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From call to home: The role of dispatcher-assisted CPR in patient survival

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ABSTRACT

Background: Dispatcher-assisted cardiopulmonary resuscitation (DA-CPR) is a key strategy to reduce no-flow time in out-of-hospital cardiac arrest (OHCA), yet its impact on long-term survival remains various across emergency medical systems. *Purpose:* We aimed to evaluate the association between DA-CPR and resuscitation outcomes in a nationwide cohort of OHCA patients presenting with an initial shockable rhythm. *Methods:* We conducted a retrospective observational study including all adult OHCA cases with ventricular fibrillation or pulseless ventricular tachycardia (VF/VT) in which resuscitation was carried out by emergency medical services in Hungary during 2019, 2022, and 2023. Patients were stratified according to whether DA-CPR was ongoing upon ambulance arrival, or initiated by the ambulance crew. Primary outcomes were return of spontaneous circulation (ROSC) and hospital admission with sustained circulation. Utstein-style consensus reporting guidelines were followed. *Results:* A total of 3,674 VF/VT OHCA cases were included, of whom 1,744 (47.5%) received DA-CPR. Patients in the DA-CPR group had significantly higher rates of ROSC (92.0% vs. 12.4%), hospital admission with sustained circulation (90.8% vs. 11.7%), 30-day survival (54.6% vs. 7.1%), and one-year survival (45.8% vs. 6.2%) compared with those

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without DA-CPR (all $P < 0.001$). DA-CPR occurrence increased over time, while declined in 2022 followed by partial recovery in 2023. *Conclusion:* In this nationwide cohort of OHCA patients with shockable rhythms, dispatcher-assisted CPR was strongly associated with improved early resuscitation success and long-term survival. These findings support DA-CPR as a critical system-level intervention and highlight the importance of centralised protocols and continuous performance monitoring.

KEYWORDS

dispatcher-assisted cardiopulmonary resuscitation, out-of-hospital cardiac arrest, emergency medical services, survival analysis

INTRODUCTION

Out-of-hospital cardiac arrest (OHCA) remains a leading cause of sudden death worldwide, with survival highly dependent on the time and quality of early resuscitative interventions. Rapid recognition of cardiac arrest, immediate initiation of cardiopulmonary resuscitation (CPR), and early defibrillation represent the core elements of the chain of survival. Among these, the duration of cardiac arrest prior to the first chest compressions, i.e. the no-flow interval has been consistently identified as a critical determinant of long-term survival and neurological outcome [1].

Dispatcher-assisted CPR (DA-CPR) has been introduced as a system-level strategy to reduce no-flow time by enabling callers or bystanders to initiate CPR under structured telephone guidance [2–4]. Prior studies have demonstrated that DA-CPR substantially increases the rate of bystander CPR and is associated with improved survival compared with cases in which no dispatcher guidance is provided [3, 5]. Accordingly, international resuscitation guidelines endorse DA-CPR as an essential component of organised emergency dispatch systems. Despite these recommendations, the effectiveness of DA-CPR varies considerably between healthcare systems, reflecting differences in dispatcher training, call interrogation protocols, system centralisation, public engagement, and the coordination of prehospital resources [6]. Moreover, many previous investigations have evaluated DA-CPR in heterogeneous OHCA populations, frequently combining shockable and non-shockable rhythms, thereby limiting the interpretability of outcome estimates due to marked prognostic differences between these groups.

Patients presenting with ventricular fibrillation or pulseless ventricular tachycardia (VF/VT) constitute a distinct OHCA subgroup with the highest likelihood of survival [2, 4]. Although early defibrillation remains the cornerstone of successful resuscitation in these cases, growing evidence indicates that uninterrupted, high-quality chest compressions delivered before the arrival of the ambulance may substantially improve myocardial and cerebral perfusion, particularly when defibrillation is delayed. In this context, DA-CPR may play a pivotal role in preserving organ viability during the critical early phase of VF/VT-related cardiac arrest.

Hungary offers a unique national framework for evaluating the system-level impact of DA-CPR. The Hungarian National Ambulance Service (NAS) operates a highly centralised dispatch system with nationwide call reception, unified medical oversight, and standardised dispatcher protocols implemented across 19 county-based dispatch teams. In 2018, NAS introduced digital dispatch documentation and issued a national directive mandating early

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recognition of cardiac arrest and the immediate initiation of bystander CPR through telephone instruction. This directive was further strengthened by a refined standard operating procedure introduced in 2021, supported by comprehensive, system-wide dispatcher training. Dispatch protocols ensure the simultaneous deployment of the closest available NAS unit and the activation of additional advanced life support NAS units when indicated. Nationwide coverage is provided by 202 advanced life support units and 603 basic life support units operating from 256 ambulance stations and 20 emergency service points, enabling uniform implementation of DA-CPR across the country.

