

Missions of the Helicopter Emergency Medical Service in rural and urban areas in Poland – A comparative retrospective analysis

Patryk Rzońca^{1,A,C-D}, Robert Gałązkowski^{2,B,F}, Angelina Wójcik-Fatla^{3,E}, Lech Panasiuk^{3,E}, Joanna Gotlib^{2,F}

¹ Medical University, Lublin, Poland

² Medical University, Warsaw, Poland

³ Institute of Rural Health, Lublin, Poland

A – Research concept and design, B – Collection and/or assembly of data, C – Data analysis and interpretation, D – Writing the article, E – Critical revision of the article, F – Final approval of article

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Abstract

Introduction. Mortality due to various causes, despite continuous efforts to improve the quality of medical services, is a serious problem for modern healthcare systems. Ischaemic heart disease and stroke are the cause of over 15 million deaths annually, and are therefore known as the world's number one killer.

Objective. The aim of this study is to characterise the missions and the most common reasons for dispatching Helicopter Emergency Medical Service (HEMS) crews, with special emphasis on the differences between urban and rural areas.

Materials and method. The study was conducted using a retrospective analysis of HEMS missions, including flights to accidents and diseases carried out by HEMS crews in Poland from January 2014 – December 2018. The final analysis included 35,213 cases of HEMS missions.

Results. The study group consisted mainly of male patients (66.40%), aged 50–64 (22.06%), mean age of the entire analysed group – 47.71 (SD: 25.96). The main reason for HEMS missions were strokes (21.63%). Analysis of patients' clinical status revealed that the clinical status of patients treated in rural areas was more severe, which was indicated by the Glasgow Coma Scale – GCS (12.03 vs 12.35) and the Revised Trauma Scale – RTS (10.14 vs 10.60) scores. When assessed by the National Advisory Committee for Aeronautics (NACA) score, body injuries and fatal diseases were observed more often in patients in rural areas (NACA 7 6.12% vs 3.46%) ($p < 0.05$).

Conclusions. Multi-organ injuries, head traumas, sudden cardiac arrest, traumatic brain injuries, collapse and epilepsy, were more frequent reasons for HEMS missions in rural areas than in urban areas.

Key words

Helicopter Emergency Medical Service, rural and urban areas, prehospital care

INTRODUCTION

The increasing number of health threats observed in recent years resulting from technological progress, the development of motoring and other external causes related to style and the environment are a huge problem and a challenge for modern healthcare systems. One of the main tasks of the administrative authorities of all countries in the world is to provide health safety for citizens through fair access to medical services. That is why emergency medical services are established, the aim of which is to provide first aid to accident victims and in other medical emergencies [1, 2, 3]. In many countries, Helicopter Emergency Medical Service (HEMS) has been established to provide the highest level of care to patients requiring immediate medical treatment. The benefits of using HEMS in emergency medicine have been described by many authors. The main advantages of using patient transport by air are: shorter time of arrival at the scene, reaching places which are difficult to access, implementing advanced life support, and fast transportation

to target hospitals. All these elements reduce the treatment time and thus increase the chances of patients' survival. Therefore, the dispatch of Helicopter Medical Emergency Service crews is of great importance in the case of rural areas and places difficult to access for Emergency Medical Service teams [4, 5, 6, 7, 8, 9, 10].

In Poland, the medical emergency system consists of two basic pillars: Hospital Emergency Departments and Emergency Medical Service Teams, including the Polish Medial Air Rescue Teams. In Poland, HEMS crews are a part of the Polish Medical Air Rescue – a system consisting of 21 permanent bases and one seasonal base (operating from June – September), which provide medical care all over the country. The crews of the Helicopter Emergency Medical Service consist of three persons: a professional pilot, a doctor and paramedic or nurse. All helicopters are equipped with the necessary apparatus and medical supplies to perform advanced life support at the scene, and specialist care during transport to hospital [4, 11].

According to current statistics published by the World Health Organization (WHO), there were 56.9 million deaths worldwide in 2016 due to various causes, with ischaemic heart disease and stroke being the leading causes of death globally. In Poland, the primary cause of death is cardiovascular

Address for correspondence: Patryk Rzońca, Medical University of Lublin, Lublin, Poland
E-mail: patryk.rzonca@gmail.com

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diseases, which in 2014 accounted for over 45% of all deaths. The second most frequent cause of death is cancer, accounting for one-quarter of all deaths [12, 13, 14].

