Audit. Resuscitation. 2014;85(8):987–92. https://doi.org/10.1016/j.resuscitation.2014.04.002.
21. Goodarzi A, Jalali A, Almasi A, Naderipour A, Kalhori RP, Khodadadi A. Study of survival rate after cardiopulmonary resuscitation (CPR) in hospitals of Kermanshah in 2013. Global journal of health science. 2015;7(1):52.

https://dx.doi.org/10.5539%2Fgjhs.v7n1p52.

22. Salari A, Mohammadnejad E, Vanaki Z, Ahmadi F. Survival rate and outcomes of cardiopulmonary resuscitation. Iran J Crit Care Nurs. 2010;3(2):45–9.
23. Keivanpazhoh K, Rahimi Rad MH, Farrokh Eslamlou H. Quality and outcome of cardiopulmonary resuscitation in imam Khomeini teaching hospital-report according to Utstein style. Studies in Medical Sciences. 2011;22(4):346–52.
24. Benjamin EJ, Virani SS, Callaway CW, Chamberlain AM, Chang AR, Cheng S, et al. Heart disease and stroke statistics—2018 update: a report from the American Heart Association. Circulation. 2018. https://doi.org/10.1161/CIR.0000000000000558.
25. Sultanian P, Lundgren P, Strömsöe A, Aune S, Bergström G, Hagberg E, et al. Cardiac arrest in COVID-19: characteristics and outcomes of in-and out-of-hospital cardiac arrest. A report from the Swedish Registry for Cardiopulmonary Resuscitation. European heart journal. 2021. https://doi.org/10.1093/eurheartj/ehaa1067.
26. Shao F, Xu S, Ma X, Xu Z, Lyu J, Ng M, et al. In-hospital cardiac arrest outcomes among patients with COVID-19 pneumonia in Wuhan, China. Resuscitation. 2020;151:18–23. https://doi.org/10.1016/j.resuscitation.2020.04.005.
27. Thapa SB, Kakar TS, Mayer C, Khanal D. Clinical outcomes of in-hospital cardiac arrest in COVID-19. JAMA Internal Medicine. 2020.
28. Abella BS. High-quality cardiopulmonary resuscitation: current and future directions. Curr Opin Crit Care. 2016;22(3):218–24. https://doi.org/10.1097/MCC.0000000000000296.
29. Ezzati E, Mohammadi S, Karimpour H, Saman JA, Goodarzi A, Jalali A, et al. Assessing the effect of arrival time of physician and cardiopulmonary resuscitation (CPR) team on the outcome of CPR. Interventional Medicine Applied Science. 2020;11(3):139–45. DOI:10.1556/1646.10.2018.33.
30. Hayek SS, Brenner SK, Azam TU, Shadid HR, Anderson E, Berlin H. etal. In-hospital cardiac arrest in critically ill patients with covid-19: multicenter cohort study. bmj. 2020;371. https://doi.org/10.1136/bmj.m3513.
31. McNally B, Robb R, Mehta M, Vellano K, Valderrama AL, Yoon PW, et al. Out-of-hospital cardiac arrest surveillance—cardiac arrest registry to enhance survival (CARES), United States, October 1, 2005–December 31, 2010. Morbidity and Mortality Weekly Report: Surveillance Summaries. 2011;60(8):1–19.
32. Perkins GD, Jacobs IG, Nadkarni VM, Berg RA, Bhanji F, Biarent D, et al. Cardiac arrest and cardiopulmonary resuscitation outcome reports: update of the Utstein resuscitation registry templates for out-of-hospital cardiac arrest: a statement for healthcare professionals from a task force of the International liaison Committee on resuscitation (American heart association, European resuscitation Council, Australian and New Zealand Council on resuscitation, heart and stroke Foundation of Canada, InterAmerican heart Foundation, resuscitation Council of southern Africa, resuscitation Council of Asia); and the American heart association emergency cardiovascular care Committee and the Council on cardiopulmonary, critical care, perioperative and resuscitation. Circulation. 2015;132(13):1286–300. https://doi.org/10.1161/CIR.0000000000000144.
33. Nolan JP, Berg RA, Andersen LW, Bhanji F, Chan PS, Donnino MW, et al. Cardiac arrest and cardiopulmonary resuscitation outcome reports: update of the Utstein resuscitation registry template for in-hospital cardiac arrest: a consensus report from a task force of the international Liaison committee on resuscitation (American heart association, European resuscitation Council, Australian and New Zealand Council on resuscitation, heart and stroke foundation of Canada, InterAmerican heart foundation, resuscitation Council of southern africa, resuscitation Council of asia). Circulation. 2019;140(18):e746-e57. https://doi.org/10.1161/CIR.0000000000000710.
34. Emami A, Javanmardi F, Pirbonyeh N, Akbari A. Prevalence of underlying diseases in hospitalized patients with COVID-19: a systematic review and meta-analysis. Archives of academic emergency medicine. 2020;8(1):e35.
35. Sun K, Chen J, Viboud C. Early epidemiological analysis of the coronavirus disease 2019 outbreak based on crowdsourced data: a population-level observational study. The Lancet Digital Health. 2020;2(4):e201-e8. https://doi.org/10.1016/S2589-7500(20)30026-1.
36. Chen N, Zhou M, Dong X, Qu J, Gong F, Han Y, et al. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. The lancet. 2020;395(10223):507–13.

https://doi.org/10.1016/S0140-6736(20)30211-7.

