Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Out-of-hospital and in-hospital cardiac arrest of non-cardiac origin: a retrospective two-period comparison at a Slovenia tertiary center

Ema Kocjancic
University of Ljubljana
Anja Jazbec
University Medical Center Ljubljana
Spela Tadel Kocjancic
spela.tadel@kclj.si

University Medical Center Ljubljana

Research Article

Keywords: cardiac arrest, non-cardiac origin, OHCA, IHCA, survival, intensive care

Posted Date: June 25th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-9980924/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

Abstract

Background

Cardiac arrest of non-cardiac origin represents a heterogeneous group of critically ill patients in whom causes, management, and outcomes differ from those of primary cardiac arrest. Data on temporal changes in this population are limited.

Objective

To compare the characteristics, management, and outcomes of patients admitted after non-cardiac-origin cardiac arrest in two time periods, 2010/2011 and 2022/2023, at a tertiary center in Slovenia.

Methods

We conducted a retrospective observational study of consecutive adult patients admitted to the Center for Intensive Internal Medicine after out-of-hospital (OHCA) or in-hospital cardiac arrest (IHCA) of non-cardiac origin. Variables included patient characteristics, arrest features, treatment, and outcomes. Groups were compared using chi-square, Student's t-test, or Mann–Whitney U test.

Results

A total of 306 patients were included (138 in 2010/2011; 168 in 2022/2023). The proportion of admitted cardiac arrest patients classified as non-cardiac origin increased (35,0% vs. 43,1%, p = 0,021). The proportion of OHCA increased (39,9% vs. 55,4%, p = 0,007), while IHCA decreased (60,1% vs. 44,6%, p = 0,007). Bystander CPR increased significantly (23,1% vs. 63,1%, p < 0,001). Diagnostic intensity and ICU length of stay increased. Survival improved after IHCA (30,1% vs. 45,3%, p = 0,048), but overall survival and neurological outcomes did not differ significantly.

Conclusions

In this single-center retrospective study, non-cardiac-origin cardiac arrest represented a distribution shifted toward more out-of-hospital and fewer in-hospital events, while patient age remained similar and the proportion of male patients increased. The later period was characterized by more extensive diagnostic evaluation, greater treatment intensity, and longer ICU stay. Survival improved after in-hospital non-cardiac-origin cardiac arrest, but overall survival and favorable neurological outcome did not improve significantly. These findings suggest that advances in post-arrest evaluation and in-hospital management have not yet translated into better overall outcomes for this heterogeneous patient population.

1. Introduction

Cardiac arrest remains a major cause of mortality worldwide and is among the leading causes of natural death in Europe. It is commonly classified according to location—out-of-hospital cardiac arrest (OHCA) and in-hospital cardiac arrest (IHCA)—and underlying etiology, broadly divided into cardiac and non-cardiac origin. This distinction is clinically important, as mechanisms, management strategies, and outcomes differ substantially (1–3).

While cardiac-origin arrest has been extensively studied, non-cardiac-origin cardiac arrest remains comparatively underexplored due to its heterogeneity. Causes include respiratory failure, infection, trauma, hemorrhage, intoxication, and neurological conditions (1–9). Outcomes are often determined by the severity of the underlying disease rather than the arrest itself (1–3).

Advances in emergency and intensive care medicine have improved survival after cardiac arrest (10–17). At the same time, demographic changes and increasing comorbidity may have altered the epidemiology, potentially increasing the relative burden of non-cardiac causes.

The aim of this study was to compare patients admitted after non-cardiac-origin cardiac arrest in two periods (2010/2011 vs. 2022/2023) at a tertiary center, focusing on characteristics, management, and outcomes.

2. Materials and Methods

Study design and setting

We conducted a retrospective observational cohort study at the Center for Intensive Internal Medicine (CIIM), University Medical Center Ljubljana, a tertiary referral hospital in Slovenia. The study compared two time periods: 1 January 2010 to 31 December 2011 and 1 January 2022 to 31 December 2023.

