Out-of-Hospital Cardiac Arrest in the Karlovy Vary Region in 2023: An Utstein-Style Report

Viktorie Šimečková[1,2], Lýdie Klempová[1], Pavel Provazník[1], Václav Budín[1], Iveta Šejbová[1], Adam Gabriel[1], Michal Klapuch[1], Gustav Sosnovec[1], Jiří Smetana[1], Roman Sýkora[1,3,4], David Peřan[1,3,5]

[1]Emergency Medical Services of the Karlovy Vary Region, Karlovy Vary, Czech Republic
[2]Faculty of Biomedical Engineering, Czech Technical University in Prague, Kladno, Czech Republic
[3]Department of Anaesthesia and Intensive Care Medicine, Charles University, Third Faculty of Medicine and FNKV University Hospital, Prague, Czech Republic
[4]Air Rescue Service and Emergency Medicine Department Pilsen-Line, Military Medical Agency, Czech Republic
[5]Emergency Medical Services of Zlin Region, Zlin, Czech Republic

Introduction: The Emergency Medical Services (EMS) of the Karlovy Vary Region, serving over 295,000 residents, faces the critical challenge of managing out-of-hospital cardiac arrests (OHCA). Effective cardiopulmonary resuscitation (CPR) is essential for survival, requiring coordinated efforts from dispatch to first responders. This article analyses the quality of CPR in 2023 using the Utstein protocol, following an internal audit that introduced a feedback system to enhance outcomes.

Methods: This study retrospectively examines the 2023 Cardiac Arrest Registry of the Karlovy Vary Region using the 2024 Utstein template. Data were analysed with descriptive statistics and verified with defibrillator and GPS records. The closed registry adheres to strict data protection standards, with reports presented anonymized.

Results: The primary outcome of OHCA, defined as survival to hospital admission, was 36 %. The secondary outcomes, defined as survival to discharge or 30 days, were 15.1 % with a good neurological outcome at discharge or 30 days (CPC 1 or 2) in 12.2 %.

Discussion: The results of this study indicate that the EMS of the Karlovy Vary Region is performing well in several areas, with outcomes that surpass the Czech Republic average reported in the EuReCa TWO and ONE studies, particularly in terms of survival rates and neurological outcomes. This suggests that the local methods for managing out-of-hospital cardiac arrests are effective and that improved coordination and quicker responses might be key contributing factors.

Conclusion: In 2023, the incidence of OHCA was 133 per 100,000 inhabitants, with a resuscitation rate of 43.9 %. Layperson CPR was frequently initiated. Survival to hospital admission was 36 %, while survival to discharge or 30 days was 15.1 %. A good neurological outcome was achieved in 12.2 % of cases.

Key words: cardiopulmonary resuscitation, out-of-hospital cardiac arrest, Utstein protocol, epidemiology.

Mimonemocniční srdeční zástava v Karlovarském kraji v roce 2023

Úvod: Zdravotnická záchranná služba Karlovarského kraje (ZZS KVK), poskytující péči na území kraje o 295 000 obyvatelích, se potýká s problematikou mimo nemocniční zástavy oběhu (OHCA). Efektivní kardiopulmonální resuscitace (KPR) je zásadní pro přežití pacientů a vyžaduje koordinovanou spolupráci od dispečerů až po členy zasahujících výjezdových skupin. Tento článek se zaměřuje na analýzu kvality poskytované KPR v roce 2023 na základě Utsteinského protokolu, na který navazuje nastavení

DECLARATIONS:

Declaration of originality:
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Ethical principles compliance:
The authors attest that their study was approved by the local Ethical Committee and is in compliance with human studies and animal welfare regulations of the authors' institutions as well as with the World Medical Association Declaration of Helsinki on Ethical Principles for Medical Research Involving Human Subjects adopted by the 18th WMA General Assembly in Helsinki, Finland, in June 1964, with subsequent amendments, as well as with the ICMJE Recommendations for the Conduct, Reporting, Editing, and Publication of Scholarly Work in Medical Journals, updated in December 2018, including patient consent where appropriate.

