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Can a Motorcycle Paramedic Increase the Survival of Patients after OHCA?—20 Years of Experience in Ljubljana

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Can a Motorcycle Paramedic Increase the Survival of Patients after OHCA?—20 Years of Experience in Ljubljana

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Abstract: *Background and Objectives:* Despite advancements in modern medicine, the survival rate of patients after out-of-hospital cardiac arrest (OHCA) remains low. The proportion of OHCA patients that could be saved under ideal circumstances is unknown. A significant portion of patients experience cardiac arrest due to irreversible conditions. The survival of patients with reversible causes depends on the prompt initiation of basic life support (BLS) and early defibrillation. In order to increase the chances of survival, the motorcycle paramedic project was implemented in Ljubljana in 2003. The motorcycle paramedic is equipped with an AED. In the case of OHCA with a shockable rhythm, he performs defibrillation before the arrival of the emergency medical team (EMT). The purpose of the research is to determine whether the motorcycle paramedic, by reducing the response time to patients experiencing OHCA, increases the survival rate of these patients. *Materials and methods:* A retrospective analysis of OHCA within the area covered by Ljubljana Emergency Medical Service (EMS) was conducted for the period from January 2003 to December 2022. *Results:* Between January 2003 and December 2022 EMT performed resuscitation on 3352 patients. The motorcycle paramedic was simultaneously activated and arrived at the scene before the EMT in 316 cases. In 16 patients, Return of Spontaneous Circulation (ROSC) was achieved before the arrival of the EMT. The group in which the motorcycle paramedic arrived at the scene before the EMT showed a higher ROSC compared to the other group (44.3% vs 36.9%) and a larger proportion of patients were discharged from the hospital (18.7% vs 13.0%). The proportion of patients with favorable neurological outcomes was also statistically significantly higher (15.9% vs 10.6%, p=0.004). *Conclusion:* The study has demonstrated that the implementation of the motorcycle paramedic into the EMS in Ljubljana has increased the survival rate of OHCA patients.

Keywords: motorcycle paramedic; OHCA; cardiopulmonary resuscitation; Ljubljana

1. Introduction

Despite the progress of modern medicine, survival rates after out-of-hospital cardiac arrest (OHCA) remain low both in Slovenia and around the world [1–3]. The proportion of OHCA patients who could be saved under ideal circumstances is unknown. A significant portion of patients experience sudden cardiac arrest due to conditions that are irreversible. The fate of patients with reversible causes of cardiac arrest depends on the timely initiation of resuscitation procedures. Numerous studies have proven that only two factors influence the survival of OHCA patients: the immediate or as rapid as possible initiation of basic life support (BLS) procedures and early defibrillation [4]. It has been found that OHCA patients have a threefold higher chance of survival with a good neurological outcome if bystanders perform bystander BLS [5]. The same applies to the early use of AEDs, whose utilization in Europe remains low [5].

In order to increase the chances of survival, the motorcycle paramedic project was implemented in Ljubljana in 2003 with the aim of reducing response times. Although the motorcycle paramedic vehicle lacks patient transport capabilities, its shape, size, and speed can shorten response times to

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the patient, which is crucial for a patient in cardiac arrest. Experiences from abroad have shown that the response and access times of motorcycle paramedics are shorter than those of ambulance teams, especially in urban centers [6–9]. Shorter response times have been proven to be associated with higher patient survival rates after OHCA [9,10].

The rescue motorcycle used in Ljubljana is a modified commercial motorcycle [Figure 1]. It is equipped with three blue strobe lights and speakers for emitting audible warning tones. There are three compartments on the motorcycle for storing medical equipment. A stationary VHF radio station, mounted on the handlebars of the motorcycle, is used for communication with the dispatch center. Additionally, a microphone system is integrated into the protective motorcycle helmet for communication during rides [11].

Figure 1. Motorcycle paramedic in Ljubljana (Source: Ambulance Service Ljubljana).

The motorcycle paramedic is activated by the dispatch center in all cases of vital threats, including OHCA or suspicion of it. Besides other equipment, the motorcycle paramedic carries a semi-automatic defibrillator (AED). In the case of OHCA, he initiates BLS procedures and, when dealing with a shockable rhythm, performs early defibrillation – usually even before the arrival of the emergency medical team (EMT).

