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# Clinical Characteristics and Factors Influencing the Outcomes of In-Hospital Cardiac Arrest Patients: A Retrospective Observational Study

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| *Objective* | Analyze the clinical characteristics and resuscitation outcomes of patients with in-hospital cardiac arrest (IHCA) and explore the factors affecting the success rate of cardiopulmonary resuscitation in IHCA patients. |
| *Material and methods* | A retrospective observational study was conducted. Patients who received resuscitative treatment for IHCA between September 2022 and December 2023 were evaluated. Clinical data and prognostic information were collected and analyzed, including age, gender, underlying diseases, time of cardiac arrest, cause of cardiac arrest, presence of shockable rhythm, application of defibrillation, duration of CPR (>30 min), presence of endotracheal intubation, cumulative dose of adrenaline, and resuscitation outcomes (return of spontaneous circulation, survival to discharge). |
| *Results* | A total of 323 IHCA patients were included in this study. After CPR treatment, 246 had return of spontaneous circulation (ROSC), with 90 surviving to discharge. Coronary artery disease, shockable initial rhythm, presence of a shockable rhythm during resuscitation, defibrillation, and absence of emergency endotracheal intubation differed statistically between the ROSC and non-ROSC groups (univariate analysis, $p < 0.001$) Age was a statistically significant determinant of whether patients survived to discharge ($p < 0.05$). Multivariate logistic regression analysis showed that CPR duration ≥ 30 min was an independent risk factor for ROSC, while younger age, application of emergency endotracheal intubation, and lower cumulative dose of adrenaline were independent protective factors for ROSC ($p < 0.05$). |
| *Conclusion* | Age lower than 60 years old, application of defibrillation, and emergency endotracheal intubation are positively associated with increased likelihood of ROSC. Age is an independent risk factor negatively related to survival after discharge. Clinicians should pay close attention to these factors to improve the outcomes of cardiopulmonary resuscitation patients. |

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| *Keywords* | In-hospital cardiac arrest resuscitation outcomes; cardiopulmonary resuscitation; clinical characteristics; prognostic factors |
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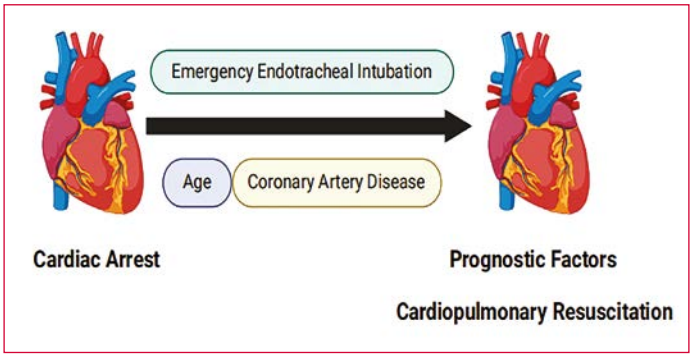
## Introduction

Cardiac arrest (CA) is a medical emergency characterized by the sudden cessation of heartbeats, leading to the interruption of systemic blood flow and oxygen supply, and posing a life-threatening situation [1]. CA can be an initial symptom of certain diseases such as Brugada syndrome [2], long QT syndrome [3], and hypertrophic cardiomyopathy [4] or a terminal manifestation of various conditions including advanced heart failure [5], severe coronary artery disease [6], and septic shock [7], ultimately serving as a significant primary factor in the pathophysiology of sudden cardiac death. Statistics show that the annual incidence of sudden cardiac death in China is 41.84 cases per 100,000 individuals [8]. Currently, sudden cardiac

Central illustration. Clinical Characteristics and Factors Influencing the Outcomes of In-Hospital Cardiac Arrest Patients: A Retrospective Observational Study





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death has become one of the major health threats to global residents [9]. As compared to out-of-hospital CA (OHCA), in-hospital CA (IHCA) refers to CA events that occur within medical institutions, thus providing patients with an opportunity to receive immediate response and intervention from a professional medical team [10].