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VS: Investigation, Data Curation, Writing – Original Draft; **LK:** Investigation, Writing – Review & Editing; **PP:** Investigation, Writing – Review & Editing; **VB:** Investigation, Writing – Review & Editing; **IŠ:** Investigation, Writing – Review & Editing; **AG:** Investigation, Writing – Review & Editing; **MK:** Investigation, Writing – Review & Editing; **GS:** Investigation, Writing – Review & Editing; **JS:** Conceptualization; Supervision, Funding acquisition; **RS:** Writing – Review & Editing; **DP:** Conceptualization, Methodology, Formal Analysis, Writing – Original Draft.

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Dr. David Peran, Ph.D., FERC
david.peran@zzskvk.cz

interního auditu a systému zpětné vazby výjezdovým skupinám, který má za cíl přispět ke zlepšení celkových výsledků.
Metody: Studie retrospektivně hodnotí případy srdeční zástavy z roku 2023 za použití standardů Utsteinského protokolu z roku 2024. Data byla analyzována pomocí deskriptivní statistiky a ověřena na základě záznamů z defibrilátorů a GPS dat. Z důvodu ochrany osobních údajů pacientů byla databáze zcela anonymizována.
Výsledky: Primární výstup OHCA, definovaný jako přežití do přijetí do nemocnice, činil 34 %. Sekundární výstup, tj. 30denní přežití, dosahoval 15,1 %. Dobrého neurologického výsledku při propuštění (CPC 1 nebo 2) bylo dosaženo ve 12,2 % případů.
Diskuze: Výsledky studie naznačují, že výjezdové skupiny ZZS KVK dosahují v několika oblastech nadprůměrných výsledků ve srovnání s průměrem České republiky, jak jej dokumentovaly studie EuReCa 1 a 2. Zejména výsledky, jako je přežití a neurologický stav, ukazují na vysokou efektivitu zavedených postupů rozšířené resuscitace. Zlepšení v koordinaci jednotlivých zásahů a zkrácení reakční doby by mohlo přinést další pozitivní vliv na výsledky pacientů.
Závěr: V roce 2023 byla incidence OHCA na území Karlovarského kraje 133 případů na 100 000 obyvatel, přičemž resuscitace byla zahájena ve 43,9 % případů. V mnoha případech byla resuscitace zahájena laickými zachránci. Přežití do přijetí do nemocnice dosahovalo 36 %, zatímco přežití do propuštění z nemocnice činilo 15,1 %. Dobrého neurologického výsledku bylo dosaženo ve 12,2 % případů.

Klíčová slova: kardiopulmonální resuscitace, mimonemocniční zástava oběhu, Utsteinský protokol, epidemiologie.

Introduction

The Emergency Medical Services (EMS) of the Karlovy Vary Region provides pre-hospital emergency care for over 295,000 inhabitants. Although out-of-hospital cardiac arrest (OHCA) is not among the most common emergencies that the EMS in the Karlovy Vary Region responds to, it is certainly one of the most demanding. Timely and high-quality cardiopulmonary resuscitation (CPR) is crucial for improving patient outcomes.

The entire chain of survival depends on several fundamental factors. The process begins in the medical dispatch centre, where trained dispatchers must quickly and accurately locate the incident scene, utilizing tools such as automated mobile locators (AML) or other localization applications. They must also recognize OHCA and provide effective telephone-assisted CPR. As part of a comprehensive system for delivering quality and timely emergency care, the EMS employs a system of first responders. These trained teams or individuals can initiate and promptly administer emergency CPR, including the use of automated external defibrillators (AEDs), until the EMS teams arrive. This coordinated approach ensures that patients receive prompt and effective treatment during the critical moments before professional medical teams reach the scene (1, 2, 3).