The present nationwide study aimed to evaluate the association between dispatcher-assisted CPR and clinical outcomes of adult OHCA patients with an initial shockable rhythm. The primary objective was to compare rates of return of spontaneous circulation and survival between patients who received DA-CPR and those in whom resuscitation was initiated only after the arrival of Hungarian National Ambulance Service units. Secondary objectives included the evaluation of hospital admission with spontaneous circulation, 30-day survival, 1-year survival, and temporal trends across distinct operational periods following the introduction and refinement of national DA-CPR regulations. By focusing on a homogeneous VF/VT population within a centrally regulated ambulance service system, this study seeks to provide robust real-world evidence on the effectiveness of dispatcher-assisted resuscitation at a national level.

METHODS

Study design and population

This retrospective observational study included all adult patients (≥18 years) treated for out-of-hospital cardiac arrest (OHCA) by the Hungarian National Ambulance Service (NAS) during the full calendar years of 2019, 2022, and 2023. The years 2020 and 2021 were deliberately excluded due to substantial system-level disruptions related to the SARS-CoV-2 pandemic, including a documented reduction in emergency calls for cardiac arrest and a decreased willingness for layperson-initiated resuscitation.

Eligible cases were those in which resuscitation was initiated by a NAS unit and the initial cardiac rhythm was documented as ventricular fibrillation (VF) or pulseless ventricular tachycardia (VT) by the first responding NAS unit or by an automated external defibrillator (AED) used by a layperson prior to ambulance arrival. Patients with incomplete documentation, missing personal identification data, or insufficient information to allow reliable linkage between databases were excluded from the analysis.

System description and data sources

See the Appendix.

Variable definitions

Dispatcher-assisted CPR was defined as continuous telephone-guided chest compressions actively ongoing at the time of NAS unit arrival. This definition may underestimate cases in which DA-CPR was initiated but not continued upon the NAS unit's arrival. For the supplementary information describing the dispatcher protocol, see the Appendix.

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Outcome variables were defined in accordance with the Utstein reporting recommendations and included [7]:

- Return of spontaneous circulation (ROSC) at least once during resuscitation,
- Arrival at hospital with sustained spontaneous circulation,
- Survival at 30 days following cardiac arrest,
- Survival at one year following cardiac arrest.

Study cohort and stratification

During the study periods, a total of 72,238 resuscitation attempts were recorded by the Hungarian National Ambulance Service (NAS). Of these, 30,989 cases involved resuscitation initiated by laypersons or emergency response units. A shockable initial rhythm was identified in 4,693 patients. Cases were excluded due to incomplete follow-up documentation, missing personal identifiers, or insufficient data for reliable database linkage. The final study cohort consisted of 3,674 patients (Fig. 1).

Patients were grouped according to the calendar year of cardiac arrest (2019: $n = 1{,}111$; 2022: $n = 1{,}307$; 2023: $n = 1{,}252$). Additionally, the entire cohort was stratified based on whether dispatcher-assisted CPR was provided prior to the arrival of a Hungarian National Ambulance Service unit. Patients classified in the non-DA-CPR group were those in whom chest compressions were not actively ongoing before EMS arrival and resuscitation was initiated by EMS personnel at the scene.

For the supplementary information describing the broader OHCA population, see the Appendix.

Statistical analysis

Descriptive statistics were used to summarise patient characteristics and clinical outcomes. Categorical variables were compared using the chi-squared test or Fisher's exact test, as appropriate. The distribution of continuous variables was assessed using the Shapiro–Wilk test and visual inspection of box plots. As continuous variables were not normally distributed, data are reported as median and interquartile range (IQR) and were compared using the Mann–Whitney *U* test for two-group comparisons and the Kruskal–Wallis test for comparisons across multiple groups. Odds ratios (ORs) with corresponding 95% confidence intervals (CIs) were calculated to quantify the association between dispatcher-assisted CPR and outcome measures. Pairwise comparisons between calendar years were performed using chi-squared tests for categorical outcomes. No multivariable adjustment was performed; therefore, the reported associations should be interpreted with caution. Analyses were performed using Python version 3.10, with inferential statistical testing conducted in IBM SPSS Statistics for Windows, version 30.0 (IBM Corp., Armonk, NY, USA). A two-sided p-value <0.05 was considered statistically significant.

Ethics approval

The study protocol was approved by the competent national ethics authority (approval number: **BM/9299-1/2026**). The study was conducted in accordance with the principles of the Declaration of Helsinki and applicable national regulations. Due to the retrospective, registry-based design of the study, the requirement for informed consent was waived by the ethics committee.

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The data processing workflow, including personal data linkage and pseudonymisation procedures, was reviewed and approved by the competent national ethics authority and was conducted in accordance with the General Data Protection Regulation **(EU 2016/679)** and applicable national data protection legislation.