The work of the motorcycle paramedic has some significant limitations - unfortunately, it is restricted to daylight hours from May to November and good weather conditions. Moreover, due to their nature, motor vehicles are far less crashworthy than enclosed vehicles. They are also less visible to other drivers and pedestrians and are less stable than four-wheeled vehicles [12]. Motorcyclists are more vulnerable to road conditions and weather hazards compared to enclosed vehicle drivers [12]. No one can predict all the hazards motorcycle paramedics might encounter. Therefore, questions and dilemmas often arise, such as: Is it safe enough to include motorcycle paramedics in the emergency medical service system? Does the benefit justify the risk?

The purpose of the study is to determine whether the motorcycle paramedic by reducing response times to OHCA patients increases the survival of these patients.

2. Materials and Methods

Study design: A retrospective analysis of cardiac arrests was conducted in the area primarily covered by the Emergency Medical Service (EMS) of Ljubljana, for the period from January 1, 2003, to December 31, 2022. The study was observational and causal-comparative.

Study setting: The area primarily covered by the EMS of Ljubljana includes not only the City Municipality of Ljubljana but also nine neighboring municipalities. The area spans 904 km² and has a population of 365,000 residents (with the majority residing in the City Municipality of Ljubljana –

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293,000). On working days, the population increases by approximately 150,000 due to daily migrations to the City Municipality of Ljubljana. The EMS in Ljubljana is centralized and single-tiered, with the emergency medical teams always operating from the base (Emergency Department Ljubljana). Until 2020, a doctor accompanied the ambulance, but in 2020, the doctor was withdrawn from the ambulance and now arrives at the scene simultaneously with a dedicated vehicle (urgent doctor's vehicle). A motorcycle paramedic has been part of the EMS since June 1, 2003. He is available from May to the end of October during daylight hours and favorable weather conditions.

Study population: The study included all patients who underwent resuscitation by the EMS Ljubljana during the period from January 1, 2003, to December 31, 2022. The paramedic on a motorcycle was activated when he was available by the health dispatcher in all cases of vital endangerment or merely upon suspicion of it (which also includes OHCA, unconsciousness, severe bleeding…). The study considered interventions by the motorcycle paramedic, who was activated simultaneously with the EMT (interventions where the motorcycle paramedic was activated later were not taken into account). The paramedic on a motorcycle was not available during the nighttime hours, from November to the end of April, and in cases where they were occupied with another intervention.

Data collection: The study utilized health data obtained from records of urgent interventions at the Health Center Ljubljana, Ambulance Service Ljubljana, NMP3000Web Dispatch Center of Health Ljubljana, records from the urgent care clinics at the University Medical Centre Ljubljana, and discharge summaries from hospital departments where treated patients were admitted. Patients for whom health documentation couldn't be obtained were excluded from the study.

Statistical analysis: The statistical analysis was performed using IBM SPSS Statistics, version 29.0.0.0 (241) (IBM, USA) (descriptive statistical analysis, t-test for independent samples and the chi-squared statistical test). A significance level of $p<0.05$ was considered statistically significant.

3. Results

In the period from January 1, 2003, to December 31, 2022, a total of 3352 patients experiencing OHCA were resuscitated within the area covered by EMS Ljubljana. In 355 resuscitations (10.6% of all resuscitations), a motorcycle paramedic was present at the scene of the intervention, with 316 cases (9.4% of all resuscitations) where the motorcycle paramedic arrived at the scene before the EMT. Interventions where the motorcycle paramedic was activated later and arrived at the scene later were not considered in the study.

Tables 1 and 2 present the characteristics of both groups. The groups did not significantly differ in terms of average age, cause of cardiac arrest, and performance of BLS procedures before the arrival of the motorcycle paramedic and/or EMT (Tables 1 and 2). Both groups were predominantly male (in the group where the motorcycle paramedic arrived before the EMT, 76.9%; in the other group, 69.8%), and the majority of cardiac arrests occurred in a home setting (53.0% vs. 63.1%) (Table 1). Significant difference was in the presence of witnesses of the cardiac arrest (71% in the group where the motorcycle paramedic arrived before the EMT vs. 77.6%) (Table 2).

Table 1. Basic characteristics of patients in both groups.

Characteristics	Motorcycle group	Ambulance group	p
Age (years)	63.45±18.2	64,84±17.0	0.170
Male, n (%)	243 (76.9%)	2118 (69.8%)	0.008
Location of OHCA*: Domestic environment, n (%)	167 (53.0%)	1907(63.1%)	<0.001
Non-traumatic cause of OHCA*, n (%)	298 (94.3%)	2902 (95.6%)	0.297

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*OHCA: Out-of-hospital cardiac arrest.

Table 2. Presence of witnesses of the cardiac arrest and performance of BLS procedures before the arrival of the motorcycle paramedic/EMT.

