

Characteristics of aeromedical transport, both interhospital and directly from the scene of the incident, in patients with acute myocardial infarction or acute trauma between 2011–2016 in Poland: A case-control study

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Abstract

Background. Patients with acute myocardial infarction (AMI) or acute trauma (AT) are transported by air to save time. Helicopter Emergency Medical Service (HEMS) provides both flights to and from the emergency scene, as well as interhospital transport (interHtransport).

Objectives. The objective of this study was to compare aeromedical transport and HEMS missions of AMI and AT patients regarding safety, medical procedures and the length of flights.

Material and methods. This is a case-control study analyzing the medical history records of AMI and AT patients transported between hospitals and from the scene identified using ICD-10 codes. Research of customary data (age, sex and general health status measured with Glasgow Coma Scale (GCS) and Revised Trauma Score (RTS)) was performed.

Results. There were 48,555 flights in the years 2011–2016, of which 7,645 (15.7%) were interhospital (19% AMI and 12% AT). Out of these, 40,910 (84.3%) HEMS missions were to patients on the scene (10% AMI and 13% AT). No fatalities were noted. The AMI GCS score was higher than in AT patients: 15.0 vs 14.0, respectively. The medical procedures during transport of AMI patients between hospitals and from the scene were the following: cardiopulmonary resuscitation (CPR): 6 vs 73 cases ($p < 0.001$); oxygen therapy: 41.1% vs 50.2%, respectively. The median distance was 59.4 km vs 52.1 km ($p < 0.001$), while median flight time was 45.0 min vs 38.0 min ($p < 0.001$), respectively. Regarding AT patients, the procedures performed (during interhospital and from the scene transport) were the following: CPR: 5 vs 244 cases ($p < 0.001$); intubation: 10.7% vs 17.3% ($p < 0.001$); sedation: 50.1% vs 24.3% ($p < 0.001$); oxygen therapy: 17.6% vs 36.6% ($p < 0.001$); spinal board: 17.1% vs 66% ($p < 0.001$); cervical collar: 15.9% vs 63.4% ($p < 0.001$), respectively. Interhospital transport and HEMS mission median flight distance was 135.9 km vs 56.3 km ($p < 0.001$), while median flight time was 66.0 min vs 45.0 min ($p < 0.001$), respectively.

Conclusions. Aeromedical transport is safe and very rarely requires resuscitation during the flight. The long distances of flights and time required can reflect the scarcity of trauma centers (TCs) compared to cardiovascular wards. The location of hemodynamic centers in Poland is optimal.

Key words: acute myocardial infarction, Helicopter Emergency Medical Service, aeromedical transport, patient with trauma

Introduction

Similarly to the rest of the world, in Poland aeromedical interhospital transport (interHtransport) in the rescue mode is the most frequent form of transporting both patients with acute trauma (AT) and with acute myocardial infarction (AMI).^{1,2} The Medical Air Rescue Service (MARS) has at its disposal 2 kinds of aircraft: 22 EC 135 2+ and H135 P3 helicopters, forming the Helicopter Emergency Medical Service (HEMS). Of all its air bases, 4 work all year while 1 is seasonal and operates only in the summer. The other kinds of aircraft are 2 Plane Transport Teams (PTS), which mostly provide interHtransport of patients in the planned mode. In addition to carrying out flights to the immediate scene of the emergency incident, HEMS is also used for rescue transport between treatment institutions which have helipads (functioning either during the day or round-the-clock). It is essential to transport the AMI patient in a sudden critical health condition who requires intensive supervision during the flight to a hospital which has a hemodynamics department, so that percutaneous coronary intervention (PCI) can be carried out.^{1,3} The responsibility for the organization and choice of transport mode between an ambulance and a helicopter falls on the dispatching doctor who is in charge of the patient. The decision can be consulted with the doctor from the interventional cardiology department. The procedures described above function both in the Polish and in the American healthcare system.^{4,5} In the case of patients in a critical condition, when making the decision about transport to another center, the doctor in charge of the patient must first make sure that all the diagnostic and treatment possibilities have been exhausted and then must be guided by the principle that potential benefits should outweigh risks, including that of death in the course of transport.⁶

Transport takes place between hospitals that have adjacent helipads. In each and every case enrollment of the patients for transport is implemented by the medical dispatcher of the Operational Center of the Medical Air Rescue Service (OP MARS), who then actively participates in coordinating transport operations. Research reports from all the world all agree that when it comes to saving time, aeromedical transport of AMI patients from the place of the incident to the center implementing PCI is superior to transport from hospital to hospital.⁴ In fact, under Polish conditions, where many hospitals have no land transport units, HEMS is the only possibility of transporting a patient in a critical, life-threatening condition.