RESULTS

Baseline characteristics stratified by dispatcher-assisted cardiopulmonary resuscitation (DA-CPR) are presented in Table 1. Patients receiving DA-CPR were slightly younger than those without dispatcher assistance (median age 64 years [IQR 54–72] vs. 67 years [IQR 57–75], $P < 0.001$), although the absolute difference was small. The median age of patients was 63 years (IQR 54–73) in 2019, 64 years (IQR 55–74) in 2022, and 64 years (IQR 54–75) in 2023. No statistically significant difference in patient age was observed across the examined periods ($P = 0.130$)

Male patients predominated in both groups, accounting for 63.3% (1,104/1,744) of cases in the DA-CPR group and 67.7% (1,306/1,930) in the no DA-CPR group ($P = 0.006$).

The location of cardiac arrest differed between groups: among patients receiving DA-CPR, 33.2% (552/1,662) of events occurred in public locations compared with 19.0% (359/1,894) in the no DA-CPR group, whereas arrests without dispatcher assistance were more frequently reported at home (81.0% vs. 66.8%, $P < 0.001$).

Advanced life support units constituted the majority of first responding units in both groups, with ALS involvement observed in 87.6% (1,527/1,744) of dispatcher-assisted cases and 84.2% (1,625/1,930) of cases without dispatcher assistance ($P = 0.004$). The distribution of cases across calendar years showed minor differences between groups ($P = 0.013$).

Table 1. Baseline characteristics of adult out-of-hospital cardiac arrest patients with an initial shockable rhythm according to the presence or absence of dispatcher-assisted cardiopulmonary resuscitation (DA-CPR). Continuous variables are presented as median and interquartile range (IQR); categorical variables as absolute numbers and percentages, *p*-values were calculated using the Mann–Whitney *U* test for continuous variables and the chi-squared test for categorical variables

Characteristic	DA-CPR (n = 1,744)	No DA-CPR (n = 1,930)	p-value
Age, years, median (IQR)	64 (54–72)	67 (57–75)	<0.001
Male sex, n (%)	1,104 (63.3)	1,306 (67.7)	0.006
Location of cardiac arrest, n (%)			<0.001
Home	1,110 (66.8)	1,535 (81.0)	
Public place	552 (33.2)	359 (19.0)	
First responding NAS unit, n (%)			0.004
ALS	1,527 (87.6)	1,625 (84.2)	
BLS	217 (12.4)	305 (15.8)	
Calendar year, n (%)			0.013
2019	516 (29.6)	599 (31.0)	
2022	592 (33.9)	715 (37.0)	
2023	636 (36.5)	616 (31.9)	

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Data on the interval between emergency call initiation and EMS arrival at the scene were available for 3,670 of 3,674 patients (99.9%), allowing reliable assessment of EMS response times within the study cohort. The median interval from call receipt to EMS arrival was 10.3 min (IQR 6.3–16.7) in the DA-CPR group and 11.1 min (IQR 7.1–16.8) in the NO-DACPR ($P = 0.010$).

Thus, patients receiving DA-CPR experienced a modestly shorter EMS response interval, with an absolute median difference of approximately 0.8 min.

However, as information regarding AED availability at the scene is not collected systematically, we identified only 190 cases in which a shock was delivered by a layperson-operated AED before EMS arrival, corresponding to approximately 5.2% of the study population. Due to the unreliability of this data, statistical analysis related to the bystander AED use was not performed.

Association between dispatcher-assisted CPR and clinical outcomes

A total of 3,674 adult out-of-hospital cardiac arrest patients with ventricular fibrillation or pulseless ventricular tachycardia as the initial rhythm were included in the final analysis. Among these, 1,744 patients (47.5%) received ongoing DA-CPR at the time of arrival of the Hungarian National Ambulance Service unit (Group 1), whereas 1,930 patients (52.5%) did not receive DA-CPR and resuscitation was initiated only after ambulance arrival (Group 2).

Return of spontaneous circulation (ROSC) at least once during resuscitation occurred in 91.97% of patients in Group 1, compared with 12.44% in Group 2. This corresponded to a