Cardiopulmonary resuscitation (CPR) is the primary initial emergency intervention for cardiac arrest, which can be followed by other treatments such as defibrillation and advanced cardiac life support medications if available. Timely and effective CPR for IHCA patients can prompt the return of spontaneous circulation (ROSC), thereby improving the success rate of resuscitation [11]. ROSC refers to the restoration of the patient's autonomous heart rhythm and blood circulation after CA, and it serves as an important monitoring target for evaluating patient survival and prognosis. High-quality CPR is a crucial condition for achieving ROSC [12].

The first 4 min after cardiac arrest are considered the golden rescue period. Prolonged absence of perfusion beyond this critical period can lead to irreversible damage to the body. Therefore, early implementation of CPR for CA patients increased the success rate of this treatment [13]. However, the survival rate of IHCA patients has not yet reached the desired level, and there are significant differences in long-term outcomes among patients before as well as after discharge. Hence, it is crucial to identify factors affecting the recovery outcomes of IHCA patients. This would provide a basis for clinical decision-making and enhance both short-term and long-term survival rates [14, 15].

Globally, the incidence rate and mortality of CA are increasing, as is the incidence of IHCA [16, 17], which may have high clinical significance. Despite timely implementation of high-quality CPR measures, including proper chest compression depth (5–6 cm) and rate (100–120 compressions per minute), minimal interruptions to compressions, appropriate ventilation, early defibrillation, and adherence to advanced cardiac life support protocols, the survival rates of patients remain unsatisfactory. According to the American Heart Association's Get with The Guidelines-Resuscitation registry data from 2017, the discharge survival rate of IHCA patients is 25%. In the UK, statistics from 2011 to 2013 reported an even lower discharge survival rate of 18% [18]. A retrospective study conducted from 2006 to 2015 by the Swedish Register of Cardiopulmonary Resuscitation revealed that the 30-day survival rate of 18,069 IHCA patients was 28.3%, while the one-year survival rate was 25.0% [19]. In China, due to significant differences in geographical location, social medical systems, and cultural backgrounds compared to other countries, the incidence and treatment outcomes of CA show noticeable disparities compared to the international data. China has over 230 million cardiovascular disease patients, with approximately 550,000 individuals experiencing CA events annually [20]. With continuous advancements in CPR technology and the dissemination of relevant knowledge, the probability of successful CPR following CA has increased. However, the rates of ROSC and long-term survival remain low, highlighting the need for further improvement in strategies and treatment outcomes for IHCA [21].

Research indicates that the effectiveness of CPR rescue is influenced by various factors such as patient gender, age, underlying diseases, CA etiology, initial monitored heart rhythm, CPR initiation time and duration, defibrillation, intubation, ventilation methods, among others [22, 23]. Therefore, enhancing the success rate of CPR remains a significant challenge in clinical practice. The effects of CPR rescue and its influencing factors is a key focus of clinical research. Currently, there is still debate on the clinical characteristics of IHCA patients and the related factors affecting the success rate of CPR. Thus, clarifying the factors that affect ROSC is crucially significance in improving the success of cardiopulmonary resuscitation. Therefore, this study focused on resuscitation patients with IHCA. The clinical characteristics of adult IHCA patients were analyzed, and the factors influencing the success rate of CPR in IHCA patients was explored.

## Material and methods

### *Patients*

This retrospective study included 323 in-hospital cardiac arrest (IHCA) patients in our hospital (139 males (43%) and 184 females (57%)) who experienced CA during hospitalization from September 2022 to December 2023, were over 18 years old, and underwent CPR. Exclusion criteria: 1) patients with OHCA who were resuscitated and then admitted to the hospital; 2) patients in late-stage malignancy or terminal conditions of other diseases; 3) patients for whom outcome data of CPR could not be tracked; 4) patients whose immediate family members refused CPR.

### *Clinical data*

The clinical conditions included coronary artery disease, myocardial infarction, cardiomyopathy, arrhythmias, structural heart disease, electrolyte imbalances, drugs and toxins. The data included general patient information, IHCA-related conditions and resuscitation outcome data, and relevant time data. The main outcome measures were ROSC rate and 30-day survival rate after IHCA. Finally, through statistical analyses and comparisons, the clinical characteristics of IHCA patients were analyzed, and the factors influencing ROSC and 30-day survival after IHCA were summarized.

