

# Cerebral Performance Category score in patients after out-of-hospital cardiac arrest.

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## Abstract

**OBJECTIVE:** Reporting epidemiological data on prehospital cardiac arrest in the Pilsen Region in 2022. Expression of cardiopulmonary resuscitation success using the Cerebral Performance Category (CPC) score.

**MATERIALS AND METHODS:** The study looked at the survival rate of out-of-hospital sudden cardiac arrest in all patients in whom emergency medical services performed cardiopulmonary resuscitation (CPR). The study covered the period from 1 January 2022 to 31 December 2022. Both electronic and paper medical records were used to obtain data. All cases were evaluated according to Utstein-style guidelines.

**RESULTS:** During the studied period, emergency response teams in the Pilsen Region carried out CPR in 499 cases. The incidence of prehospital CPR was 88.43 cases per 100,000 population. A total of 146 patients (29.26%) were referred to the hospital with spontaneous circulation, and results indicating survival with a good neurological outcome of CPC 1 or 2 were recorded in 48 cases (9.62%). The first monitored rhythm was shockable in 119 cases (23.85%). In this subgroup, ROSC was achieved in 71 cases (59.66%) and 61 of them (51.26%) were referred to hospital. In this study subgroup, a total of 36 patients (30.25%) achieved a good neurological outcome with a CPC score of 1 or 2.

**CONCLUSION:** The study presented epidemiological data on OHCA and prehospital CPR in the Pilsen region in 2022. The data obtained shows a survival rate with good neurological outcome in 9.62% of cases.

**Abbreviations:**

AED	- Automated external defibrillator
BLS	- Basic life support
CPC	- Cerebral performance category
CPR	- Cardiopulmonary resuscitation
DACR	- Dispatcher-assisted cardiopulmonary resuscitation
DNR	- Do not resuscitate
EMS	- Emergency medical service
OHCA	- Out-of-hospital cardiac arrest
PEA	- Pulseless electrical activity
ROSC	- Return of spontaneous circulation

**INTRODUCTION**

Out-of-hospital cardiac arrest accounts for approximately half of heart disease-related deaths and is responsible for up to 20% of all deaths without an apparent external cause in developed countries. The aim of the study was to obtain epidemiological data on the outcomes of cardiopulmonary resuscitation in patients with OHCA in the Pilsen Region in 2022. We consider the Cerebral Performance Category score to be a significant indicator of the success of cardiopulmonary resuscitation. This neurological score indicates patients' ability to take care of themselves in everyday life (Table 1). A Cerebral performance category (CPC) score of 1 or 2 is considered favourable.

The Pilsen Region is a higher territorial administrative unit in the western part of the Czech Republic. The region covers an area of 7,649 km<sup>2</sup> and has 605,388 permanent residents. The population density is 79.1 inhabitants/km<sup>2</sup>. The administrative centre of the Region is the Statutory City of Pilsen, which has 181,240 inhabitants on an area of 137.67 km<sup>2</sup>. The only provider of prehospital emergency care in the Pilsen Region is the Emergency Medical Service (EMS) of the Pilsen Region. On the territory of the region, 45 emergency teams are strategically deployed at 27 bases in continuous operation. A physician is present in 12 of these emergency response teams, working together with paramedics in a rendezvous system.

Physicians are thus active in approximately a third of EMS emergency response teams. The medical operations centre dispatches a physician to all out-of-hospital sudden cardiac arrest events. The benefit of having

a physician present during prehospital cardiopulmonary resuscitation has been investigated in many studies, and most studies have not found significant evidence that having a physician on the team increases the chance of surviving out-of-hospital sudden cardiac arrest (Arntz *et al.* 2008; Olasveegen *et al.* 2009).