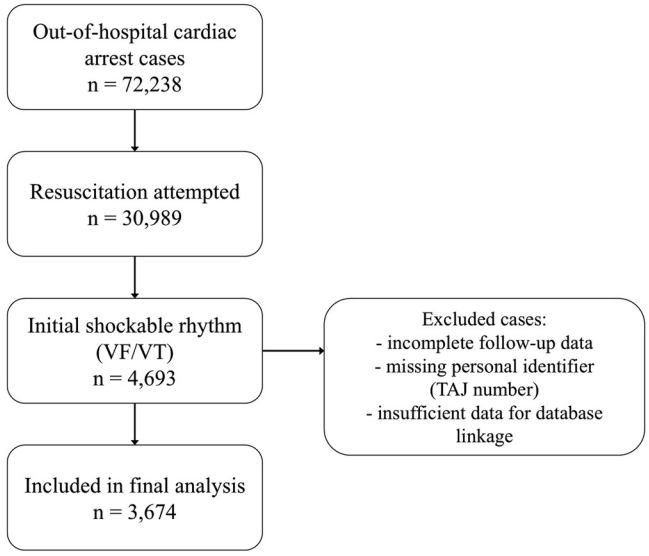


Fig. 1. Flow diagram of patient selection for the study cohort. All adult out-of-hospital cardiac arrest cases recorded by the Hungarian National Ambulance Service during 2019, 2022, and 2023 were screened. Patients with resuscitation attempted and an initial shockable rhythm (ventricular fibrillation or pulseless ventricular tachycardia) were identified. Exclusion criteria included incomplete follow-up data, missing identifiers required for outcome linkage, or insufficient documentation. The final study cohort comprised 3,674 patients included in the analysis

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markedly higher likelihood of ROSC in the DA-CPR group (OR 80.68, 95% CI 64.79–100.47; $P < 0.001$) (Fig. 2A, Table 1).

Similarly, hospital handover with sustained spontaneous circulation was significantly more frequent in patients receiving DA-CPR (90.83%) than in those without DA-CPR, resulting in an odds ratio of 75.78 (95% CI 61.17–93.89; $P < 0.001$) (Fig. 2B, Table 1).

Thirty-day survival was observed in 54.64% of patients in Group 1, compared with 7.10% in Group 2 (OR 15.77, 95% CI 12.94–19.21; $P < 0.001$) (Fig. 2C, Table 1). One-year survival followed a similar pattern, with survival rates of 45.81% in the DA-CPR group and 6.17% in the non-DA-CPR group (OR 12.87, 95% CI 10.45–15.84; $P < 0.001$) (Fig. 2D, Table 1).

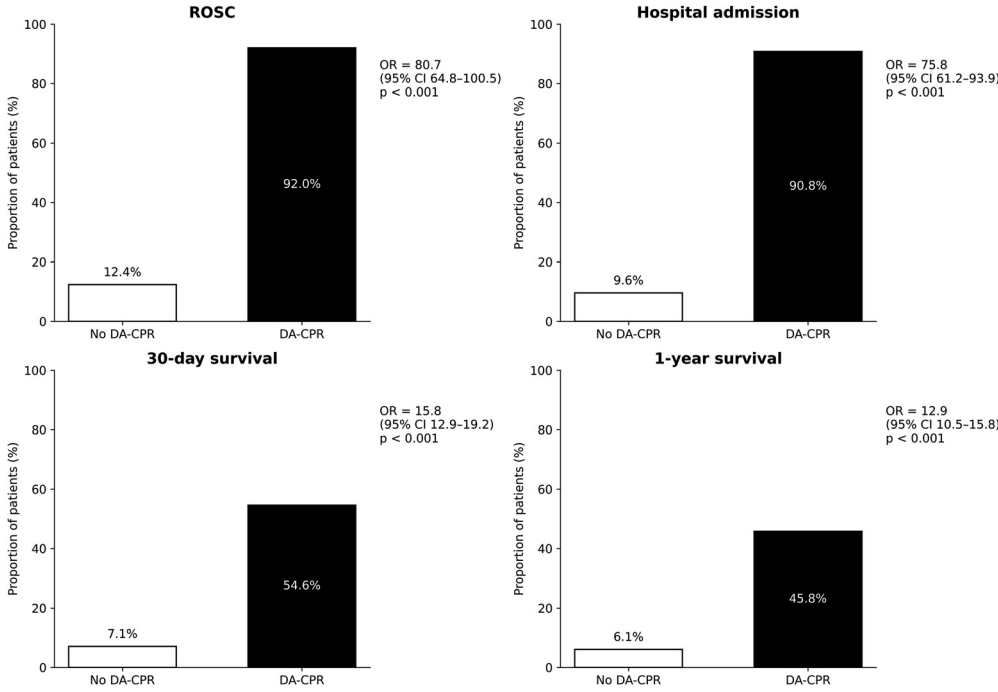


Fig. 2. Association between dispatcher-assisted cardiopulmonary resuscitation (DA-CPR) and resuscitation outcomes in adult out-of-hospital cardiac arrest patients with an initial shockable rhythm (ventricular fibrillation or pulseless ventricular tachycardia).

Panel A shows the proportion of patients achieving at least one return of spontaneous circulation (ROSC) during resuscitation.

Panel B depicts the proportion of patients admitted to hospital with sustained spontaneous circulation.

Panel C illustrates survival at 30 days following cardiac arrest.

Panel D shows survival at 1 year.

Bars represent the percentage of patients with the respective outcome among those who received DA-CPR and those without dispatcher-assisted CPR. Odds ratios (ORs) and corresponding 95% confidence intervals (CIs) were calculated as reported in Table 1

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Temporal trends in dispatcher-assisted CPR and outcomes

Across the study periods, the proportion of cases receiving DA-CPR was 46.28% in 2019, 45.29% in 2022, and 50.80% in 2023. Compared with 2022, DA-CPR utilization in 2023 was higher by 5.51 percentage points, while the increase relative to 2019 was 4.52 percentage points (both $P < 0.001$) (Fig. 3, Table 2).