37. Zheng Y-Y, Ma Y-T, Zhang J-Y, Xie X. COVID-19 and the cardiovascular system. Nature Reviews Cardiology. 2020;17(5):259–60. https://doi.org/10.1038/s41569-020-0360-5.
38. Sheth V, Chishti I, Rothman A, Redlener M, Liang J, Pan D, et al. Outcomes of in-hospital cardiac arrest in patients with COVID-19 in New York City. Resuscitation. 2020.
39. Hassager C, Price S, Huber K. Cardiac arrest in the COVID-19 era. SAGE Publications Sage UK: London; 2020. https://doi.org/10.1177%2F2048872620922789.
40. Kramer DB, Lo B, Dickert NW. CPR in the COVID-19 era—an ethical framework. N Engl J Med. 2020;383(2):e6. DOI:10.1056/NEJMp2010758.
41. Goto Y, Funada A, Goto Y. Relationship between the duration of cardiopulmonary resuscitation and favorable neurological outcomes after out-of-hospital cardiac arrest: a prospective, nationwide, population-based cohort study. Journal of the American Heart Association. 2016;5(3):(e002819. https://doi.org/10.1161/JAHA.115.002819.
42. Chan PS, Krumholz HM, Nichol G, Nallamothu BK, Investigators AHANRoCR. Delayed time to defibrillation after in-hospital cardiac arrest. N Engl J Med. 2008;358(1):9–17. DOI:10.1056/NEJMoa0706467.
43. Bradley SM, Liu W, Chan PS, Girotra S, Goldberger ZD, Valle JA, et al. Duration of resuscitation efforts for in-hospital cardiac arrest by predicted outcomes: Insights from Get With The Guidelines – Resuscitation. Resuscitation. 2017;113:128–34. https://doi.org/10.1016/j.resuscitation.2016.12.017.
44. Do SN, Luong CQ, Pham DT, Nguyen CV, Ton TT, Pham TT, et al. Survival after out-of-hospital cardiac arrest, Viet Nam: multicentre prospective cohort study. World Health Organization Bulletin of the World Health Organization. 2021;99(1):50–61. https://dx.doi.org/10.2471%2FBLT.20.269837.
45. Goldberger ZD, Chan PS, Berg RA, Kronick SL, Cooke CR, Lu M, et al. Duration of resuscitation efforts and survival after in-hospital cardiac arrest: an observational study. The Lancet. 2012;380(9852):1473–81. https://doi.org/10.1016/S0140-6736(12)60862-9.
46. Bonanad C, Garcia-Blas S, Tarazona-Santabalbina F, Sanchis J, Bertomeu-González V, Facila L, et al. The effect of age on mortality in patients with COVID-19: a meta-analysis with 611,583 subjects. J Am Med Dir Assoc. 2020;21(7):915–8. https://doi.org/10.1016/j.jamda.2020.05.045.
47. Nadkarni VM, Larkin GL, Peberdy MA, Carey SM, Kaye W, Mancini ME, et al. First documented rhythm and clinical outcome from in-hospital cardiac arrest among children and adults. Jama. 2006;295(1):50–7.

Tables

Table 1. Participants' underlying diseases

Underlying disease	Out-of-hospital CA		In-hospital CA		Total	
	N	%	N	%	N	%
1. Hypertension	0	0	31	6.8	31	6.6
2. Diabetes mellitus	2	13.3	49	10.8	51	10.9
3. Cancer	0	0	31	6.8	31	6.6
4. Ischemic heart disease	1	6.7	28	6.2	29	6.2
5. 1 and 4	1	6.7	19	4.2	20	4.3
6. Chronic Renal disease	1	6.7	14	3.1	15	3.2
7. Chronic obstructive pulmonary disease	0	0	10	2.2	10	2.1
8. 1, 2, and 3	0	0	3	0.7	3	0.6
9. Organ transplantation	0	0	2	0.4	2	0.4
10. 1, 2, and 4	1	6.7	20	4.4	21	4.5
11. Cerebrovascular accident	0	0	6	1.3	6	1.3
12.1 and 2	1	6.7	19	4.2	20	4.3
Other	0	0	33	7.3	33	7.1
None	8	50	188	41.5	196	41.9
Total	15	100	453	100	468	100

Table 2. CPR outcomes

Outcomes	In-hospital CA		Out-of-hospital CA		Total	
	N	%	N	%	N	%
ROSC						
Yes	43	9.1	1	6.3	44	9
No	**428**	90.9	15	93.8	443	91
Survival to discharge						
Yes	10	2.1	0	0	10	2
No	33	7	1	6.3	34	7