### *Statistical methods*

SPSS 26.0 was used for statistical analysis. Normally distributed, continuous data are presented as mean ± standard deviation (SD), non-normally distributed, continuous data are presented as median (first, third quartiles), and categorical data are presented as frequencies and percentages. For comparison between groups, Student's t-test was used for normally distributed continuous variables with equal variances, while Welch's t-test was applied for normally distributed continuous variables with unequal variances. Mann–Whitney U test was used for non-normally distributed continuous variables. Chi-square tests were used to compare categorical variables between groups. Univariate analysis using t-tests for continuous variables and chi-square tests for categorical variables was performed to identify factors associated with ROSC and discharge survival rate. This approach allowed us to screen for significant differences between groups before further analysis. Variables with $p<0.05$ in a single-factor analysis or which were otherwise considered clinically relevant were included in a multiple-factor logistic regression analysis. For all analyses, a two-tailed $p<0.05$ indicated statistical significance.

**Table 1.** Clinical data and resuscitation measures of patients with IHCA (n=323)

| Variables | Percentage, % | t (for Student's t-test) | p, value |
|---|---|---|---|
| Age | | | |
| <60 years, n=180 | 55.7±2.8 | 2.02 | 0.04 |
| ≥60 years, n=143 | 44.3±2.8 | | |
| Gender | | | |
| Male, n=139 | 43.0±2.8 | 2.48 | 0.01 |
| Female, n=184 | 57.0±2.8 | | |
| Smoking | | | |
| No, n=224 | 69.3±2.6 | 6.84 | <0.001 |
| Yes, n=99 | 30.7±2.6 | | |
| Alcohol | | | |
| No, n=209 | 64.7±2.7 | 5.20 | <0.001 |
| Yes, n=114 | 35.3±2.7 | | |
| Coronary heart disease | | | |
| No, n=164 | 50.8±2.8 | 0.30 | 0.77 |
| Yes, n=159 | 49.2±2.8 | | |
| Hypertension | | | |
| No, n=176 | 54.5±2.8 | 1.60 | 0.11 |
| Yes, n=147 | 45.5±2.8 | | |
| Diabetes | | | |
| No, n=165 | 51.1±2.8 | 0.39 | 0.69 |
| Yes, n=158 | 48.9±2.8 | | |
| The cause of CA | | | |
| Cardiogenic, n=161 | 49.8±2.8 | 0.07 | 0.94 |
| Non-cardiogenic, n=162 | 50.2±2.8 | | |
| Initial heart rhythm | | | |
| Defibrillation, n=159 | 49.2±2.8 | 0.29 | 0.78 |
| Non-defibrillable, n=164 | 50.8±2.8 | | |
| Shockable heart rhythm | | | |
| No, n=91 | 28.2±2.5 | 7.85 | <0.001 |
| Yes, n=232 | 71.8±2.5 | | |
| Defibrillation | | | |
| No, n=146 | 45.2±2.8 | 1.71 | 0.09 |
| Yes, n=177 | 54.8±2.8 | | |
| Emergency endotracheal intubation | | | |
| No, n=196 | 60.7±2.7 | 3.87 | <0.001 |
| Yes, n=127 | 39.3±2.7 | | |

## Results

### *Clinical data*

Etiological analysis of the IHCA patients: 161 cases (49.8%) were due to cardiac causes and 162 cases (50.2%) were due to non-cardiac causes. Initial cardiac rhythm at onset: shockable rhythm in 232 cases (71.8%), non-shockable rhythm in 91 cases (28.2%). The continuous duration of CPR was 28.48±11.72 min. CPR duration ≤30 min in 176 cases (54.5%) and >30min in 147 cases (45.5%). Defibrillation was successfully applied in 177 cases (54.8%); cumulative dose of adrenaline was 3.5±1.9 mg; emergency tracheal intubation in 127 cases (39.3%). See Table 1 for details.