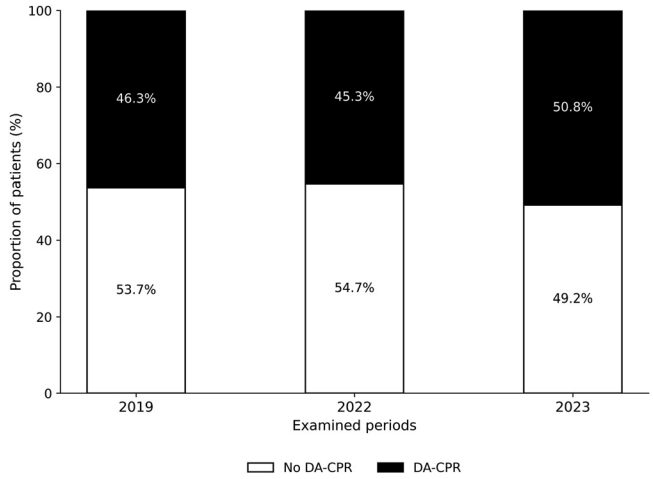


Fig. 3. Temporal distribution of dispatcher-assisted cardiopulmonary resuscitation (DA-CPR) among adult out-of-hospital cardiac arrest patients with an initial shockable rhythm across the examined periods (2019, 2022, and 2023). Bars represent the proportion of cases with and without ongoing DA-CPR at the time of arrival of the Hungarian National Ambulance Service unit within each calendar year. DA-CPR was defined as continuous telephone-guided chest compressions actively ongoing when the ambulance unit arrived at the scene

Table 2. Association between dispatcher-assisted cardiopulmonary resuscitation (DA-CPR) and clinical outcomes in adult out-of-hospital cardiac arrest patients with an initial shockable rhythm. Data are presented as absolute numbers and percentages. Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated using chi-squared tests. ORs refer to the presence versus absence of DA-CPR

Outcome	DA-CPR (n = 1,744) n (%)	No DA-CPR (n = 1,930) n (%)	Odds ratio (95% CI)	p-value
Return of spontaneous circulation (ROSC)	1,604 (92.0)	240 (12.4)	80.68 (64.79–100.47)	<0.001
Hospital admission with sustained circulation	1,584 (90.8)	226 (11.7)	75.78 (61.17–93.89)	<0.001
Survival at 30 days	953 (54.6)	137 (7.1)	15.77 (12.94–19.21)	<0.001
Survival at 1 year	799 (45.8)	119 (6.2)	12.87 (10.45–15.84)	<0.001

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ROSC was achieved in 49.51% of cases in 2019, 48.13% in 2022, and 52.96% in 2023. Accordingly, ROSC rates increased by 4.83 percentage points between 2022 and 2023 and by 3.45 percentage points between 2019 and 2023 (both $P < 0.001$) (Fig. 4A, Table 2). A comparable pattern was observed for hospital admission with sustained circulation, which increased from 47.17% in 2019 and 47.67% in 2022 to 52.56% in 2023, corresponding to absolute increases of 5.39 and 4.89 percentage points, respectively (both $P < 0.001$) (Fig. 4B, Table 2).

In contrast, longer-term outcomes demonstrated a biphasic pattern. Thirty-day survival declined by 21.67 percentage points, from 43.86% in 2019 to 22.19% in 2022, before increasing by 2.65 percentage points to 24.84% in 2023 (Fig. 4C, Table 2). Similarly, one-year survival decreased by 17.14 percentage points, from 36.50% in 2019 to 19.36% in 2022, followed by a