Study population

We included all consecutive adult patients admitted to CIIM after successful resuscitation from cardiac arrest of non-cardiac origin during the study periods. Both out-of-hospital cardiac arrest (OHCA) and in-hospital cardiac arrest (IHCA) cases were included.

Cardiac arrest of non-cardiac origin was defined as cardiac arrest resulting from a primary non-cardiac condition, including but not limited to respiratory failure, infection or sepsis, hemorrhage, intoxication, or neurological causes. Classification was based on clinical evaluation and available diagnostic data.

Patients with cardiac arrest of primary cardiac origin were excluded. No additional exclusion criteria were applied.

Data collection

Data were extracted retrospectively from the CIIM cardiac arrest registry and electronic medical records. The following variables were collected:

- • Patient characteristics: age, sex
- • Cardiac arrest characteristics: location (OHCA vs. IHCA), witness status, bystander basic life support (BLS), time from emergency call to emergency medical services (EMS) arrival (for OHCA), initial rhythm, and duration of advanced cardiac life support (ACLS)
- • Diagnostic and treatment variables: use of mechanical ventilation, vasopressors/inotropes, antibiotics, hemodialysis, coronary angiography, and imaging studies (head CT, chest/abdominal CT or CT angiography)
- • Post-resuscitation care: temperature management strategy
- • Outcomes: survival to hospital discharge and neurological outcome assessed using the Glasgow–Pittsburgh Cerebral Performance Category (CPC) scale.

Outcomes

The primary outcomes were proportion of non-cardiac-origin cardiac arrest among all admitted cardiac arrest cases and survival to hospital discharge.

Secondary outcomes included distribution of OHCA and IHCA, neurological outcome (CPC 1–2 vs. CPC 3–5) (5), ICU length of stay, changes in diagnostic and treatment practices.

Statistical analysis

Data were analyzed using IBM SPSS Statistics (version 29.0; IBM Corp., Armonk, NY, USA).

Categorical variables are presented as counts and percentages and were compared using the chi-square test or Fisher's exact test (10), as appropriate. Continuous variables are presented as mean ± standard deviation (SD) or median with interquartile range (IQR), depending on distribution.

Normality was assessed using visual inspection of Q–Q plots. For normally distributed variables with homogeneous variances, Student's t-test was used. For non-normally distributed variables or variables with significant outliers, the Mann–Whitney U test was applied.

A two-sided p-value < 0.05 was considered statistically significant.

Given substantial changes in post-resuscitation temperature management between the two periods, formal statistical comparison of temperature management strategies was not performed.

Ethics

The study was approved by the National Medical Ethics Committee of the Republic of Slovenia (approval number: 0120–247/2024-2711-3). Due to the retrospective design and use of anonymized data,

informed consent was waived in accordance with national regulations.

3. Results

3.1 Study population

A total of 306 patients were included: 138 in 2010/2011 and 168 in 2022/2023.

The proportion of admitted cardiac arrest patients classified as non-cardiac origin was significantly higher in 2022/2023 compared with 2010/2011 (43,1% vs. 35,0%, p = 0,021).

Among non-cardiac-origin cardiac arrests, the distribution by location changed significantly (p = 0,007), with a higher proportion of out-of-hospital cardiac arrest (OHCA) in 2022/2023 (55,4% vs. 39,9%) and a lower proportion of in-hospital cardiac arrest (IHCA) (44,6% vs. 60,1%).

The proportion of male patients increased significantly between periods (61,3% vs. 47,1%, p = 0,013), while patient age did not differ significantly (*Table 1*).

Table 1: Patients' characteristics according to sex and location of CA

	2010/2011		2022/2023		All male / all female
	OHCA	IHCA	OHCA	IHCA	
Male	23 (41,8%)	42 (50,6%)	54 (58,1%)	49 (65,3%)	**168** (54,9%)
Female	32 (58,1%)	41 (49,4%)	39 (41,9%)	26 (34,7%)	**138** (45,1%)
All	55	83	93	75	**306**

3.2 Out-of-hospital cardiac arrest (OHCA)

The proportion of non-cardiac-origin OHCA among all non-cardiac cardiac arrests increased significantly between periods (p = 0,007). Bystander basic life support increased markedly from 23,1% in 2010/2011 to 63,1% in 2022/2023 (p < 0,001). Time from emergency call to EMS arrival did not differ significantly between periods (approximately 10 minutes). The distribution of initial rhythms was similar between periods, with pulseless electrical activity and asystole predominating.