### *Univariate analysis of ROSC and OHCA survival of IHCA patients*

Results of the univariate analysis between the ROSC group and non-ROSC group show statistical significance for age, coronary heart disease, hypertension, CA etiology, initial heart rhythm, presence of shockable rhythm during resuscitation, use of defibrillation, and emergency tracheal intubation ($p<0.001$); univariate analysis between deceased group and surviving group indicates statistical difference in age ($p=0.014$). See Table 2 for details

### *Multifactorial logistic analysis of ROSC in IHCA patients*

Using ROSC as the dependent variable, statistically significant factors identified in the univariate analysis were included in binary logistic regression analysis. The results showed that younger age, non-shockable initial heart rhythm, defibrillation, and emergency endotracheal intubation are independent protective factors for ROSC. See Table 3 for details.

## Discussion

CA is a critical condition with low survival rates. IHCA accounts for 6% to 26% of CA cases, whereas OHCA typically has a survival rate of less than 10% [24]. CPR is an essential intervention for saving CA patients. Research has found that a significant portion of patients who achieve ROSC after CPR may die in the early stages of resuscitation


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**Table 2.** Univariate analysis of IHCA patient data for ROSC and survival after 30 days as outcomes

| Variable | Category | ROSC ratio (%) | | t/$\chi^2$ | p value | Survival after 30 days of IHCA (%) | | t/$\chi^2$ | p value |
|---|---|---|---|---|---|---|---|---|---|
| | | Non-ROSC | ROSC | | | Death | Survival | | |
| Age | <60 | 24 (31.2) | 156 (63.4) | 24.715 | <0.001 | 120 (51.5) | 60 (66.7) | 6.051 | 0.014 |
| | ≥60 | 53 (68.8) | 90 (36.6) | | | 113 (48.5) | 30 ( (3.3) | | |
| Sex | Male | 35 (45.5) | 104 (42.3) | 0.241 | 0.623 | 99 (42.5) | 49 (44.4) | 0.101 | 0.75 |
| | Female | 42 (54.4) | 142 (57.7) | | | 134 (57.5) | 50 (55.6) | | |
| Smoking | NO | 58 (75.3) | 166 (67.5) | 1.698 | 0.193 | 163 (70.0) | 61 (67.8) | 0.145 | 0.703 |
| | Yes | 19 (24.7) | 80 (32.5) | | | 70 (30.0) | 29 (32.2) | | |
| Alcohol | No | 53 (68.8) | 156 (63.4) | 0.753 | 0.385 | 152 (65.2) | 57 (63.3) | 0.103 | 0.748 |
| | Yes | 24 (31.2) | 90 (36.6) | | | 81 (34.8) | 33 (36.7) | | |
| CHD | No | 60 (77.9) | 104 (42.3) | 29.813 | <0.001 | 118 (50.6) | 46 (51.1) | 0.006 | 0.94 |
| | Yes | 17 (22.1) | 142 (57.7) | | | 115 (49.4) | 44 (48.9) | | |
| HP | No | 59 (76.6) | 117 (47.6) | 19.974 | <0.001 | 130 (55.8) | 46 (51.1) | 0.574 | 0.449 |
| | Yes | 18 (23.4) | 129 (52.4) | | | 103 (44.2) | 44 (48.9) | | |
| Diabetes | No | 38 (49.4) | 127 (51.6) | 0.122 | 0.727 | 118 (50.6) | 47 (52.2) | 0.065 | 0.799 |
| | Yes | 39 (50.6) | 119 (48.4) | | | 115 (49.4) | 43 (47.8) | | |
| Cause of CA | Cardiogenic | 60 (77.9) | 101 (41.1) | 31.88 | <0.001 | 117 (50.2) | 44 (48.9) | 0.046 | 0.831 |
| | Non-Cardiogenic | 17 (22.1) | 145 (58.9) | | | 116 (49.8) | 46 (51.1) | | |
| IHR | Defibrillation | 56 (72.7) | 121 (49.2) | 13.12 | <0.001 | 129 (55.4) | 48 (53.3) | 0.108 | 0.742 |
| | Non-defibrillable | 21 (27.3) | 125 (50.8) | | | 104 (44.6) | 42 (46.7) | | |
| DHR | No | 43 (55.8) | 48 (19.5) | 38.254 | <0.001 | 67 (28.8) | 24 (26.7) | 0.14 | 0.708 |
| | Yes | 34 (44.2) | 198 (80.5) | | | 166 (71.2) | 66 (73.3) | | |
| DCPR | | 23.26 ± 9.88 | 30.11±11.80 | -4.614 | <0.001 | 28.46 ± 11.96 | 28.53±11.16 | -0.051 | 0.959 |
| Defibrillation | No | 62 (80.5) | 114 (46.3) | 27.642 | <0.001 | 131 (56.2) | 45 (50.0) | 1.014 | 0.314 |
| | Yes | 15 (19.5) | 132 (53.7) | | | 102 (43.8) | 45 (50.0) | | |
| ETI | No | 67 (87.0) | 129 (52.4) | 29.381 | <0.001 | 145 (62.2) | 51 (56.7) | 0.843 | 0.359 |
| | Yes | 10 (13.0) | 117 (47.6) | | | 88 (37.8) | 39 (43.3) | | |
| Adrenaline | | 2.7 ± 1.8 | 3.7 ± 1.9 | -4.054 | <0.001 | 3.5 ± 1.9 | 3.31 ± 1.7 | 1.028 | 0.305 |