Characteristics	Motorcycle group	Ambulance group	p
Bystanders present, n (%)	223 (71.2%)	2064 (77.6%)	0.012
Performing of BLS*, n (%)	191 (61.8%)	1642 (62.1%)	0.927

*BLS: Basic life support.

In the group where a motorcycle paramedic was present before the arrival of the EMT, the response times (time from the call to arrival at the patient) were significantly shorter (7.70 vs. 9.93 minutes) (Table 3). The proportion of patients where the initial rhythm recorded on the monitor was VF/VT was significantly higher where the motorcycle paramedic was on-site before the arrival of the EMT (36.5% vs. 26.8%) (Table 3).

Table 3. Response times and initial rhythm on the monitor at the beginning of resuscitation.

	Motorcycle group	Ambulance group	p
Response time* (min)	7.70±4.1	9.93±6.5	**<0.001**
Initial rhythm VF/VT**, n (%)	115 (36.5%)	813 (26.8%)	**<0.001**

*Response time: Time from call to patient arrival, **VF/VT: ventricular fibrillation/ventricular tachycardia.

ROSC was achieved in 16 patients before the arrival of the EMT in the group where the motorcycle paramedic was on-site before the arrival of the EMT (5.1%).

In the group where the motorcycle paramedic was on-site before the arrival of the EMT, ROSC was significantly higher (44.3% vs 36.9%, p=0.009). There was also a significantly higher proportion of patients discharged from the hospital (18.7% vs 13.0%, p=0.005) as well as a higher proportion of patients with Cerebral performance category (CPC) 1 or 2 at discharge (15.9% vs 10.6%, p=0.004) (Table 4).

Table 4. OHCA* outcomes.

	Motorcycle group	Ambulance group	P
ROSC**, n (%)	140 (44.3%)	1119 (36.9%)	**0.009**
Discharged from the hospital, n (%)	59 (18.7%)	394 (13.0%)	**0.005**
CPC*** 1 or 2 at discharge, n (%)	50 (15.9%)	321 (10.6%)	**0.004**

*OHCA: Out-of-hospital cardiac arrest. **ROSC: Return of spontaneous circulation. ***CPC: Cerebral performance category.

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4. Discussion

The study has demonstrated that the implementation of the motorcycle paramedic into the EMS in Ljubljana has increased the survival rate of OHCA patients.

The reasons for sudden cardiac arrest are highly diverse. A significant portion of patients experience sudden cardiac arrest due to irreversible causes, which can be acute (such as heart rupture due to an acute myocardial infarction) or a terminal phase of a chronic disease, in which case on-site resuscitation can't be successful. In patients who suffer sudden cardiac arrest due to reversible causes (e.g., arrhythmias during acute myocardial infarction, malignant arrhythmias in accordance with Brugada syndrome or WPW syndrome), resuscitation procedures can be successful, and the patient's outcome can be favorable under the condition that resuscitation procedures are initiated immediately or as quickly as possible, and defibrillation is performed promptly in the case of shockable rhythms [4]. It has been found that a patient with OHCA has three times greater chances of survival with a favorable neurological outcome if bystanders perform BLS procedures [5]. Similarly, early use of an AED has a positive impact, yet its utilization remains relatively low in Slovenia and Europe [5]. Numerous studies have demonstrated that two factors have the most significant influence on OHCA patient survival: immediate or as quick as possible initiation of BLS procedures and early defibrillation of VF/VT rhythms [4].

Despite the progress of modern medicine, survival after OHCA remains low [1–3]. Part of the reason lies in the fact that a significant portion of patients suffer from irreversible conditions where resuscitation efforts can't be successful. The cause of cardiac arrest is often challenging for the on-site EMT to identify during resuscitation, as diagnostic capabilities in the field, despite considerable medical advancements, are still quite limited. The EMT frequently lacks even basic information about the patient's general condition and medical history at the beginning of resuscitation. Another reason for the low survival rate after OHCA is the delay in initiating resuscitation procedures (long response times). The longer the response times and delays in starting resuscitation, the lower the chances of patient survival [9,10].

In Ljubljana, a one-tier EMS has been ingrained for several years, which is incapable of saving the majority of patients with reversible causes of sudden cardiac arrest, unless the arrest happens in the presence of the EMT or in its immediate vicinity. The one-tier system of EMS is a centrally-oriented organization of EMS, where all teams are concentrated and dispatched from the base in Ljubljana. A weakness of such organization lies in the long and unevenly distributed response times of the EMT [13].