Diagnostic intensity increased in 2022/2023, with significantly more frequent use of head CT (p < 0,001) and chest/abdominal CT or CT angiography (p = 0,011).

Mechanical ventilation and vasoactive support were widely used in both periods without significant differences.

Survival after OHCA was numerically lower in 2022/2023 compared with 2010/2011 (25,8% vs. 40,0%), but this difference was not statistically significant (p = 0,071). There were no significant differences in

favorable neurological outcome (CPC 1–2) (*Table 2*).

Table 2: Patients’ characteristics, data on OHCA, treatment and outcome

	S-OHCA 2010/2011	S-OHCA 2022/2023	p value (significant: **p<0,05**)
No. Of pts (% all S-OHCA)	55 (39,9)	93 (55,4)	**0,007**
age (years) ± SD	68,8 ± 14,5	67,6 ± 16,2	0,707
Sex (%)			0,056
male	23 (41,8)	54 (58,1)	
female	32 (58,2)	39 (41,9)	
Data about S-OHCA			
witness (%);	46 (83,6)	75 (80,6)	0,649
lay/none	39 (84,7)	65 (86,7)	
EMS	7 (15,2)	10 (13,3)	
BLS (%)*	9 (23,1)	41 (63,1)	**<0,001**
Time to EMS arrival (mins)± SD	9,6 ± 5,5	9,7 ± 5,25	0,910
Initial rhythm (%)			0,125
PEA	28 (50,9)	53 (57,0)	
Asystole	23 (41,8)	39 (41,9)	
VF	4 (7,3)	1 (1,8)	
ACLS duration (mins) ± SD	15,7 ± 10,6	16,1 ± 12,4	0,878
Treatment			
TTM (%)			/
normothermia	0	52 (55,9)	
hypothermia	39 (70,9)	5 (5,4)	
no TTM	16 (29,1)	36 (38,7)	
Head CT (%)	26 (47,3)	74 (79,6)	**<0,001**
Chest and abdominal CT/CTA (%)	16 (29,1)	47 (50,5)	**0,011**

Coronary angiography (%)	4 (7,3)	6 (6,5)	0,548
Mechanical ventilation (%)	53 (96,4)	93 (100)	0,137
Inotropes/vasopressors (%)	49 (89,1)	83 (89,2)	0,976
Antibiotics (%)	34 (61,8)	62 (66,7)	0,550
Hemodyalisis (%)	2 (3,6)	6 (6,5)	0,710
ICU stay (days) ± SD	4,4 ± 3,7	4,9 ± 4,4	0,513
Outcome			
Survival (%)	22 (40,0)	24 (25,8)	0,071
CPC (%)			/
CPC 1/2	9 (16,4)	11 (11,8)	
CPC 3	3 (5,5)	3 (3,2)	
CPC 4	14 (27,3)	53 (57,0)	
CPC 5	3 (5,5)	9 (9,7)	
missing data	26 (45,5)	17 (18,3)	
Survival CPC 1/2 (%)	9 (16,4)	11 (11,8)	0,435

3.3 In-hospital cardiac arrest (IHCA)

The proportion of IHCA among non-cardiac-origin cardiac arrests decreased significantly between periods (p = 0,007). In both periods, the majority of patients were male, with a higher proportion in 2022/2023.

Diagnostic intensity increased significantly, particularly head CT (p < 0,001) and chest/abdominal CT or CT angiography (p < 0,001). Antibiotic use increased significantly (73,5% vs. 86,7%, p = 0,040).

ICU length of stay was significantly longer in 2022/2023 (5,6 ± 5,5 vs. 3,9 ± 3,8 days, p = 0,022).

Survival improved significantly in the later period (30,1% vs. 45,3%, p = 0,048), although favorable neurological outcome (CPC 1–2) did not differ significantly (*Table 3*).