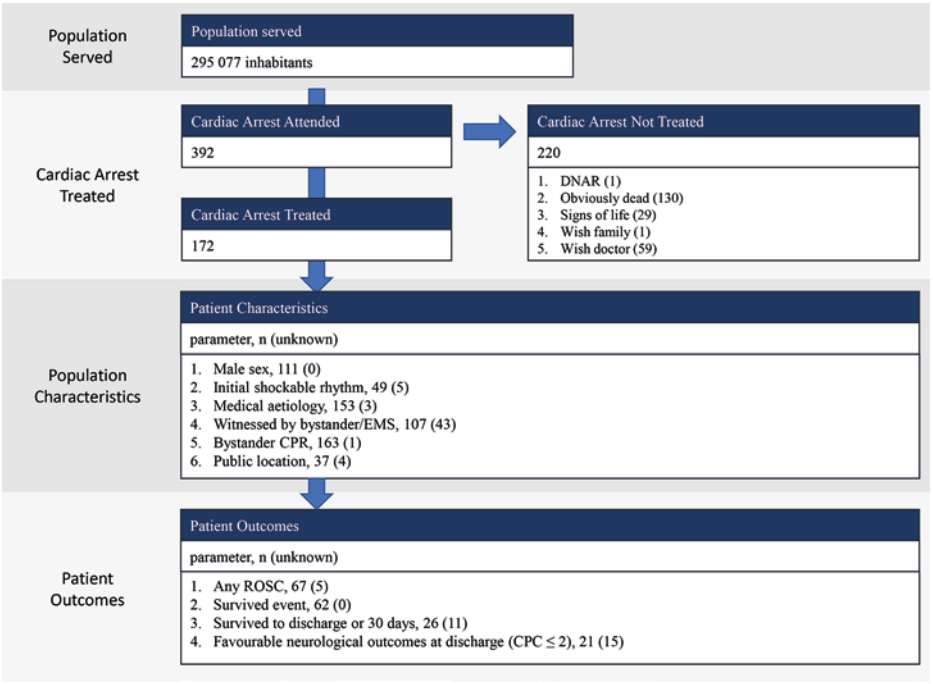
The quality of CPR provided by EMS also significantly impacts the patient's final outcomes (2). To establish recommended CPR guidelines, the EMS of the Karlovy Vary Region conducted an internal quality audit of advanced life support provided by EMS teams. One outcome of this audit was the successful implementation of a feedback system for all healthcare providers attending particular CPR, which began on January 1, 2024, focusing on key aspects of CPR. The primary aim was to create a comprehensive analysis of CPR conducted in 2023, as presented in this article according to the Utstein protocol, which serves as the foundation for all subsequent projects, including the feedback system (4).

Material and methods

This study is a retrospective analysis of the Cardiac Arrest Registry of the Emergency Medical Services of the Karlovy Vary Region for the year 2023 (from January 1st to December 31st). The 2024 update of the Utstein Out-of-Hospital Cardiac Arrest Registry template was used for data collection and presentation. Descriptive statistics were employed to report the epidemiological data, Kolmogorov-Smirnov test of normality was used to determine whether mean and standard deviation or median and interquartile range will be used for data presentation.

Basic information was extracted from patient healthcare records and, when possible, verified against defibrillator records using the Code-Stat software (Physio-Control Corporation/Stryker Corporation, Redmond, U.S.). All times were recorded by healthca-

Fig. 1. *Utstein OHCA flowchart for system effectiveness (attempted resuscitation)*



Tab. 1. *Results presented as core and supplementary items of the 2024 Utstein template*