**MATERIAL AND METHODS**

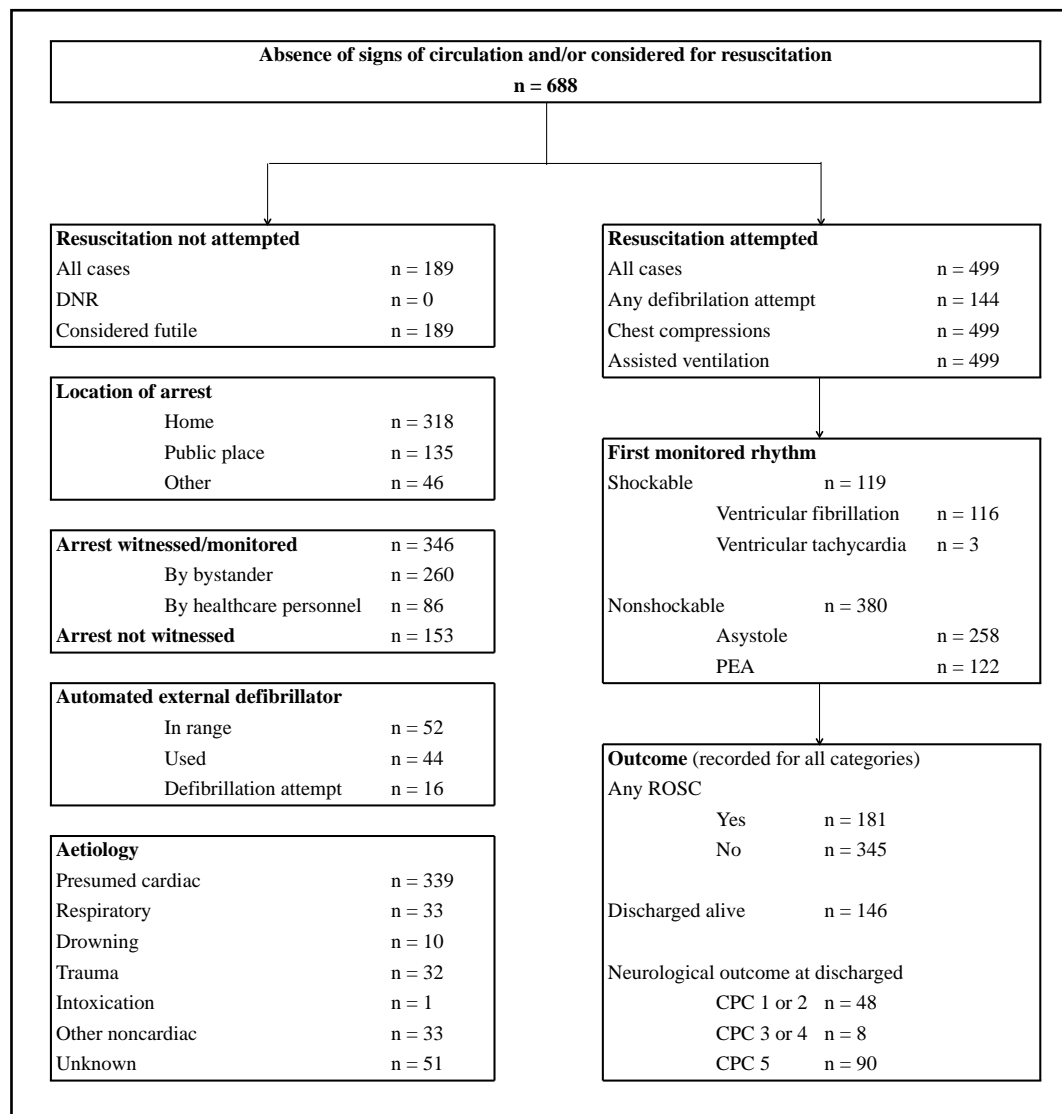
In accordance with current national legislation, the operators of the medical operations centre classify the severity of received emergency calls into four levels. The highest first level of urgency includes conditions in which the patient's basic life functions have failed or are in imminent danger of failing. This category includes, of course, sudden cardiac arrest. The task of the operators is to locate the patient as quickly as possible, recognise the symptoms of sudden cardiac arrest, dispatch the nearest emergency response team as quickly as possible and provide telephone assistance for emergency resuscitation.

If a physician is not present in the nearest emergency team, the medical operations centre must also send the nearest rendezvous vehicle or air ambulance helicopter to the scene. If a first responder is in the vicinity, they will be dispatched to the patient's location. Typically such first responders are a police patrol, fire fighters, a mountain rescue service in the mountains or a water rescue service on a large body of water or in its vicinity; they are equipped with an automated external defibrillator (AED).