Table 3: Patients' characteristics, data on IHCA, treatment and outcome

	S-IHCA 2010/2011	Se-IHCA 2022/2023	p value (significant **p<0,05**)
No. of pts (% all S-CA)	83 (60,1)	75 (44,6)	**0,007**
Age (years) ± SD	70,7 ± 13,0	67,8 ± 13,3	0,177
Sex (%)			0,061
male	42 (50,6)	49 (65,3)	
female	41 (49,4)	26 (34,7)	
Data about S-IHCA			
witness (%)	76 (91,6)	71 (94,7)	0,444
Initial rhythm (%)			0,562
PEA	52 (62,7)	51 (68,0)	
Asystole	26 (31,3)	18 (24,0)	
VF	5 (6,0)	6 (8,0)	
ACLS duration (mins) ± SD	10,4 ± 8,3	13,9 ± 13,1	0,228
Treatment			
TTM (%)			/
normothermia	0 (0,0)	46 (61,3)	
hipothermia	44 (53,0)	0 (0,00)	
no TTM	39 (47,0)	29 (38,7)	
Head CT (%)	13 (15,7)	41 (54,7)	**<0,001**
Chest and abdominal CT/CTA (%)	8 (9,6)	40 (53,3)	**<0,001**
Coronary angiography (%)	4 (4,8)	7 (9,3)	0,266
Mechanical ventilation (%)	83 (100,0)	75 (100,0)	/
Inotropes/vasopressors (%)	75 (90,4)	69 (92,0)	0,927
Antibiotics (%)	61 (73,5)	65 (86,7)	**0,040**
Hemodyalisis (%)	6 (7,2)	13 (17,3)	0,051
ICU stay (days) ± SD	3,9 ± 3,8	5,6 ± 5,5	**0,022**
Outcome			

Survival (%)	25 (30,1)	34 (45,3)	**0,048**
CPC (%)			/
CPC 1/2	21 (25,3)	25 (33,3)	
CPC 3	0 (0,00)	6 (8,0)	
CPC 4	22 (25,3)	29 (38,7)	
CPC 5	0 (0,00)	0 (0,00)	
Missing data	40 (49,4)	15 (20,0)	
Survival CPC 1/2 (%)	18 (21,7)	25 (33,3)	0,100

3.4 Combined analysis (all non-cardiac-origin cardiac arrests)

When OHCA and IHCA were analyzed together, the proportion of non-cardiac-origin cardiac arrest among admitted patients increased significantly (p = 0,021).

The shift in location distribution (more OHCA, fewer IHCA) remained significant (p = 0,007), as did the change in sex distribution (p = 0,013).

Diagnostic procedures increased significantly overall, particularly head CT (p < 0,001) and chest/abdominal CT or CT angiography (p < 0,001). The proportion of patients receiving hemodialysis increased (5,8% vs. 12,5%, p = 0,046).

Mean ICU length of stay increased significantly (5,2 ± 4,9 vs. 4,1 ± 3,8 days, p = 0,027).

Despite these changes, there were no significant differences in overall survival (34,5% vs. 34,1%, p = 0,932) and favorable neurological outcome (CPC 1–2) (*Table 4*).

Table 4: Patients' characteristics, data on OHCA/IHCA, treatment and outcome

	S-CA 2010/2011	S-CA 2022/2023	p value (significant:**p<0,05**)
No. Of pts (% all CA)	138 (35,0)	168 (43,1)	**0,021**
Location (%)			**0,007**
IHCA	83 (60,1)	75 (44,6)	
OHCA	55 (39,9)	93 (55,4)	
Age (years)± SD	69,8 ± 13,6	67,7 ± 14,9	0,271
Sex (%)			**0,013**
male	65 (47,1)	103 (61,3)	
female	73 (52,9)	65 (38,7)	
Data about CA			
Witness (%)	122 (88,4)	146 (86,9)	0,692
Initial rhythm (%)			0,591
PEA	80 (58,0)	104 (61,9)	
Asystole	49 (35,5)	57 (33,9)	
VF	9 (6,5)	7 (4,2)	
ACLS duration (mins) ± SD	16,5 ± 21,8	12,5 ± 6,5	0,102
Treatment			
TTM (%)			/
normothermia	0 (0,00)	98 (58,3)	
hypothermia	83 (60,1)	5 (3,0)	
no TTM	55 (39,9)	65 (38,7)	
Head CT (%)	39 (28,3)	115 (68,5)	**<0,001**
Chest and abdominal CT/CTA (%)	24 (17,4)	87 (51,8)	**<0,001**
Coronary angiography (%)	8 (5,8)	13 (7,7)	0,504
Mechanical ventilation (%)	136 (98,6)	168 (100,0)	0,203
Inotropes/vasopressors (%)	124 (89,9)	152 (90,5)	0,856