With the aim of reducing response times to patients with OHCA in the existing EMS in Ljubljana, the motorcycle paramedic project was introduced in 2003. The idea was not new, as its initial roots can be traced back to 1956 when a neighboring Austrian automobile club introduced roadside assistance using a motorcycle equipped with slightly more advanced equipment for providing aid [11]. The use of rescue motorcycles in the EMS was already known in the second half of the 20th century in several European countries as well as in the USA [11,14]. The Chicago Fire Department, inspired by motorcycle police officers, introduced motorcycle paramedics into their organization in 1979 [14]. The idea was not new in our context either, as in 1994, inspired by successful experiences abroad and on the initiative of a businessperson in Ljubljana, attempts were made to introduce a motorcycle paramedic into the EMS [11]. The motorcycle was provided by the aforementioned businessperson, but it was not as suitable for such activities as today's motorcycles (Figure 2) [11]. The motorcycle paramedic did not use full protective gear and did not have an AED among his equipment.

The first motorcycle paramedic in Ljubljana and Slovenia was paramedic Robert Sabol (Figure 2), who worked as a motorcycle paramedic in his free time for three months in 1994. He carried out 26 interventions, which was insufficient to gain approval from the Ministry of Health for the project [15]. However, in 2003, the motorcycle paramedic was formally introduced into the EMS system in Ljubljana and continues to operate to this day [11].

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Figure 2. Motorcycle paramedic in the past (Robert Sabol) on the left picture and today on the right picture [11].

Motorcycle paramedics in Ljubljana are employed at the Ljubljana Ambulance Service. To work as a motorcycle paramedic, one must meet the required conditions regarding education and work experience as a paramedic, a valid motorcycle license and experiences in motorcycle riding. Before the start of each season, demanding preparations are carried out (safe driving training, physical and psychological preparation) [11].

The study revealed that the average response time of the motorcycle paramedic from the call to patient arrival in cases of sudden cardiac arrest is significantly shorter than the average response time of a conventional ambulance vehicle. This is understandable as the motorcycle paramedic with its size, shape and speed can be much faster, especially in crowded urban areas. This is consistent with data in the literature [6–8]. Consequently, the proportion of patients who has a shockable rhythm on the monitor upon the arrival of the motorcycle paramedic is higher compared to the group without a motorcycle paramedic. In fact, in sixteen patients, the motorcycle paramedic achieved ROSC with early defibrillation before the arrival of the EMT.

Despite the fact that the group where the motorcycle paramedic was on-site before the EMT had a significantly lower proportion of patients with witnesses present at the onset of sudden cardiac arrest, the survival of patients in this group was statistically significantly higher. The proportion of patients achieving ROSC, the proportion of patients discharged from the hospital, and the proportion of patients with favorable neurological outcomes (CPC 1 or 2) were all significantly higher in this group (Table 4).

The study demonstrated that the implementation of the motorcycle paramedic significantly increased patient survival, despite the fact that the motorcycle paramedic was relatively rare (9.4% of cases) on-site before the arrival of the EMS team. There are numerous limitations to the motorcycle paramedic's capabilities. For safety reasons, the motorcycle paramedic is available only from the beginning of May to the end of October, in favorable weather conditions, during daylight hours, and when not occupied with another intervention. Consequently, only a relatively small number of OHCA patients benefit from their services. The study also revealed that the motorcycle paramedic was activated later than the ambulance vehicle for thirty-nine OHCA patients, even though they were available (11% of all motorcycle paramedic activations).

In order to ensure the reduction of response times for as many OHCA patients as possible, it would be necessary to introduce a two-tier EMS system alongside the optimization of activating the motorcycle paramedic. In a two-tier EMS system, emergency ambulances are strategically located across the region according to probabilistic models of emergency incidents. In the case of life-threatening patients (e.g., OHCA), the nearest ambulance or motorcycle paramedic will be dispatched first, arriving in a shorter response time. This, along with the establishment of an effective system of certified first responders, an adequate number of publicly accessible AEDs, and educating and encouraging bystanders by the dispatcher, can significantly shorten the response times to the initiation of resuscitation and early defibrillation in cases of shockable rhythms. This could result in improved chances of survival for those patients who experience sudden cardiac arrest due to reversible causes in the future.

In the 20 years of motorcycle paramedic experiences in Ljubljana, with an average of 500 interventions carried out by motorcycles in each season, there have been no accidents involving motorcycle paramedics resulting in their death or the death of anyone else involved in the accident. There was one traffic accident that resulted in disability for a motorcycle paramedic. There were two accidents where injuries were severe, but the motorcycle paramedics returned to work. Additionally, there were some slips and minor accidents without injuries or with minor injuries to the motorcycle rescuer.