Table 3. The relationships of participants' characteristics with CPR outcomes

Variable		N (%)	ROSC N (%)	Test value*	P value	Survival to discharge N (%)	Test value*	P value
Gender	Male	301 (61.8)	31 (10.30)	1.532	0.216	7 (2.32)	0.001	0.971
	Female	186 (38.2)	13 (6.99)			3 (1.61)		
Type of CA	In-hospital	471 (96.7)	43 (9.13)	0.156	0.693	10 (2.12)	0.301	1.00
	Out-of-hospital	16 (3.3)	1 (6.25)			0 (0)		
On-arrival status	Alert	242 (51.2)	25 (10.33)	6.542	0.088	6 (2.48)	0.886	1.00
	Verbal	131 (27.6)	16 (12.21)			4 (3.05)		
	Painful	51 (10.8)	2 (3.92)			0 (0)		
	Unresponsive	50 (10.5)	1 (2.0)			0 (0)		
CPR time	08:00–14:00	131 (26.9)	15 (11.45)	1.724	0.632	2 (1.53)	4.501	0.194
	14:01–20:00	126 (25.9)	12 (9.52)			5 (3.97)		
	20:01–24:00	80 (16.4)	6 (7.5)			0 (0)		
	00:01–07:59	150 (30.8)	11 (7.33)			3 (2)		
Underlying disease	Yes	272 (58.1)	21 (7.7.72)	2.155	0.142	5 (1.84)	0.027	0.870
	No	196 (41.9)	23 (11.73)			5 (2.55)		
First documented rhythm	Ventricular tachycardia	3 (0.6)	2 (66.66)	10.656	0.023*	1 (33.33)	7.165	0.042*
	Ventricular fibrillation	3 (0.6)	1 (33.33)			0 (0)		
	Bradycardia	147 (30.2)	10 (7.30)			5 (3.40)		
	Asystole	330 (67.9)	31 (9.39)			4 (1.21)		
	PEA	3 (0.6)	0 (0)			0 (0)		
Epinephrine administration Intervals	< 3 minutes	2 (0.4)	0 (0)	43.469	< 0.001*	0 (0)	0.310	0.578
	3–5 minutes	66 (13.7)	23 (34.85)			6 (9.09)		
	> 5 minutes	414 (85.9)	21 (5.07)			4 (0.97)		
Intravenous cannulation time	< 1 minutes	464 (95.3)	43 (9.27)	0.645	0.422	10 (2.15)	0.301	1.00
	>1 minute	23 (4.7)	1 (4.35)			0 (0)		

Epinephrine delay	yes	38(7.9)	2(5.26)	0.731	0.393	0(0)	0.616	1.00
	no	446(92.1)	42(9.42)			10(2.24)		
Atropine	yes	128(87.7)	9(7.03)	0.082	0.775	4(3.12)	1.111	1.00
	no	19(12.93)	1(5.26)			1(5.26)		
Amiodarone	yes	5(83.33)	3(60)	1.200	1.00	1(20)	N/A‡	N/A‡
	no	1(16.67)	0(0)			0(0)		
Defibrillation	yes	6(100)	3(50)	N/A‡	N/A‡	1(33.33)	N/A‡	N/A‡
	no	0(0)	(0)			0(0)		
Air way management	Intubation	479(98.56)	43(8.98)	0.236	0.488	10(2.09)	0.301	1.00
	Mask	7(1.44)	1(14.28)			0(0)		

*: The results of the Chi-square or the Fisher's exact test

‡: No statistics are computed

Table 4. The relationships of age and CPR duration with CPR outcomes

Variable	Total range	ROSC	N (Mean±SD)	Test value*	P value	Survival to discharge	N (Mean±SD)	Test value*	P value
Age (Years)	18–100	Yes	44 (64.82±14.00)	-2.464	0.014	Yes	10 (64.50±9.11)	-0.533	0.594
		No	443 (69.76±14.74)			No	34 (64.91±15.26)		
CPR duration (Minutes)	5–85	Yes	44 (24.09±12.58)	-9.716	< 0.001	Yes	10 (18.80±5.83)	-1.101	0.271
		No	442 (43.77±6.17)			No	34 (25.65±13.64)		

*: The results of the Mann-Whitney *U* test

Table 5. The predictors of CPR outcomes

Dependent variable	Independent variables	B	Std. Error	Wald	df	Sig.	Exp (B)	95% CI	
								Upper Bound	Lower Bound
ROSC	First documented rhythm	0.345	0.189	3.335	1	0.068	1.411	0.975	2.043
	Epinephrine interval	2.018	0.327	38.004	1	< 0.001	7.522	3.960	14.287
	CPR duration	0.198	0.022	82.010	1	< 0.001	1.220	1.168	1.273
	Age	0.021	0.010	4.442	1	.035	1.021	1.001	1.041
Survival to discharge	First documented rhythm	– 0.592	0.366	2.615	1	0.106	0.553	0.270	1.134