Antibiotics (%)	95 (68,8)	127 (75,6)	0,188
Hemodyalisis (%)	8 (5,8)	21 (12,5)	**0,046**
ICU stay (days) ± SD	4,1 ± 3,8	5,2 ± 4,9	**0,027**
Outcome			
Survival (%)	47 (34,1)	58 (34,5)	0,932
CPC (%)			/
CPC 1/2	30 (21,7)	36 (21,4)	
CPC 3	3 (2,2)	9 (5,4)	
CPC 4	36 (26,1)	82 (48,8)	
CPC 5	3 (2,2)	9 (5,4)	
Missing data	66 (47,8)	32 (19,0)	
Survival CPC 1/2 (%)	27 (19,6)	36 (21,4)	0,688

3.5 Causes of non-cardiac-origin cardiac arrest

Respiratory causes were the most common etiology in both periods.

- In OHCA, respiratory causes accounted for 67,3% (2010/2011) and 55,9% (2022/2023) cardiac arrests of non-cardiac origin.

- In IHCA, respiratory causes accounted for 45.8% (2010/2011) and 46.7% (2022/2023) cardiac arrests of non-cardiac origin.

The second most common causes were infections and sepsis not originating in the respiratory system.

Other causes included poisoning and overdose (including suicide attempts), hemorrhagic shock, neurological conditions. These causes were less frequent and varied between periods.

5. Discussion

Principal findings

In this single-center retrospective study, we observed that non-cardiac-origin cardiac arrest accounted for a greater proportion of admitted cardiac arrest cases in 2022/2023 compared with 2010/2011. This change was accompanied by a shift in arrest location, with a higher proportion of out-of-hospital cardiac arrests and a lower proportion of in-hospital events in the later period. We also found increased use of diagnostic investigations and longer ICU stays in 2022/2023. Survival improved after in-hospital non-

cardiac-origin cardiac arrest, whereas overall survival and neurological outcomes did not differ significantly between the two periods.

Changing profile of non-cardiac-origin cardiac arrest

The observed increase in the proportion of non-cardiac-origin cardiac arrest among admitted patients may reflect broader changes in patient populations and healthcare systems. Advances in the prevention and treatment of cardiovascular disease may have reduced the relative burden of primary cardiac arrest, while improved survival of patients with chronic and complex conditions may increase susceptibility to secondary causes of cardiac arrest, such as infection or respiratory failure.

The shift from predominantly in-hospital to more out-of-hospital events is notable. One possible explanation is improved recognition and management of clinical deterioration in hospitalized patients, resulting in fewer in-hospital arrests (10, 19). At the same time, increased survival after out-of-hospital resuscitation may lead to a higher number of patients being admitted after OHCA.

Prehospital care and bystander resuscitation

A key finding of our study is the marked increase in bystander basic life support in OHCA. This likely reflects improvements in dispatcher-assisted cardiopulmonary resuscitation, public education, and awareness of cardiac arrest recognition. Increased bystander intervention is known to improve survival to hospital admission (6) and may partly explain the higher proportion of OHCA patients admitted in the later period.

Despite these improvements, the time from emergency call to arrival of emergency medical services did not change significantly. This suggests that system-level constraints, including geographic and organizational factors, remain important determinants of prehospital care and may limit further improvements in outcomes.