Dispatcher-assisted cardiopulmonary resuscitation (DACR) is a standard integral part of the work of medical operations centre dispatchers. The dispatcher plays an important role in the chain of survival by recognizing sudden cardiac arrest, providing telephone assistance for emergency resuscitation, and locating and summoning the nearest AED (Perkins *et al.* 2015). The protocols for implementing DACR have been simplified. As checking the carotid pulse has been shown to be an inaccurate method for detecting cardiac arrest (Tiballs *et al.* 2010), it is now recommended to assess only the state of consciousness and respiration. As gasping breathing can be

**Tab. 1.** Cerebral Performance Category (CPC) score scale

CPC score	Neurofunctional manifestations
1	Good cerebral performance: conscious and alert, able to work, with normal neurological function or only slightly cerebral disability.
2	Moderate cerebral disability: conscious and sufficient cerebral function for independent activities of daily life. Able to work in sheltered environment.
3	Severe cerebral disability: conscious and dependent on others for daily support because of impaired brain function.
4	Coma or vegetative state: any degree of coma without the presence of all brain death criteria. Unawareness, even if appears awake without interaction with environment.
5	Brain death: apnea, areflexia, EEG silence.



**Fig. 1.** Out-of-hospital cardiac arrest summary. CPC - Cerebral performance category DNR - patients with category "do not resuscitate" PEA - pulseless electrical activity ROSC - Return of spontaneous circulation

mistaken for normal breathing (Tanaka *et al.* 2012; Lewis *et al.* 2013), the protocol only requires verification that breathing is regular. If breathing is irregular or not present at all, basic life support (BLS) is initiated. Bystander cardiopulmonary resuscitation should ideally be initiated within 1 minute of a call to the emergency line after rapid recognition of sudden cardiac arrest.

The study included all cases of out-of-hospital cardiopulmonary resuscitation performed by EMS emergency response teams in the territory of the Pilsen Region in the period from 1 January 2022 to 31 December 2022. No exclusion criteria were applied. Data were obtained from the Electronic Patient Record program, ambulance callout records, Cardiopulmonary resuscitation (CPR) protocols and the SOS dispatching program (Per4mance, Brno, Czech Republic). Data were complete for all events assessed. The primary success rate of cardiopulmonary resuscitation was assessed as transferring the patient to the hospital with spontaneous circulation. Secondary

survival of patients was assessed for a period of 30 days after sudden cardiac arrest. The patient's neurological status was assessed using the CPC score (Table 1).

## RESULTS

During the reporting period from 1 January 2022 to 31 December 2022, emergency response teams dealt with 57,995 emergency callouts. All OHCA in 2022 were attended by a physician in the emergency response team. This also completely fulfilled the legal obligation. A total of 688 cases of patients with signs of cardiac arrest were recorded. CPR was not performed on 189 persons by decision of a rendezvous physician. In all cases, the decision not to perform CPR conformed to best practice. No patient was in possession of a written decision freely deciding not to undergo CPR, which is referred to in Czech legislation as a "previously expressed wish". In 2022, emergency response teams performed 499 cardiopulmonary resuscitations throughout the Pilsen Region. In

**Tab. 2.** Dispatcher-assisted cardiopulmonary resuscitation

	No. of such patients [n (%)]	CPC 1 - 2 [n (%)]
Resuscitated	499 (100.0)	48 (9.62)
counsciouss at the time of calling	106 (21.24)	15 (14.15)
uncounsciouss at the time of calling	374 (74.95)	33 (8.82)
dispatcher-assisted CPR - yes	294 (78.61)	27 (9.18)
dispatcher-assisted CPR - no	80 (21.39)	6 (7.5)

CPC - Cerebral performance category, CPR - Cardiopulmonary resuscitation

**Tab. 3.** Comparison of all rhythms and shockable rhythm groups

Basic data	All	Shockable
Resuscitated [n]	494	119
Incidence (rel. to 100,000)	88.43	19.66
Average age [years]	66.34	64.5
Patients with shockable rhythm [n (%)]	119 (23.85)	119 (100.0)
ROSC [n (%)]	181 (36.27)	71 (59.66)
Discharged alive [n (%)]	146 (29.26)	61 (51.26)
CPC 1 - 2 [n (%)]	48 (9.62)	36 (30.25)

340 cases (68.14%) the patients were male, 159 persons (31.86%) affected by OHCA were female. Figure 1 shows a summary of the data.

In 318 cases (63.73%), sudden cardiac arrest occurred at home. There were 135 cases (27.05%) in public place and 46 circulatory arrests (9.22%) in other locations. Of the total 499 sudden cardiac arrests with cardiopulmonary resuscitation, 346 (69.34%) were witnessed and 153 (30.66%) were unwitnessed. At the time of the call to the emergency line of the medical operations centre, 106 patients (21.24%) were conscious. In 374 cases (74.95%) the patient was unconscious. In 19 cases (3.81%), the patient's state of consciousness could not be assessed during the retrospective evaluation of the emergency call. If the patient was unconscious, DACR was performed in 294 cases (78.61%). In 80 cases (21.39%), telephone-assisted resuscitation was not provided. The effect of state of consciousness and provision of DACR on quality survival with CPC 1 or 2 is shown in Table 2.