OBJECTIVE

The importance of the issue of health threats and their impact on the health of society motivated the authors to conduct a study aimed at presenting the characteristics of the missions, and the most common reasons for dispatching HEMS crews, with particular emphasis on the differences between urban and rural areas.

MATERIALS AND METHOD

The study was conducted using a retrospective analysis of HEMS missions within the period January 2014 – December 2018 in Poland. HEMS flights to accidents and diseases were included in the study. The study excluded cancelled HEMS missions, missions that were not completed due to bad weather conditions, missions when the patient refused medical treatment, and when there was no patient at the scene requiring medical treatment. After excluding the cases according to the exclusion criteria, 35,213 cases of HEMS missions were included in the final analysis.

The study was conducted based on the medical and operational documentation of HEMS crews. The director of Polish Medical Air Rescue gave his consent to use the documentation. The following information was extracted in the process of documentation analysis: date and place of the mission, gender and age of patients, main reasons for HEMS dispatch based on ICD-10 classification, clinical status of patients, medical emergency procedures provided by the crew, and information related to HEMS mission characteristics. Three scales were used to compare the clinical status of patients: The Glasgow Coma Scale (GCS), the Revised Trauma Score (RTS) and the National Advisory Committee for Aeronautics (NACA) score.

The Glasgow Coma Scale (GCS) is commonly used to assess a patient's level of consciousness. Three responses are measured: eye opening (scores 1–4), verbal response (scores 1–5) and motor response (scores 1–6). The maximum possible score on the GCS is 15 and the minimal possible – 3, the lower the score the more severe the consciousness disorders. The final scores can be divided into three categories of disorders of consciousness: severe (GCS 3–8), moderate (GCS 9–12) and mild (GCS 13–15) [15].

The Revised Trauma Score (RTS) is a commonly used scoring system to qualify the severity of trauma injuries in a pre-hospital setting. The result is the sum of coded variables, such as the initial, Systolic Blood Pressure (SBP) and Respiratory Rate (RR). Each parameter is evaluated on a scale of 0–4 points, the maximum number of points is 12 and the minimum – 0 points. A score below 4 means that the patients should be treated in a trauma centre [16].

The National Advisory Committee for Aeronautics (NACA) score is used to assess the severity of injuries or diseases and is widely used in Western European countries. The NACA score is an 8-level scale assessing the severity of vital function disorder:

- NACA 0 – no injury or disease;
- NACA 1 – body injuries or diseases not requiring medical intervention;
- NACA 2 – body injuries or diseases requiring medical examination and treatment, but not requiring hospitalisation;
- NACA 3 – body injuries or diseases not life-threatening, but requiring hospitalisation;
- NACA 4 – body injuries or diseases which may lead to the deterioration of vital signs;
- NACA 5 – body injuries or diseases with acute threat to life;
- NACA 6 – body injuries or diseases leading to sudden cardiac arrest;
- NACA 7 – body injuries or fatal diseases) [17].

Statistical Analysis. The data obtained from the medical and operational documentation were subjected to statistical analysis using the StatSoft, Inc. (2017) STATISTICA (data analysis software system), version 13, www.statsoft.com. To describe qualitative data, the number (n) and percentage (%) were used, and the mean (M) and standard deviation (SD) used to describe the quantitative data. The Shapiro-Wilk test was used to determine normality. Chi-squared test was used to assess the significant differences between the analysed qualitative variables. The non-parametric U Mann-Whitney test was used to assess the differences between the two groups. The value of $p < 0.05$ was statistically significant.

RESULTS

A total of 35,213 cases of HEMS missions were analysed in the study, of which over two-thirds took place in rural areas (66.88%). The study group consisted mainly of males (66.40%), patients aged 50–64 (22.06%), mean age for the entire analysed group – 47.71 (SD: 25.96). The main reason for HEMS missions were strokes (21.63%). The vast majority of patients, after being treated at the scene, were transported to hospital by HEMS personnel (84.35%), while 7.26% of the patients died with the great majority of deaths occurred during action at the scene (69.39%). The most common heart rhythm observed in the patients was sinus rhythm (77.50%). In the analysed material, Emergency Medical Service (EMS) teams were the first team at the scene in nearly four-fifths of cases (79.92%), and HEMS crews were called in support, while in 20.08% of cases, the HEMS crews were dispatched first and were the only team at the scene (Tab. 1).