Dispatch core		
Dispatcher OHCA recognition	yes no unknown not recorded	154 4 14 0
Dispatcher CRP instructions	yes no unknown not recorded	97 73 2 0
Reasons dispatcher instructions NOT provided	CA occurred later CPR in progress landline non cooperating not recognized other EMS third party trapped willing but unable not recorded	22 5 1 4 2 24 5 1 7 2
Dispatch supplemental		
Time to dispatcher OHCA recognition (not recorded in 60 cases)	1:59 (1 : 21; 3 : 10)	
Patient core		
Age	68 (56; 75)	
Sex	male female	111 61
Witnessed arrest	yes, bystander EMS no unknown	65 42 22 43
Arrest location	residence public building street work/office long-term-care sport facility EMS ambulance prison other unknown not recorded	93 9 28 3 13 4 9 2 7 3 1
Bystander CPR	CCO CPR full CPR any bystander w/o additional information no CPR unknown	101 58 4 8 1
Bystander AED use	AED used shock delivered/AED used no shock delivered/AED used unknown shock/AED not used/not recorded	11 7 4 161
First arresting rhythm	VF pulseless VT PEA asystole not recorded	48 1 44 74 5
Presumed cause	medical trauma drowning/electrocution asphyxia Not recorded	153 7 1 8 3
Patient supplemental		
CPR first	bystander person sent to help EMS not recorded	96 16 59 1

re providers through status updates in car computers and were verified in Fleetware software (Radium s.r.o., CZ) using GPS location and timestamps.

The Cardiac Arrest Registry of the Emergency Medical Services in the Karlovy Vary Region is a closed database with restricted access. All data protection regulations are strictly adhered to, and reports like this one are presented without any patient-identifying information.

Results

In 2023, the Emergency Medical Services of the Karlovy Vary Region received 392 calls indicating signs of cardiac arrest, of which 172 patients (43.9 %) were resuscitated. The incidence was 133 cardiac arrests per 100,000 inhabitants. The most common reasons for not continuing layperson CPR were signs of death (33.2 %, n = 130), the decision of the physician on site (15.1 %, n = 59), and the presence of signs of life (7.4 %, n = 29). For further details, refer to the Utstein OHCA flowchart for system effectiveness (attempted resuscitation) in Figure 1 and the Utstein OHCA flowchart for system efficacy (Utstein comparator) in Figure 2.

Layperson CPR was initiated in 94.8 % (n = 163) of cases, with dispatcher-assisted CPR provided in 59.5 % (n = 97). In 101 cases (62 %), chest-only CPR was administered, while full CPR was provided in 58 cases (35.6 %). Data on the type of CPR provided is missing for 4 cases. The reasons for not providing telephone-assisted CPR are detailed in Table 1.

Of the patients, 64.5 % were male, with a median age of 68 years (IQR 1,3: 56; 75). Patient characteristics are further described in Table 1. Fifty-four percent (n = 93) of OHCAs occurred at home, and 62.2 % (n = 107) were witnessed by someone.

The primary outcome of OHCA, defined as survival to hospital admission, was 36 % (n = 62; 0 missing data). The secondary outcomes, defined as survival to discharge or 30 days, were 15.1 % (n = 26; missing data in 11 cases). A good neurological outcome at discharge or 30 days (CPC 1 or 2) was recorded in 12.2 % (n = 21; missing data in 15 cases). Detailed results of the core and supplementary items of the 2024 Utstein protocol are provided in Table 1.

Defibrillated first	AED EMS unknown not recorded	7 55 1 109
Process intra-arrest core		
Response time (from "call answered by EMS" to "EMS arrived at scene")	6:53 (4:44; 10:27)	
Drugs given	yes no	135 37
Process intra-arrest supplemental		
Time to first compression	3:27 (± 1:56)	
Prehospital airway management	none used BMV supraglottic airway endotracheal tube multiple not recorded	3 14 52 95 2 6
Number of shocks	recorded not recorded	65 107
Vascular access type	peripheral i. v. i. o. unkonwn not recorded	143 17 2 10
Mechanical CPR	yes no not recorded	5 161 6
Extracorporeal CPR	yes no	0 172
Outcome core		
Survived event	yes no not recorded	62 110 0
Transported to hospital	yes no	72 100
Survival to discharge or 30 d (out of those transported, n = 72)	yes no unknown	26 35 11
Neurological outcome at discharge or 30 d (out of those handovered to ED, n = 63)	CPC 1 CPC 2 CPC 3 CPC 4 CPC 5 not recorded	20 1 1 0 26 15
Outcome supplemental		
Scene outcome	ROSC CPR in progress deceased	71 1 100
Hospital arrival outcome (out of those who were transported to the hospital, n = 72)	transfer with ROSC transfer with ongoing CPR dead	62 1 9
Organ donation (out of those who were handovered to ED, n = 63)	yes no unknown	4 28 31