In-hospital management and outcomes

We observed a substantial increase in diagnostic intensity in the later period, particularly in the use of computed tomography. This likely reflects both improved availability of imaging and greater emphasis on identifying reversible causes of cardiac arrest. Similarly, increased use of antibiotics and organ support therapies suggests more aggressive and comprehensive post-arrest management.

Survival after in-hospital non-cardiac-origin cardiac arrest improved significantly in 2022/2023. This may be attributable to earlier recognition, rapid initiation of advanced life support, and improvements in critical care management. However, overall survival and favorable neurological outcomes did not improve significantly across the entire cohort.

One possible explanation is that many determinants of outcome, particularly in OHCA, occur before hospital admission. Delays in recognition, variability in bystander response, and prolonged low-flow or

no-flow states may result in irreversible injury that cannot be fully mitigated by in-hospital care. In addition, patients with non-cardiac-origin cardiac arrest often have severe underlying disease, which limits the potential for recovery despite optimal treatment.

Comparison with previous studies

Our findings are broadly consistent with previous studies reporting that non-cardiac-origin cardiac arrest is associated with heterogeneous etiologies and generally poorer outcomes compared with cardiac-origin arrest (1, 2, 4, 5). Respiratory and infectious causes were the most common etiologies in our cohort, in line with prior literature. However, direct comparisons between studies are challenging due to differences in case definitions, inclusion criteria, and healthcare system organization.

Clinical implications

Our results highlight several important aspects of care. First, improvements in prehospital response, particularly bystander resuscitation, appear to increase the number of patients who survive to hospital admission. Second, advances in in-hospital management may improve outcomes for selected groups, particularly IHCA. However, these improvements have not translated into better overall survival or neurological outcomes, underscoring the need for further advances across the entire chain of survival.

Future research should focus on identifying modifiable factors in prehospital care, optimizing post-resuscitation management, and better characterizing subgroups of non-cardiac-origin cardiac arrest that may benefit from targeted interventions.

6. Conclusion

In this single-center retrospective study, non-cardiac-origin cardiac arrest accounted for a larger proportion of admitted cardiac arrest cases in 2022/2023 compared with 2010/2011, with a shift toward more out-of-hospital and fewer in-hospital events. Diagnostic evaluation and treatment intensity increased over time, accompanied by longer ICU stays. Survival improved after in-hospital non-cardiac-origin cardiac arrest, whereas overall survival and favorable neurological outcomes did not change significantly. These findings highlight the persistent challenges in improving outcomes in this heterogeneous patient population and emphasize the importance of further advances across the entire chain of survival.

7. Limitations of our study

This study has several limitations. First, it was a retrospective single-center study based on patients admitted to one tertiary intensive care unit, which limits generalizability and does not allow national-level conclusions. Second, only patients who survived long enough to be admitted to CIIM were included, so the findings reflect a selected post-resuscitation cohort rather than all non-cardiac-origin cardiac arrests. Third, some variables were missing or estimated, particularly prehospital timing data and CPC data in

the earlier period. Fourth, changes in post-arrest care between the two periods, especially temperature management and the later introduction of routine neuroprognostication, reduce comparability of neurological outcomes. Finally, the population was heterogeneous with respect to etiology, which limits causal interpretation and may have obscured subgroup-specific differences.

Declarations

Author Contribution

All authors collected data.S.T.K. : idea, design, interpretation of data, draft and revisionE.K. aquisition, analysis, draftS.T.K and A.J. reviewed the manuscript.

Data Availability

The data that support the findings of this study are available from Cardiac arrest registry (University Medical center Ljubljana, Department for intensive internal medicine), but restrictions apply to the availability of these data, data cannot be shared openly to protect study participant privacy, and so are not publicly available. The data are, however, available upon request and with the permission of University Medical center Ljubljana, Department for intensive internal medicine.