Comparative analysis showed that males (67.32% vs 64.52%) and younger persons (46.77 years vs. 49.61 years), i.e. aged 19–34 (16.37% vs. 12.03%) and 35–49 (14.93% vs. 12.26%) were significantly more often the patients receiving help from HEMS crews in rural areas. Analysis of the reasons for HEMS missions revealed that multi-organ injuries (21.01% vs. 12.87%), head trauma (16.18% vs. 12.33%), sudden cardiac arrest (11.08% vs. 8.90%), traumatic brain injury (7.50% vs. 6.40%), collapse (5.52% vs. 3.62%) and epilepsy attacks (4.69% vs. 3.86%) occurred more often in rural areas. Patients treated in urban areas were transported to hospitals more often by HEMS crews (88.15% vs. 82.47%), whereas in rural areas patients were significantly more often transported to hospitals by EMS teams (5.54% vs. 5.06%) and pronounced dead at the scene (8.53% vs. 4.67%). Deaths before the arrival of HEMS crew occurred significantly more often in rural

Table 1. Characteristics and analysis of the study group divided into the area of HEMS mission

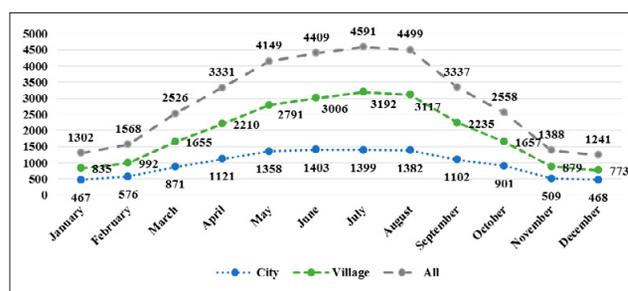
Variables	All n (%)	City n (%)	Village n (%)	p-value
Gender				
Female	11727 (33.60)	4100 (35.48)	7627 (32.68)	0.0000
Male	23172 (66.40)	7457 (64.52)	15715 (67.32)	
Age				
< 19-years-old	6226 (17.84)	2095 (18.13)	4131 (17.70)	
19 – 34-years-old	5212 (14.93)	1390 (12.03)	3822 (16.37)	
35 – 49-years-old	4901 (14.04)	1417 (12.26)	3484 (14.93)	0.0000
50 – 64-years-old	7698 (22.06)	2604 (22.53)	5094 (21.82)	
65 – 79-years-old	6853 (19.49)	2548 (22.05)	4305 (18.44)	
80 and older	4009 (11.49)	1503 (13.01)	2506 (11.74)	
Mean age M (SD)	47.71 (25.96)	49.61 (26.45)	46.77 (25.67)	0.0000
Main reasons for HEMS missions				
Stroke	4928 (21.63)	2253 (27.73)	2675 (18.25)	
Multi-organ injuries	4125 (18.11)	1046 (12.87)	3079 (21.01)	
Head trauma	3373 (14.80)	1002 (12.33)	2371 (16.18)	
Heart attack	2496 (10.96)	1286 (15.83)	1670 (11.39)	
Sudden cardiac arrest	2393 (10.50)	723 (8.90)	1456 (11.08)	0.0000
Traumatic brain injury	1619 (7.11)	520 (6.40)	1099 (7.50)	
Burns	1173 (5.15)	455 (5.60)	718 (4.90)	
Collapse	1103 (4.84)	294 (3.62)	809 (5.52)	
Epilepsy	1002 (4.40)	314 (3.86)	688 (4.69)	
Heart failure	571 (2.51)	232 (2.86)	339 (2.31)	
Treatment				
Transport to hospital by HEMS	29438 (84.35)	10187 (88.15)	19251 (82.47)	
Transport to hospital by EMS	1877 (5.38)	585 (5.06)	1292 (5.54)	0.0000
Death at the scene	2532 (7.26)	540 (4.67)	1992 (8.53)	
Remained at the scene	1052 (3.01)	245 (2.12)	807 (3.46)	
Time of death of patient				
During action at the scene	1757 (69.39)	411 (76.11)	1346 (67.57)	0.0002
Before HEMS arrival	775 (30.61)	129 (23.89)	646 (32.43)	
ECG monitoring				
Sinus rhythm	25881 (77.50)	8681 (78.68)	17200 (76.92)	
Asystole / PEA	2424 (7.26)	536 (4.86)	1888 (8.44)	
VF / VT	336 (1.01)	80 (0.73)	256 (1.14)	
Atrial fibrillation / atrial flutter	2168 (6.49)	858 (7.78)	1310 (5.86)	0.0000
Bradycardia / AV block	581 (1.74)	232 (2.10)	349 (1.56)	
Ventricular / supraventricular tachycardia	2005 (6.00)	647 (5.86)	1358 (6.07)	
First team at the scene				
HEMS	7008 (20.08)	1304 (11.28)	5704 (24.44)	0.0000
EMS	27891 (79.92)	10253 (88.72)	17638 (75.56)	