Discussion

This analysis is presented according to the updated 2024 Utstein protocol. The primary outcome – survival to hospital admission (36 %) – along with secondary outcomes such as survival to discharge or 30 days (15.1 %) and good neurological outcomes (12.2 %), highlight areas of both success and opportunities for improvement.

The incidence of cardiac arrest reported in the EuReCa TWO study was 88.6 per 100,000 inhabitants (99 per 100,000 in the Czech Republic), compared to 133 per 100,000 in the Karlovy Vary Region (KV). The incidence of CPR provided, as reported in EuReCa TWO, was 56.3 per 100,000 inhabitants (91 per 100,000 in the Czech Republic), compared to 58.3 per 100,000 in the KV. In the EuReCa ONE study, the reported incidence of cardiac arrest and CPR in the Czech Republic was 244 per 100,000 and 104 per 100,000, respectively. In the neighbouring Pilsen Region, the incidence of cardiac arrests was 128.9 per 100,000 inhabitants, with a CPR incidence rate of 88.2 per 100,000 inhabitants, which is higher than that in our region (5, 6, 7).

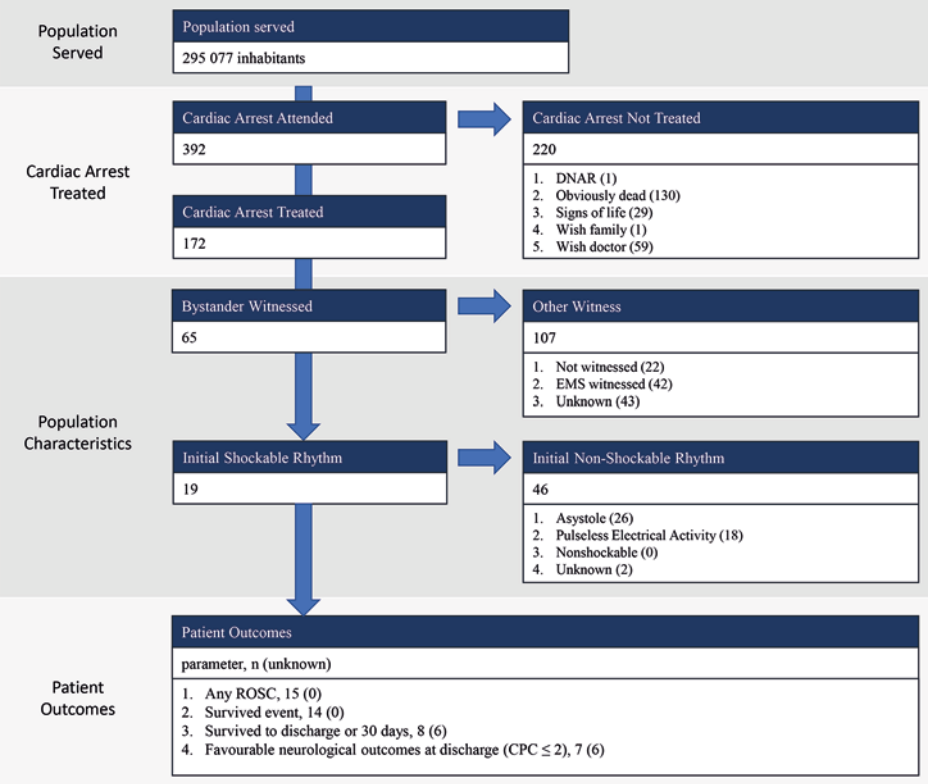
Layperson CPR was initiated in 94.8% of cases in the KV, compared to a 58% rate in Europe as reported in EuReCa TWO (and 82.5% for the Czech Republic) and 48% in EuReCa ONE. Both EuReCa TWO and the ERC 2021 guidelines emphasize the importance of early CPR initiation by bystanders, demonstrating that regions with higher rates of bystander CPR tend to have better survival outcomes. The high rates of layperson CPR and dispatcher assistance in the Karlovy Vary Region are likely key factors contributing to the relatively high survival and neurological outcome rates observed (5, 6).