There may be many reasons why it is not feasible for a medical operations centre dispatcher to perform telephone-assisted emergency resuscitation with a caller. In 24 cases it was due to a third-hand call where the caller was not at the scene. In 15 cases, bystander resuscitation was not initiated due to the caller's advanced age and associated physical limitations, and in 13 cases the caller refused to perform basic emergency resuscitation. In 24 cases, the emergency operator did not recognise the disturbance of consciousness. In 4 cases, the reason for not providing DACR could not be accurately determined retrospectively.

BLS was performed in 346 cases. In 87.86% of cases (n = 304), only chest compressions were performed.

If the patient was unconscious at the time of the emergency call (n=374), a nearby trained first responder was dispatched by the medical operations centre in 74 cases (19.79%). They were always contacted via a phone call or a mobile phone app. An AED was used at the scene in 44 cases. Discharge was then administered in 16 cases. Every year, the number of activations of first responders from the integrated rescue system and volunteers increases. At the same time, the number of cases of AED use is also increasing. In the vast majority of cases, these are mobile AEDs.

After the arrival of the first emergency response team, the first monitored rhythm was shockable in 119 cases (23.85%), i.e. ventricular fibrillation or pulseless ventricular tachycardia. In the remaining 380 cases (76.15%), the first monitored rhythm was non-shockable. ROSC was achieved in 181 patients (36.27%). Of the total 499 resuscitated patients, 146 (29.26%) were delivered with spontaneous circulation to the hospital. 48 patients (9.62%) achieved a CPC score of 1 or 2. If the first monitored rhythm was shockable, ROSC was achieved in 71 cases (59.66%) and then 61 of them (51.26%) were delivered to hospital. In this study subgroup, 36 patients (30.25%) achieved CPC 1 or 2. Comparison of the OHCA results of the all patients group with the subgroup of patients with a shockable rhythm is shown in Table 3.

In most cases, a cardiac cause of OHCA was determined (n = 339, 67.94%). In 33 cases (6.61%) a respiratory cause was determined by the treating physician, in 10 cases (2.0%) it was drowning. Trauma was the cause of 32 cardiac arrests with CPR performed (6.41%). Only 1 case of intoxication was recorded. In another 33 cases (6.61%) it was another cause and in 51 patients

(10.22%) the treating physician could not determine the exact cause of cardiac arrest.

The incidence of all OHCA was 113.65 per 100,000 population and OHCA with CPR performed was 88.43 cases per 100,000 population. In 490 cases (98.2%) it was an adult, in the remaining 9 cases (1.8%) it was a child, i.e. a person under 18 years of age. Men accounted for 68.14% of cases (n = 340) and women 31.86% (n = 159). Patients in the age group 71-80 years (n = 148, 29.66%) were most likely to suffer cardiac arrest. The second largest group was patients aged 61-70 years (n = 103, 20.64%).

## DISCUSSION

Our study confirmed that patients are more likely to survive sudden cardiac arrest if the first monitored rhythm is shockable (Daya et al. 2015; Rea et al. 2021). Therefore, this subgroup of patients is monitored in all studies. Many studies report that ventricular fibrillation occurs as the first monitored rhythm in a minority of cases (Lara et al. 2022; Thibodeau et al. 2022). However, the proportion of cardiac arrests with a shockable rhythm is gradually increasing (Jensen et al. 2022). In the present study, the first monitored rhythm was shockable, i.e. ventricular fibrillation or pulseless ventricular tachycardia, in 23.85% of cases.

ROSC was achieved at the scene in 36.27% of patients in the entire study cohort, regardless of the first monitored rhythm. At 30 days after sudden cardiac arrest, a CPC score of 1 or 2 was achieved in 9.62% of cases. If the first monitored rhythm was shockable, ROSC was achieved in 59.66% of cases and then 51.26% of patients were delivered to the hospital. In this subgroup, CPC 1 or 2 was observed in 30.25% of patients. Our study confirmed observations and data from other authors abroad (Lai et al. 2015; Adnet et al. 2017; Okubo et al. 2017).