Data are frequency (percentage) or mean ±SD. CHD, coronary atherosclerotic heart disease; HP, hypertension; CA, cardiac arrest; IHR, initial heart rhythm; DHR, defibrillible heart rhythm; HR, heart rate; DCPR, defibrillator cardiopulmonary resuscitation; ETI, emergency tracheal intubation.

due to a unique and complex pathophysiological process known as the "post-CA syndrome" [25]. Therefore, ROSC does not necessarily indicate a good clinical outcome for patients, highlighting the need for simple, convenient, and reliable monitored indicators for prognostic assessment. Despite significant progress in the field of IHCA in both domestic and international studies, the overall prognosis remains poor, with higher incidence rates of IHCA in China compared to international levels and with lower rates of ROSC survival, and lower rates of neurological outcomes [26, 27].

While IHCA receives less attention than OHCA, the epidemiological characteristics and influencing factors differ between the two, emphasizing the importance of studying the epidemiology and influencing factors of IHCPR to improve ROSC rates and patient outcomes. This study retrospectively analyzed the clinical characteristics of IHCA patients and identified key factors influencing CPR success. The results indicated that CPR duration significantly impacts ROSC and discharge survival, with younger age, emergency endotracheal intubation, and lower cumulative adrenaline dose serving as independent protective factors for ROSC.

Previous research suggests that prognosis for CA is generally poorer in elderly patients [28]. This study also found age to be an independent factor affecting IHCA patients, possibly due to increased comorbidities and physiological decline in vital organ function in older patients that reduce tolerance to hypoxia. Studies have indicated that age under 70 years is a favorable factor for ROSC and survival to discharge in CA patients [29]. Gender did not have a significant impact on ROSC or discharge survival in this study. This is consistent with other research results [30], although recent studies suggest a higher 30-day survival rate for females [31]. This may be potentially attributed to the protective effects of female hormones in preventing

**Table 3.** Multifactorial logistic analysis of ROSC in IHCA patients

| Variables | p value | Odds ratio (OR) | 95% CI of OR |
|---|---|---|---|
| Age | <0.001 | 4.519 | 2.375~8.602 |
| CHD | 0.606 | 2.304 | 0.097~55.004 |
| HP | 0.670 | 1.281 | 0.410~4.000 |
| The cause of CA | 0.253 | 0.377 | 0.071~2.005 |
| IHR | 0.020 | 0.393 | 0.178~0.866 |
| DHR | 0.085 | 2.56 | 0.877~7.472 |
| DCPR | 0.850 | 1.267 | 0.109~14.671 |
| Defibrillation | <0.001 | 0.25 | 0.116~0.541 |
| Emergency endotracheal intubation | 0.004 | 0.21 | 0.073~0.600 |
| Accumulated amount of adrenaline | 0.367 | 1.114 | 0.881~1.410 |

CHD, coronary atherosclerotic heart disease; HP, hypertension; IHR, initial heart rhythm; DHR, defibrillible heart rhythm; DCPR, defibrillator cardiopulmonary resuscitation.

ischemia-reperfusion injury and excessive inflammatory response post-resuscitation [32–35].