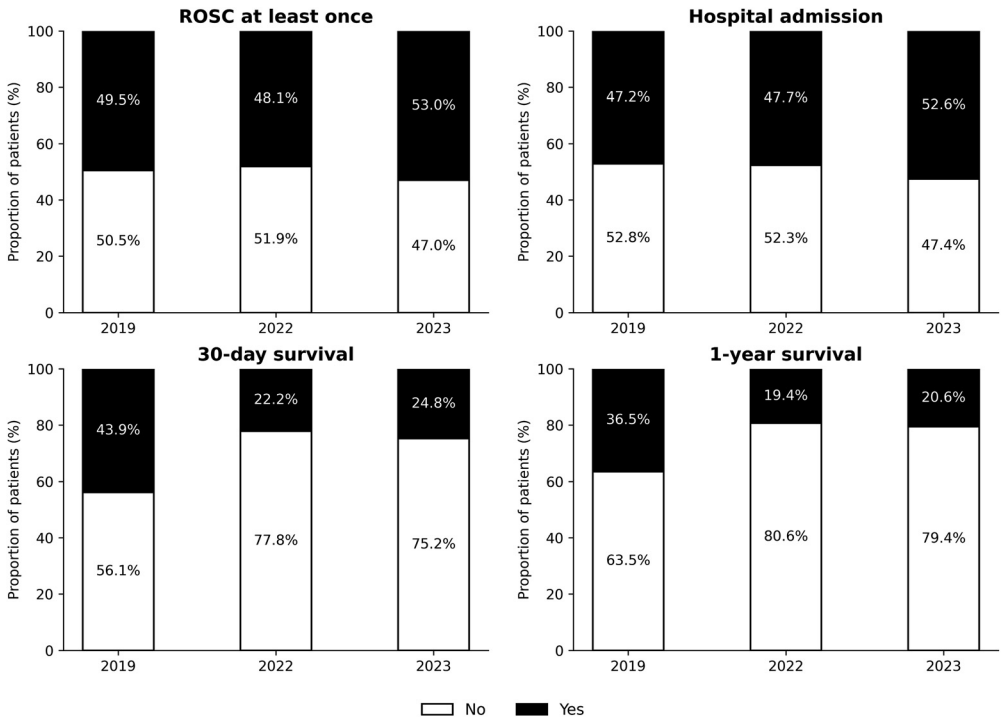


Fig. 4. Temporal trends in resuscitation outcomes among adult out-of-hospital cardiac arrest patients with an initial shockable rhythm (ventricular fibrillation or pulseless ventricular tachycardia) across the examined periods

Panel A shows the proportion of patients who achieved return of spontaneous circulation (ROSC) at least once during resuscitation.

Panel B depicts the proportion of patients delivered to hospital with sustained spontaneous circulation.

Panel C illustrates survival at 30 days after cardiac arrest, and

Panel D shows survival at 1 year.

Bars represent the percentage distribution of patients with and without the respective outcome within each calendar year (2019, 2022, and 2023)

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modest recovery of 1.25 percentage points to 20.61% in 2023 ($P < 0.001$ for comparisons with 2023) (Fig. 4D, Table 2).

DISCUSSION

This nationwide retrospective analysis demonstrates a strong and clinically meaningful association between dispatcher-assisted cardiopulmonary resuscitation (DA-CPR) and improved outcomes in adult out-of-hospital cardiac arrest (OHCA) patients presenting with an initial shockable rhythm. Across the entire study population, DA-CPR was associated with substantially higher rates of return of spontaneous circulation (ROSC), hospital admission with sustained circulation, and survival at both 30 days and one year compared with cases in which resuscitation was initiated only after the arrival of a NAS unit.

The magnitude of the observed differences in early outcomes underscores the central role of dispatcher-assisted bystander intervention in reducing no-flow time [2, 8]. Even within a cohort limited to ventricular fibrillation or pulseless ventricular tachycardia—rhythms with an inherently more favourable prognosis—early initiation of chest compressions appeared decisive in preserving myocardial and cerebral viability until advanced care became available. The exceptionally high rates of ROSC (91.97%) and hospital handover with sustained circulation (90.83%) in the DA-CPR group suggest that early chest compressions alone, independent of immediate defibrillation, may contribute to the likelihood of successful resuscitation once definitive treatment is initiated. However, the magnitude of the observed associations may partly reflect unmeasured confounding.

The temporal improvements observed during the study period likely reflect the gradual nationwide implementation of DA-CPR rather than a single discrete intervention. The Hungarian National Ambulance Service launched a nationwide dispatcher training programme in 2018; however, full implementation was achieved only in early 2021 following completion of dispatcher training and introduction of a standardized national Standard Operating Procedure (SOP). Consequently, progressive dispatcher education, protocol standardization, quality assurance processes, and increasing operational experience may all have contributed to the observed improvements over time. Although alternative system-level factors may also have influenced outcomes, Hungary currently lacks a comprehensive nationwide OHCA registry containing hospital outcome data, allowing their systematic evaluation. Therefore, these factors should be considered possible but unconfirmed contributors to the observed temporal trends.

Although AED use is formally incorporated into dispatcher training and the national DA-CPR protocol, public access defibrillation use remains limited by the absence of a comprehensive national AED registry and variable device availability across the country. In the present study, only 190 patients (5.2%) received AED shocks prior to EMS arrival. This finding suggests that improving AED mapping, accessibility, and integration into emergency dispatch systems may represent an important opportunity for strengthening the early links of the chain of survival.

Our findings are consistent with international observations demonstrating the benefit of DA-CPR, yet the effect sizes observed in the present study exceed those commonly reported in European OHCA registries. For example, data from the EURECA TWO study reported overall survival at hospital discharge of approximately 35% among shockable OHCA patients,

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substantially lower than the 30-day (54.64%) and 1-year (45.81%) survival rates observed in our DA-CPR cohort. Although direct comparison is limited by methodological differences, population structure, and outcome definitions, these findings suggest that the *quality* of DA-CPR implementation at a system level may be as important as the presence of DA-CPR protocols themselves.