In the present study, an early call to the emergency line, recognition of sudden cardiac arrest by the dispatcher, DACR, activation of first responders, and use of an AED were confirmed to increase the chance of survival (Nehme et al. 2014; Stromsoe et al. 2015). Immediate initiation of CPR can increase the chance of survival by as much as two to four times (Wissenberg et al. 2013; Hasselqvist-Ax et al. 2015). Our data show that if the patient was unconscious at the time of the call to the emergency line, BLS was performed in 78.61% of cases. In the period under review, medical operations centre dispatchers did not recognise cardiac arrest in 58 of 374 patients, giving a success rate of 84.49%. According to expert conclusions, it is desirable for dispatchers to be able to recognize 95% of all cardiac arrests if they have sufficient information from the caller (Lewis et al. 2013). New emergency video call technology can contribute to the recognition of sudden cardiac arrest and well-executed telephone-assisted emergency resuscitation.

The results of pilot studies are very promising (Sýkora et al. 2022).

The AED has been one of the major revolutions in the provision of basic cardiopulmonary resuscitation in the 21st century. The use of AEDs has been shown to increase the chance of survival in OHCA (Weisfeldt et al. 2010; Lai et al. 2015). Defibrillation within 3-5 minutes after collapse can lead to survival rates of up to 50-70% (Berdowski et al. 2011; Ringh et al. 2015). Use of the device by bystanders in public is not yet as common, with studies generally reporting an incidence of under 4% (Moon et al. 2015; Kitamura et al. 2016). In the present study, AEDs were used in 44 out of 499 cardiac arrests in the Pilsen Region in 2022, which amounts to 8.82%. This is a significant improvement compared to the 2.1% use rate observed in 2018 (Šín et al. 2021).

Gradual success has been achieved in involving trained first responders in the prehospital CPR system. These are dispatched to the scene of the incident after telephone notification if the dispatcher anticipates that they will arrive before the first emergency response team and thus be able to provide quality CPR sooner, possibly using an AED. In 2022, a first responder was activated by the dispatcher in 19.79% of cases (n=74) if the patient was already unconscious at the time of the emergency line call. This represents a significant increase in first responder activation in the Pilsen Region since 2018 – from 10.8% to 19.79% (Šín et al. 2021). The first responder system mainly involves the integrated rescue system, outpatient medical facilities and some volunteer organisations. The next step is now to involve the general public, with activation via a mobile phone app. Volunteers receive regular training in first aid from EMS staff and are provided with basic equipment.

During the study period majority of OHCA occurred at home (n = 318, 63.73%). This result correlates with data from other studies (Gräsner et al. 2016; Plodr et al. 2016; Adnet et al. 2017). Cardiac arrest occurred in a public place in 27.05% of cases. The most common cause of cardiac arrest was cardiac factors, which affected 67.94% of cases. In this regard, our observations are in line with those of other authors (Franek et al. 2010; Gräsner et al. 2016). Coronary heart disease is one of the most common causes of premature mortality in developed countries (Németh et al. 2023). In young people under the age of 40, sudden cardiac death occurs in 2.4 cases per 100,000 inhabitants of the Czech Republic. In 81% of cases, it affects men and most often occurs during normal daily activities or sleep (Rücklová et al. 2022). After ROSC, in case of non-traumatic sudden cardiac arrest, ECG recording should be standard. Initial examination of the patient by a cardiologist in the hospital then increases the likelihood of detecting acute coronary syndrome as the cause of the condition and increases the chance of survival (Jansky et al. 2023).

Other leading causes of OHCA included respiratory factors and trauma. The category of causes of cardiac arrest undetected and undiagnosed by the physician at the scene certainly includes a larger number of strokes. In the authors' clinical experience, haemorrhagic strokes are more common in younger people. The genetic and molecular mechanisms of cerebral haemorrhage remain incompletely understood. Moving forward, screening for high-risk genes for hereditary cerebral haemorrhage can be applied to identify individuals with a high risk of cerebral haemorrhage, which will effectively reduce the occurrence and progression of the disease (Zhu *et al.* 2022).

## CONCLUSION

The study mapped OHCA and prehospital CPR in the Pilsen region in 2022. The data obtained show internationally comparable survival rates with good neurological outcome (CPC 1 and 2) in 9.62% of cases. If patients' first monitored rhythm is shockable, they have a higher survival rate. Furthermore, our results confirm the positive benefit of standard telephone-assisted emergency resuscitation and a high rate of BLS performance. There has been significant growth in AED use. These are mainly mobile AEDs in the vehicles of the integrated rescue system. It is necessary to continue the established training of medical operations centre dispatchers and members of emergency response teams. Dispatchers should be required to improve their success rate of recognising sudden cardiac arrest. It is still desirable to evaluate the data in accordance with Utstein style recommendations.

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