The median age of 68 years (IQR 1,3: 56; 75) indicates that patients over 80 years were less represented in the study. Initiating CPR in older patients involves ethical considerations and complex medical decision-making processes (8). Fifty-four percent of OHCAs occurred at home, compared to 72.2 % in EuReCa TWO, while 9.4 % of OHCAs occurred on the streets, compared to 16.3 % in the KV. A presumed medical aetiology was reported in 91.1 % of all cases in EuReCa TWO, which is almost identical to our result of 89 % (5, 6).

In the KV, survival to hospital admission was 36 %. In the EuReCa TWO study, hospital survival among patients transported to the hospital, where survival status was known, was 26 %, with a range of 0 % to 48 %. Of those admitted with return of spontaneous circulation (ROSC), 35 % were discharged alive. In the KV, the survival rate for patients transported to the hospital, where survival status was known, was 42.6 %. Of those admitted with ROSC, 36.1 % were discharged alive. Overall survival in all cases where CPR was attempted was 15.1 %, compared to 8 % in EuReCa TWO and 10 % in EuReCa ONE (5, 6).

The Utstein comparator (cardiac arrest witnessed by a bystander and presenting with an initial shockable rhythm) was met in 11% of cases, compared to 13 % in EuReCa TWO. The rate of return of spontaneous circulation (ROSC) for this subgroup was 78.9 %, while overall survival to hospital discharge was 61.5 % for those with known hospital survival status. Among patients

Fig. 2. *Utstein OHCA flowchart for system efficacy (Utstein comparator)*



in the Utstein comparator group, survival to hospital discharge was slightly higher in the KV (42.1 %) compared to 30 % in EuReCa ONE and 31 % in EuReCa TWO (5 ,6).

The results of this study indicate that the EMS of the Karlovy Vary Region is performing well in several areas, with outcomes that surpass the Czech Republic average reported in the EuReCa TWO study, particularly in terms of survival rates and neurological outcomes. This suggests that the local methods for managing out-of-hospital cardiac arrests are effective and that improved coordination and quicker responses might be key contributing factors.

In conclusion, this report provides a comprehensive overview of OHCA outcomes in the Karlovy Vary Region, establishing a baseline for future quality improvement initiatives. Continued efforts to optimize CPR quality, enhance dispatcher-assisted CPR, and improve data accuracy will be essential for advancing patient outcomes in emergency care in this region.

Limitations

Before drawing any definitive conclusions, it is essential to acknowledge the inherent limitations of our study. The database primarily depends on information recorded by healthcare providers, and despite researchers' efforts to verify this data from multiple sources, it remains prone to human error. Additionally, the report contains missing and unknown data that may influence the overall presentation of the findings. As this is a one-year report, trends over time will be more critical for quality improvement than the results from a single year.

Conclusion

In 2023, the EMS of the Karlovy Vary Region handled 392 cardiac arrest cases, with a 43.9 % resuscitation rate and an incidence of 133 per 100,000 residents. Layperson CPR was widely initiated, survival to hospital admission was 36 %, and survival to discharge or 30 days was 15.1 %. A good neurological outcome was achieved in 12.2 % of cases. These results highlight the critical need for ongoing trend monitoring and improvements in CPR quality.

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