Analysis of secondary outcomes across calendar years revealed a more nuanced temporal pattern. While the proportion of DA-CPR increased gradually over time (46.28% in 2019 to 50.80% in 2023), survival metrics showed a pronounced decline in 2022, followed by partial recovery in 2023 [9]. This regression temporally coincides with the post–SARS-CoV-2 period and likely reflects cumulative system stress, including delayed emergency activation, altered bystander behaviour, and strain on both prehospital and in-hospital healthcare resources. Similar post-pandemic regressions in OHCA outcomes have been reported internationally.

Notably, the recovery observed in 2023 was predominantly confined to ROSC and short-term survival, whereas long-term outcomes remained less responsive. This divergence suggests that while prehospital performance and dispatcher effectiveness can rebound relatively quickly, longer-term survival is increasingly shaped by downstream factors beyond the direct control of ambulance services, including intensive care availability, in-hospital mortality, and post-resuscitation complications.

Two organisational factors likely contributed to the favourable primary outcomes observed in this study. First, nationwide implementation of DA-CPR protocols ensured uniform dispatcher performance, early intervention, and consistent guidance across the entire country. Second, the increased emphasis on resuscitation principles—including structured ABCDE assessment and post-resuscitation care—during mandatory national training programmes in 2021–2022 may have enhanced both dispatcher and field-provider effectiveness. Together, these findings highlight leadership-driven centralisation, continuous education, and protocol adherence as powerful quality-improvement tools within systems of care for OHCA [10, 11].

The deterioration in survival outcomes observed in 2022 should be interpreted considering the prolonged and system-wide effects of the COVID-19 pandemic on the chain of survival. Several large observational studies and international OHCA registries have demonstrated that, even beyond the acute phases of the pandemic, survival remained adversely affected by a combination of reduced bystander CPR rates, delayed emergency call activation, prolonged EMS response times, and sustained constraints on hospital and intensive care capacity [12]. Importantly, these disruptions have been shown to persist after the formal resolution of pandemic-related restrictions and may help explain the temporal dissociation observed in the present cohort between increasing DA-CPR utilisation and persistently impaired short- and long-term survival in 2022.

Limitations

Several limitations must be acknowledged. The retrospective observational design precludes causal inference, and residual confounding cannot be excluded. Important variables such as bystander characteristics, bystander response intervals, and CPR quality were not available for analysis. Information regarding AED availability at the scene is not collected systematically, consequently, the present dataset does not permit assessment of whether an AED was available but not used, or whether no AED was accessible to the bystanders.

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Furthermore, the study definition of DA-CPR was based on the presence of ongoing dispatcher-guided chest compressions at EMS arrival. Although this definition reflects operational practice within the Hungarian emergency dispatch system, it does not allow separate evaluation of dispatcher assistance and early bystander CPR as independent contributors to patient outcome. Statistical biases may also arise from differences in the baseline characteristics of each group.

As the pairwise analyses were exploratory and intended to describe temporal patterns within the study population, no formal correction for multiple comparisons was applied. We acknowledge that repeated testing may increase the risk of type I error.

Neurological outcome measures were also unavailable, limiting the assessment of favourable functional survival. Long-term survival was determined using national health insurance records, which may be subject to reporting delays. The lack of detailed data prior to 2019 restricts evaluation of the full impact of earlier organisational directives. Nevertheless, the large nationwide sample size, centralised data collection, and restriction to shockable rhythms resulted in a relatively homogeneous cohort, strengthening internal validity.

A further limitation of the present study is that cases without personal identifiers required for deterministic database linkage could not be included in the long-term survival analyses. As a result, hospital-level outcomes and post-discharge survival could not be assessed for these patients, which may have resulted in selection bias. Specifically, the exclusion of cases without valid identifiers may have led to an over- or underestimation of survival outcomes if the likelihood of missing identifiers was associated with patient characteristics, resuscitation circumstances, or early clinical course. However, the proportion of excluded cases due to missing identifiers was relatively small, and all included patients were managed within a uniformly organised national emergency medical system.

The discrepancy between improving prehospital outcomes and declining long-term survival underscores the limitations of evaluating OHCA care solely from prehospital data. A comprehensive national OHCA registry incorporating hospital treatment variables, neurological outcomes, and long-term follow-up would be essential to identify where patients are lost along the chain of survival and to determine which phases of care offer the greatest opportunity for system-level improvement.

Implications

Dispatcher-assisted CPR appears to be a key determinant of both early and long-term survival in OHCA patients with VF/VT. These findings support continued investment in dispatcher training, protocol refinement, and monitoring performance. Future research should incorporate neurological outcomes and explore strategies to better align prehospital success with sustained in-hospital survival gains [13].