The primary etiology of CA in this study was cardiac-related factors, and cardiac etiology was an independent predictor of patient survival to discharge [36]. Studies have shown that patients with cardiac etiology have a significantly better prognosis than those with non-cardiac causes of CA [37]. Early identification and appropriate management of these factors can improve survival rates. That study also emphasized the importance of high-quality CPR and timely interventions for improved outcomes [38–41].

Endotracheal intubation in CA patients has not received sufficient attention, as it may impact the delivery of high-quality CPR and timely defibrillation, which are key steps in improving patient outcomes [42–46]. Early studies did not necessarily support the benefits of early intubation for successful resuscitation [47]. However, some reports suggest a beneficial effect of early intubation on the prognosis of CA patients, especially those with non-cardiac causes and non-shockable rhythms [48, 49]. The timing and expertise in performing endotracheal intubation during IHCA require further research for consensus on optimal strategies for improving patient outcomes [50–54].

Adrenaline is commonly used during CPR, with its mechanism of action is primarily targeting alpha-1 receptors to increase peripheral vascular resistance and improve coronary perfusion pressure. However, increased cumulative doses of adrenaline may also increase the likelihood of unsuccessful resuscitation [55–57]. While adrenaline may increase the likelihood of ROSC, it may not significantly improve survival rates or may even worsen neurological outcomes due to adverse effects, such as arrhythmias and increased myocardial oxygen demand. Further research is needed to determine the optimal dosage and clinical application strategies of adrenaline in CA treatment [58].

This study analyzed the clinical characteristics of IHCA patients and key factors influencing resuscitation outcomes, providing valuable data support for optimizing IHCA treatment strategies. To further consolidate these results and explore more effective rescue measures, conducting multicenter studies in the future will be particularly important. Based on the current research findings, suggestions for future work may include strengthening specialized training on CA-related medical knowledge and enhancing medical personnel's familiarity with CPR international guidelines. Additionally, it is necessary to establish clear in-hospital IHCA emergency procedures and optimize existing resource allocations. Simultaneously, a comprehensive CPR training program and assessment system should be implemented to ensure that healthcare providers meet standard rescue skill requirements. Enhancing the monitoring and feedback mechanisms for the quality of CPR execution is equally important, as this will help continuously improve the emergency response process. Finally, for successfully resuscitated patients achieving return of spontaneous circulation (ROSC), standardized follow-up procedures should be implemented to better summarize treatment experiences, improve IHCA patients' ROSC rates, and significantly enhance their overall prognosis.

### *Limitations and advantages*

The limitations of this study are as follows: 1) Due to the small sample size and the retrospective study design with data from a single center, the general applicability and reliability of the results are limited. Secondly, the survival rate of patients after CA at 30 days is low, and the proportion of patients with good neurological function upon discharge is also low. Thus we were unable to identify the factors that affect neurological prognosis. Additionally, the nature of retrospective studies only allows for analysis of existing clinical data, which may lead to issues such as incomplete collection of observational indicators, including the inability to obtain data on the quality of CPR, thereby increasing the limitations of the study. Given these limitations, large-scale, multicenter, prospective studies are required to more comprehensively summarize the relevant experiences and lessons in CPR and further optimize the management strategies for CA.

## Conclusion

In summary, understanding the clinical characteristics and factors influencing outcomes in IHCA patients


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is crucial for enhancing resuscitation outcomes and improving survival rates. Continued research and advancements in CPR techniques, including interventions such as endotracheal intubation and adrenaline administration, are necessary to enhance patient outcomes in IHCA cases.

*No conflicts of interest are reported.*

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