Based on the number of interventions conducted, the incidence of traffic accidents involving motorcycle paramedics in Ljubljana is very low. The research results support the standpoint that a motorcycle paramedic plays an important role in the emergency medical system. With the appropriate selection of experienced motorcyclists, specific defensive driving training, and proper protective equipment, we can minimize the number of accidents and their consequences.

5. Conclusions

The response time to a patient with OHCA and the initiation of resuscitation procedures are of vital importance. The implementation of the motorcycle paramedic in the EMS system in Ljubljana has significantly shortened the response times to these patients. The study has also demonstrated that the implementation of the motorcycle paramedic into the EMS system in Ljubljana has increased the survival rate of OHCA patients despite all limitations.

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References

1. Škufca Sterle M, Kralj E: Out-of-hospital cardiac arrest in Ljubljana: Utsein style and factors influencing the outcome after implementation of the ERC resuscitation guidelines 2015. Resuscitation 2019, 142, e78-e79.
2. Cvitkovič D, Jevšenak-Peršolja M, Klemenčič A, Škufca Sterle M, Stare S: Treatment of out-of-hospital cardiac arrest in Ljubljana: outcome report for nine years (2001-2009). Resuscitation 2010; 81, S36.
3. Grasner J-T, Wnent J, Herlitz J, et al. Survival after out-of-hospital cardiac arrest in Europe – Results of the EuReCa TWO study. Resuscitation 2020, 148, 218-226. https://doi.org/10.1016/j.resuscitation.2019.12.042.
4. Sirikul W, Piankusol C, Wittayachamnankul B, Riyapan S, Supasaovapak J, Wongtanasarasin W, McNally B. A retrospective multi-centre cohort study: Pre-hospital survival factors of out-of-hospital cardiac arrest (OHCA) patients in Thailand. Resusc Plus. 2022, 9, 100196. https://doi.org/10.1016/j.resplu.2021.100196.
5. Gräsner JT, Herlitz J, Tjelmeland IBM, Wnent J, Masterson S, Lilja G, Bein B, Böttiger BW, Rosell-Ortiz F, Nolan JP, Bossaert L, Perkins GD. European Resuscitation Council Guidelines 2021: Epidemiology of cardiac arrest in Europe. Resuscitation 2021, 161, 61-79. https://doi.org/10.1016/j.resuscitation.2021.02.007.
6. Van der Pols H, Mencl F, de Vos R. The impact of an emergency motorcycle response vehicle on prehospital care in an urban area. Eur. J. Emerg. Med. 2011, 18, 328-333. https://doi.org/10.1097/mej.0b013e32834624e8.

7. Apiratwarakul K, Suzuki T, Celebi I, Tiamkao S, Bhudhisawasdi V, Pearkao C, Ienghong K. "Motorcycle Ambulance" Policy to Promote Health and Sustainable Development in Large Cities. Prehosp. Disaster Med. 2022, 37, 78-83. https://doi.org/10.1017/s1049023x21001345.
8. Apiratwarakul K, Tiamkao S, Cheung LW, Celebi I, Suzuki T, Ienghong K. Application of Automated External Defibrillators in Motorcycle Ambulances in Thailand's Emergency Medical Services. Open Access Emerg. Med. 2022, 14: 141-146. https://doi.org/10.2147/oaem.s361335.
9. Apiratwarakul K, Ienghong K, Mitsungnern T, Kotruchin P, Phungoen P, Bhudhisawasdi V. Use of a Motorlance to Deliver Emergency Medical Services; a Prospective Cross Sectional Study. Arch. Acad. Emerg. Med. 2019, 7, e48.
10. Vukmir RB. Survival from prehospital cardiac arrest is critically dependent upon response time. Resuscitation 2006, 69, 229-234. https://doi.org/10.1016/j.resuscitation.2005.08.014.
11. Andoljšek D. The role of motorcycle paramedic in prehospital unit. Faculty of health sciences, University of Primorska, 2011.
12. Kiefe CC, Soares-Oliveira M. Medical emergency motorcycles: are they safe? Eur. J. Emerg. Med. 2008, 15, 40-42. https://doi.org/10.1097/mej.0b013e3282861d2f.
13. POGLAJEN Urša. Spatial analyses of the UKC Ljubljana Emergency Medical Station data. Master's thesis. Faculty of Civil and Geodetic Engineering, University of Ljubljana, 2015.
14. Wood B. Motorcycle Paramedics Responding! – Chicago's Fire Department finds out that two wheels can be better than four. The monthly journal of the American Motorcyclist Association 1984, 19-21.