CONCLUSIONS

In a highly standardised, nationally regulated emergency medical system, ongoing dispatcher-supported CPR before EMS arrival was strongly associated with improved early resuscitation outcomes and long-term survival among OHCA patients presenting with shockable rhythms. The findings should be interpreted as reflecting the combined effect of sustained dispatcher

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support and early bystander resuscitation efforts. The operational and professional protocols of the Hungarian National Ambulance Service appear to have met their intended objectives. Ongoing monitoring of DA-CPR performance metrics and long-term outcomes should remain central elements of system level quality assurance.

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APPENDIX
Supplement to the article From Call to Home: The Role of Dispatcher-Assisted CPR in Patient Survival

Relevant National Data
Hungary's territory is 93,000 square km. Hungary's population was 9,700,000 in 2019, and 9,600,000 in 2023.

Emergency medical dispatch and ambulance system characteristics
Hungary operates a nationally centralised emergency medical dispatch system with unified medical governance. All emergency calls are received at a national level and allocated to 19 county-based dispatch teams operating under standardised protocols. During the study period, Hungary implemented a nationwide dispatcher-assisted CPR (DA-CPR) training programme within the National Ambulance Service dispatch system, involving approximately 700 emergency medical dispatch personnel. The programme was launched in 2018 as a face-to-face educational initiative; however, training of the entire dispatcher workforce was not completed by the end of 2019. Following the onset of the COVID-19 pandemic, educational activities were temporarily suspended while online training materials were developed and implemented. Comprehensive nationwide training was ultimately completed in early 2021. At the same time, the final version of the standardized DA-CPR Standard Operating Procedure (SOP) was introduced and became the basis of continuous competency maintenance and quality assurance activities.

These regulations mandate structured caller interrogation, early recognition of cardiac arrest, and the immediate initiation of telephone-guided CPR when cardiac arrest is suspected.

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Dispatch protocols ensure the simultaneous allocation of the closest available Hungarian National Ambulance Service unit and, when indicated, the activation of additional advanced life support (ALS) NAS units. Nationwide prehospital coverage is provided by 202 ALS-level units and 603 basic life support units operating from 256 ambulance stations and 20 emergency service points.

Within the Hungarian National Ambulance Service dispatch system, suspected cardiac arrest calls are managed according to a standardized national protocol. The protocol does not distinguish between callers or bystanders with previous CPR training and those without prior resuscitation experience. Once cardiac arrest is recognized and chest compressions are initiated, dispatch personnel are required to remain in the line and continuously support the resuscitation process until EMS arrival whenever feasible. This includes ongoing guidance, reinforcement of compression quality, encouragement of uninterrupted CPR, and assistance with rescuer rotation or other practical issues that may arise during the resuscitation attempt.

Consequently, in our system, continuous bystander CPR that is actively ongoing at EMS arrival is, by definition, closely linked to continuous dispatcher involvement. In contrast, patients classified in the non-DA-CPR group were those in whom resuscitation was initiated only after EMS arrival and therefore did not receive dispatcher-assisted CPR prior to professional intervention.

Data Sources and Variable definitions

Data were extracted from the Hungarian National Ambulance Service (NAS) digital documentation system (ESETLAP II®, version in operational use during the study period), which records all prehospital interventions nationwide. Data were accessed through a structured SQL-based relational database and processed using Microsoft Power BI Desktop (Microsoft Corp., Redmond, WA, USA) and Python version 3.10 due to the large volume and complexity of records. For the purpose of long-term survival follow-up, patient identifiers (Hungarian social security number, TAJ) were used exclusively within a secured administrative environment to enable deterministic linkage with the National Health Insurance Fund database. Following successful linkage, all direct personal identifiers were permanently removed and replaced by a randomly generated case identifier corresponding to the internal NAS case ID, which contains no personal data and does not allow patient re-identification. The analytical dataset accessible to the investigators therefore contained no directly or indirectly identifiable personal information.

Supplementary information about the broader OHCA population

During the study period, a total of 22,482, 25,262, and 24,494 OHCA cases managed by the Hungarian National Ambulance Service were recorded in 2019, 2022, and 2023, respectively. Resuscitation was attempted in 10,220, 10,708, and 10,061 cases, while shockable rhythms (VF/VT) were identified in 1,115, 1,307, and 1,252 patients. Corresponding ROSC counts were 552, 629, and 663, with 30-day survival observed in 489, 291, and 311 patients and one-year survival in 407, 253, and 258 patients, respectively.

These data provide useful context for interpreting the focused shockable-rhythm cohort and improve comparability with international OHCA registries.

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Table App.1. Case numbers of the broader OHCA population managed by the Hungarian NAS

	2019 (*n*)	2022 (*n*)	2023 (*n*)
TOTAL OHCA	22,482	25,262	24,494
Attempts	10,220	10,708	10,061
VF/VT	1,115	1,307	1,252
ROSC	552	629	663
30 days survival	489	291	311
1 year survival	407	253	258

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