Source: authors' own study

areas (32.43% vs. 23.89%). Among patients treated in rural areas, heart rhythms associated with cardiac arrest, i.e. asystole/PEA (8.44% vs. 4.86%) and VT/VF (1.14% vs. 0.73%) were observed more often. HEMS crews were significantly more often the first team at the scene in rural areas (24.44% vs. 11.28%). The presented correlations were statistically significant ($p < 0.001$) (Tab. 1).

Analysis of patients' clinical status revealed that the clinical status of patients treated in rural areas was more severe, as indicated by the GCS scores (12.03 vs. 12.35) and the RTS scores (10.14 vs. 10.60), while using the NACA score body injuries or diseases, which were not assessed as direct threat to life (NACA 0–3 26.24% vs. 22.07%) and body injuries and fatal diseases (NACA 7, 6.12% vs. 3.46%) ($p < 0.05$) were observed more often in patients in rural areas. Moreover, respiratory rate within the range of 0–9 breaths per minute (13.61% vs. 9.80%), systolic blood pressure < 90 mmHg (14.37% vs. 9.90%), dyspnea (8.90% vs. 7.94%) and apnea (15.11% vs. 12.14%) ($p < 0.001$) were significantly more often observed among patients in rural areas. HEMS missions in rural areas were more often connected with performing mechanical ventilation (15.69% vs. 14.67%), immobilisation of the patient (23.10% vs. 20.59%), creating vascular access (35.15% vs. 27.98%), chest compressions (8.55% vs. 5.75%) and endotracheal intubation (13.99% vs. 11.96%) ($p < 0.05$) (Tab. 2).

Figure 1 shows the frequency of HEMS missions in the studied material divided into months. Generally, HEMS missions were more frequent in the period May – August, while in rural areas the majority of missions were carried out in July – August.

**Figure 1.** Frequency of HEMS missions in rural and urban areas, divided into months.

Source: authors' own study

The characteristics of the time of the completed mission and the distances covered during the HEMS missions in rural and urban areas have been presented in Table 3. Comparative analysis concerning the place of call of HEMS crew revealed that the time of flight to the scene (17.13 vs. 16.39 min), time of action at the scene (19.25 vs. 17.12 min), time of transport to hospital (16.37 vs. 14.77 min) and time of patient care (43.33 vs. 42.07 min) were significantly longer in the case of missions in rural areas ($p < 0.05$). Similarly, the distance to the scene (46.81 km vs. 42.86 km) and the distance to hospital (45.46 km vs. 39.84 km) were significantly longer in the case of missions in rural areas ($p < 0.001$) (Tab. 3).

Table 2. Analysis of the clinical status of patients treated by HEMS teams

Variables	All n (%)	Urban n (%)	Rural n (%)	p-value
GCS n (%)				
Score 1 – 8	6593 (20.86)	1880 (18.34)	4713 (22.09)	0.0000
Score 9 – 12	3163 (9.99)	1200 (11.71)	1963 (9.20)	
Score 13 – 15	21828 (69.16)	7170 (69.95)	14658 (68.71)	
GCS M (SD)	12.13 (4.42)	12.35 (4.19)	12.03 (4.53)	0.0038
RTS M (SD)	10.29 (3.55)	10.60 (3.12)	10.14 (3.74)	0.0000
NACA score n (%)				
0 – 3	8675 (25.00)	2551 (22.07)	6124 (26.24)	0.0000
4 – 6	24395 (69.76)	8606 (74.47)	15789 (67.64)	
7	1829 (5.24)	400 (3.46)	1429 (6.12)	
NACA score M (SD)	4.06 (1.46)	4.05 (1.38)	4.07 (1.50)	0.2047
No. of breaths n (%)				
0 – 9	3900 (12.37)	1002 (9.80)	2898 (13.61)	0.0000
10 – 29	26958 (85.52)	9015 (88.19)	17943 (84.24)	
30 and more	664 (2.11)	205 (2.01)	459 (2.15)	
Systolic blood pressure n (%)				
< 90 mmHg	4059 (12.92)	1008 (9.90)	3051 (14.37)	0.0000
≥ 90 mmHg	27356 (87.08)	9170 (90.10)	18186 (85.63)	
Most common clinical symptoms n (%)				
Limb paresis	5793 (16.60)	2429 (21.02)	3364 (14.41)	0.0000
Dyspnea	2996 (8.58)	918 (7.94)	2078 (8.90)	0.0026
Apnea	4929 (14.12)	1403 (12.14)	3526 (15.11)	0.0000
Medical emergency treatment n (%)				
Sedation	7418 (21.26)	2592 (22.43)	4826 (20.68)	0.0002
Administration of muscle relaxants	3198 (9.16)	1147 (9.92)	2051 (8.79)	0.0005
Glycemia measurement	12142 (34.79)	4504 (38.97)	7638 (32.72)	0.0000
Oxygen therapy	8579 (24.58)	2967 (25.67)	5612 (24.04)	0.0009
Mechanical ventilation	5357 (15.35)	1695 (14.67)	3662 (15.69)	0.0127
Immobilisation	7773 (22.27)	2380 (20.59)	5393 (23.10)	0.0000
Vascular access	11439 (32.78)	3234 (27.98)	8205 (35.15)	0.0000
Chest compressions	2659 (7.62)	664 (5.75)	1995 (8.55)	0.0000
Intubation	4507 (12.91)	1382 (11.96)	3125 (13.99)	0.0002