References

1. Kitamura T, Kiyohara K, Sakai T, Iwami T, Nishiyama C, Kajino K, et al. Epidemiology and outcome of adult out-of-hospital cardiac arrest of non-cardiac origin in Osaka: a population-based study. BMJ Open. 2014;4(12):e006462.
2. Kuisma M, Alaspää A. Out-of-hospital cardiac arrests of non-cardiac origin. Epidemiology and outcome. Eur Heart J. 1997;18(7):1122–8.
3. Laver S, Farrow C, Turner D, Nolan J. Mode of death after admission to an intensive care unit following cardiac arrest. Intensive Care Med. 2004;30(11):2126–8.
4. Hess EP, Campbell RL, White RD. Epidemiology, trends, and outcome of out-of-hospital cardiac arrest of non-cardiac origin. Resuscitation. 2007;72(2):200–6.
5. Moriwaki Y, Tahara Y, Arata S, Toyoda H, Kosuge T, Iwashita M, et al. Out-of-hospital cardiac arrest due to non-cardiac causes. Resuscitation. 2008;77:S52.
6. Gräsner JT, Wnent J, Herlitz J, Perkins GD, Lefering R, Tjelmeland I, et al. Survival after out-of-hospital cardiac arrest in Europe - Results of the EuReCa TWO study. Resuscitation. 2020;148:218–26.
7. Stankovic N, Holmberg MJ, Høybye M, Granfeldt A, Andersen LW. Age and sex differences in outcomes after in-hospital cardiac arrest. Resuscitation. 2021;165:58–65.

8. Andersen LW, Holmberg MJ, Berg KM, Donnino MW, Granfeldt A. In-Hospital Cardiac Arrest: Rev JAMA. 2019;321(12):1200–10.
9. Tadel S, Horvat M, Noc M. Treatment of out-of-hospital cardiac arrest in Ljubljana: outcome report according to the Utstein style. Resuscitation. 1998;38(3):169–76.
10. Sandroni C, Nolan J, Cavallaro F, Antonelli M. In-hospital cardiac arrest: incidence, prognosis and possible measures to improve survival. Intensive Care Med. 2007;33(2):237–45.
11. Hypothermia after Cardiac Arrest Study Group. Mild therapeutic hypothermia to improve the neurologic outcome after cardiac arrest. N Engl J Med. 2002;346(8):549–56.
12. Nielsen N, Wetterslev J, Cronberg T, Erlinge D, Gasche Y, Hassager C, et al. Targeted temperature management at 33°C versus 36°C after cardiac arrest. N Engl J Med. 2013;369(23):2197–206.
13. Le May M, Osborne C, Russo J, So D, Chong AY, Dick A, et al. Effect of Moderate vs Mild Therapeutic Hypothermia on Mortality and Neurologic Outcomes in Comatose Survivors of Out-of-Hospital Cardiac Arrest: The CAPITAL CHILL Randomized Clinical Trial. JAMA. 2021;326(15):1494.
14. Kirkegaard H, Søreide E, de Haas I, Pettilä V, Taccone FS, Arus U, et al. Targeted Temperature Management for 48 vs 24 Hours and Neurologic Outcome After Out-of-Hospital Cardiac Arrest: A Randomized Clinical Trial. JAMA. 2017;318(4):341–50.
15. Lascarrou JB, Merdji H, Le Gouge A, Colin G, Grillet G, Girardie P, et al. Targeted Temperature Management for Cardiac Arrest with Nonshockable Rhythm. N Engl J Med. 2019;381(24):2327–37.
16. Dankiewicz J, Cronberg T, Lilja G, Jakobsen JC, Levin H, Ullén S, et al. Hypothermia versus Normothermia after Out-of-Hospital Cardiac Arrest. N Engl J Med. 2021;384(24):2283–94.
17. Nolan JP, Sandroni C, Böttiger BW, Cariou A, Cronberg T, Friberg H, et al. European Resuscitation Council and European Society of Intensive Care Medicine guidelines 2021: post-resuscitation care. Intensive Care Med. 2021;47(4):369–421.
18. McHugh ML. The chi-square test of independence. Biochem Med. 2013;23(2):143–9.
19. Hosomi S, Zha L, Kiyohara K, Kitamura T, Irisawa T, Ogura H, et al. Survival following an out-of-hospital cardiac arrest in Japan in 2020 versus 2019 according to the cause. Acute Med Surg. 2022;9(1):e777.