Source: authors' own study

DISCUSSION

The importance of the issue of health threats and their impact on the health of society motivated the authors to conduct a study aimed at presenting the characteristics of the missions and the most common reasons for dispatching HEMS crews, with particular emphasis on the differences between urban and rural areas. This is the first retrospective analysis covering 35,213 missions carried out by crews of HEMS from the whole country, in which over two-thirds of all completed missions took place in rural areas. The study conducted by Raatiniemi et al. concerning HEMS missions to patients with body injuries in Finland also showed that these missions were carried out more often in rural areas [18]. Similar results were obtained by Strehlow et al. who found that nearly 80% of EMS interventions in India were to women

Table 3. Characteristics of HEMS missions in rural and urban areas

Variables	All M (SD)	Urban M (SD)	Rural M (SD)	p-value
HEMS response time (min)	3.91 (1.94)	4.104 (2.07)	3.85 (1.87)	0.0000
Time of flight to the scene (min)	16.63 (5.76)	16.39 (5.89)	17.13 (5.45)	0.0000
Time from call to arrival to the patient (min)	22.46 (6.58)	23.17 (6.27)	22.11 (6.69)	0.0000
Time of action at the scene (min)	18.51 (8.73)	17.12 (8.36)	19.25 (8.84)	0.0000
Time of transport to hospital (min)	15.32 (5.27)	14.77 (5.33)	16.37 (4.99)	0.0000
Time of patient care (min)	42.24 (10.65)	42.07 (10.48)	43.33 (10.75)	0.0221
Distance to the scene (km)	43.86 (20.52)	42.39 (20.80)	46.81 (19.62)	0.0000
Distance to hospital (km)	41.77 (18.98)	39.84 (19.18)	45.46 (18.01)	0.0000

Source: authors' own study

in the third trimester reporting problems with pregnancy, also took place in rural areas [19]. A study by Cheung et al. concerning the use of HEMS to transport patients with mild injuries, and a study by Goldstein et al. analysing the EMS interventions in Canada, showed that interventions were also carried out more often in rural areas [20, 21].

The analysed group of patients consisted mainly of males who made up two-thirds of the entire group, and persons aged 50–64, mean age of the whole group – 47.71 years. The results of the authors' own research concerning demographic data of the patients are similar to results obtained by other authors, such as Østerås et al. and Kottmann et al. [22, 23]. In addition, literature analysis shows that males and older people more often use medical services which are a part of the medical emergency systems worldwide, as confirmed by Villani et al. and Hawkes et al. [24, 25].

According to current WHO data, the health situation indicates that the main cause of death in Europe and worldwide are non-communicable diseases, among which ischemic heart disease is the leading cause [12, 13]. This has also been confirmed by the findings of the National Institute of Public Health/National Institute of Hygiene, indicating that the main cause of death of Polish citizens are cardiovascular diseases [14]. The results of the authors' own research showed that the main reasons for HEMS missions in the analysed material were stroke, multi-organ injuries, head injuries and heart attack. Analysis shows that multi-organ injuries and head injuries were the more frequent causes for HEMS missions in rural areas. In Sweden, a study carried out by Kornhall et al. concerning HEMS missions in rural areas, showed that the main reasons for the missions were injuries, chest pain and sudden cardiac arrest [23]. In Norway, similar results were obtained by Østerås et al. in their study concerning HEMS missions [22].

The results of the authors' own research showed that the vast majority of patients were transported to hospital by HEMS crews. In the case of missions carried out in rural areas, HEMS crews more often were the first team at the scene. The percentage of deaths was higher than in the case of missions in urban areas, and the number of deaths before the arrival of the HEMS crew at the scene was higher. The

study conducted by Newgard et al. concerning the EMS interventions to patients with body injuries in the USA, found that the vast majority of patients were transported to hospital, and deaths occurred more often in rural areas [26]. Similar results were obtained by Rzońca et al. who analysed the missions of HEMS crews to out-of-hospital cardiac arrest in Poland. The study found that patients with return of spontaneous circulation were more often transported to hospitals by HEMS teams, and that the cases of death before the arrival of the HEMS team were more frequent [27].

Analysis of the authors' own research shows that the clinical status of the patients treated in rural areas was more severe than that of patients in urban areas, as indicated by the GCS scores (12.03 vs. 12.35), the RTS scores (10.14 vs. 10.60) and the NACA scores. Using the NACA score, injuries and fatal diseases were diagnosed more often in patients in rural areas (6.12% vs. 3.46%). The analysis carried out by McCowan et al. in the USA concerning the patients with blunt injuries transported by HEMS crews, revealed that the values on the GSC and trauma scale were higher in patients from rural areas, which indicates a milder clinical status of these patients [28]. The study conducted by Kottmann et al. in Switzerland concerning HEMS missions to patients with body injuries showed that the clinical status of the patients was mild and moderate (NACA 1–3) [23]. Studies by Kornhall et al. concerning HEMS missions in rural areas in Sweden and HEMS missions in Norway conducted by Østerås et al., revealed that the average NACA score was 4 [22, 29]. In the study conducted by Newgard et al. lower GCS, lower systolic blood pressure, abnormal number of breaths and pulse, were observed more often in patients treated in urban areas [26].

According to Werman et al., the use of advanced life support and fast transport to the hospital is justified, especially in patients with sudden cardiac arrest as a result of acute coronary syndrome (ACS), as these patients require coronary intervention as soon as possible [30]. The results of the study show that in the case of interventions in rural areas, the time of reaching the patient, the time of proceedings at the scene, and the time of transportation to hospital were significantly longer. Similarly, the distance to the scene and the distance to hospital were longer in the case of missions in rural areas. The results of the authors' own research has been confirmed by the study carried out by Raatinieni et al., who analysed HEMS missions in Finland [18]. This confirms the legitimacy for dispatching HEMS crews to rural areas and places difficult to access for ground teams, because by using the air route it is possible to shorten the time of reaching the patient and the time of transporting the patient to hospital. This has been confirmed by the study conducted by Moens et al. and Chen et al., from which it appears that both the time of arrival at the the missions carried out by the crews of the Helicopter Emergency Medical Service [31, 32].

This study is the first comparative retrospective analysis in Poland concerning the missions of HEMS crews carried out in rural and urban areas. Although the study covered all HEMS stations of Polish Medical Air Rescue, it has some limitations. The main limitation is the retrospective nature of the analysis, which affects the quality of the data. Although a significant number of cases were included in the study, the analysis concerns only pre-hospital proceedings and clinical status assessment based on the information available in the

medical records of HEMS crews, which makes it impossible to follow the entire therapeutic process of patients. However, these limitations do not affect the quality of the study.

It is necessary to conduct further research on the subject of health care in rural and urban areas and the use of HEMS to better understand this issue, and at the same time provide the best quality of medical services by entities that provide assistance to patients, both in pre-hospital and hospital settings.

CONCLUSIONS

The most common reasons for HEMS missions in the analysed material were strokes and multi-organ injuries. The missions of HEMS crews mainly concerned males and people aged 50–64. Actions at the scene most often ended with the transportation of the patient to hospital.

The conducted analysis shows that males and persons aged 19–49 were more often patients in rural areas. Multi-organ injuries, head traumas, sudden cardiac arrest, traumatic brain injuries, collapse and epilepsy, were the more frequent reasons for HEMS interventions in rural areas than in urban areas. Patients treated in urban areas were transported to hospitals more often by HEMS crews, whereas in rural areas patients were significantly more often transported to hospitals by EMS teams. Deaths before the arrival of HEMS teams occurred significantly more often in rural areas. Analysis of the clinical status of the patients showed that missions in rural areas were associated with a more severe condition of patients, which was indicated by the GCS, RTS and NACA scores.

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