Under the law, every medical legal entity in Poland is obliged to provide sanitary transport to a patient in a critical condition to the nearest appropriate medical facility. Such a policy is based on the premise that immediate treatment or continuation of treatment must be provided. In practice, transport contracts made between medical

units and an enterprise carrying out sanitary transport (often located at a distance of a few dozen kilometers from the dispatching hospital) are also accepted. In such cases, air transport is the desirable alternative to land transport. The key factor is to make sure that aircraft are dispatched in an optimal way, so that more patients can be helped.

Flights to AT patients who have suffered injuries in road or construction accident and other events resulting in life-threatening situations are as frequent as cases of AMI. Patients fulfilling the criteria for enrollment in a trauma center (TC), a center for the treatment of burns or a hospital performing the replantation of limbs can be transported by air, which is beneficial from the point of view of saving time, minimizes the shaking present during ambulance transport^{7,8} and also reduces the fatality rate.^{9,10} When comparing land and aeromedical transport in the course of implementing vital procedures, an important role is played by the exceptional professional experience of HEMS teams.¹¹

In Poland there are 14 TCs for 16 voivodeships (provinces). In this context, ambulance transport over a distance of many kilometers can lengthen the time of reaching the patients and transporting them to a place where specialist treatment can be provided. In most cases, reports regarding the air transport of AMI patients do not distinguish cases of cardiac arrest or fatality. What is featured in reports are cases of hypotension in the course of the flight.^{2,12}

The aim of the present study was to compare the transport of AMI and AT patients carried out by HEMS regarding undertaken medical procedures as well as the time and distance of flights.

Material and methods

A case-control study was performed using the medical and air histories of MARS regarding patients transported in the course of interhospital operations and flights to the immediate scene of the emergency incident (HEMS missions) in the years 2011–2016 in Poland. Both the medical and flight data were recorded using Microsoft Excel (Microsoft Inc., Redmond, USA) databases.

The group that was researched were patients transported due to acute coronary syndrome, identified by the following ICD-10 codes: I20, I21 and I24. The control group comprised AT patients identified by the following ICD-10 codes: S06, T06, T29, and S68. They were the second most numerous homogeneous group of patients transported during HEMS rescue service flights.

The data that was identified and compared concerned: 1) age, sex, patient status (on the basis of Glasgow Coma Scale (GCS) and Revised Trauma Score (RTS)) and death in the course of flight; 2) the medical procedures undertaken (external heart massage, defibrillation, sedation, neuromuscular block, oxygen therapy, respiratory

therapy, intubation, or using a spinal board, a cervical collar or a painkiller; 3) the time and distance of the flight.

Statistical analysis

Descriptive statistics are presented as the numerical data and percentages of categorical variables and the median weighted with the 1st and 3rd quartile for numeric variables. Comparisons of groups of patients with AMI and those with AT were carried out using χ^2 tests and the Mann–Whitney test (for the relevant category and numerical data). Analyses were conducted using R 3.4.1 software (R Core Team, 2017; Foundation for Statistical Computing, Vienna, Austria; <https://www.R-project.org/>).

Results

A total of 48,555 HEMS flights were carried out between 2011 and 2016, out of which 7,645 concerned transport between hospitals in the rescue mode, including 1,429

AMI patients and 908 AT patients (19% and 12% transport flights, respectively). Out of the 40,910 missions directly to the site of the incident, 4,002 were flights to AMI patients and 5,231 to AT patients (10% and 13%, respectively).

The basic characteristics of the patients with AMI from each group are presented in Table 1. In the group of patients with AMI, females transported between hospitals accounted for 32.3%, whereas in the AT group women comprised 31.0% (not significant (NS)). Male patients comprised 67.7% and 68.9% (NS), respectively. Unidentified patients (NN) accounted for 0.1% of the flights in both groups (NS). The median age of patients transported between hospitals was 65.9 years, and from the scene of the event – 63.6 years ($p < 0.001$).

The median state of consciousness assessed using GCS was 15 points in both groups (NS). The number of GCS points was divided into 4 ranges in patients transported between hospitals was the following: <9: 27 (2.1%), 9–12: 13 (1.0%), 13–14: 24 (1.9%), and 15: 1,230 (95.1%), while in the HEMS mission it was <9: 105 (2.8%), 9–12: 51 (1.4%), 13–14: 130 (3.5%), and 15: 3,479 (92.4%). The assessment of patients on the RTS was 12 (NS).

In the group of AT patients, women transported between hospitals accounted for 24.1%, while in the group taken from the place of the event for 26.0% (NS). The corresponding percentages for men were the following: 75.4% and 72.7% (NS), respectively. Unidentified patients accounted for 0.5% of inter-hospital flights and 1.3% of flights from the site of the event (NS). The median age of the patients transported between hospitals was 42.1 years, and from the scene of the event – 33.1 years ($p < 0.001$) (Table 2).

The median state of consciousness on GCS in interHtransport and in flights to the event amounted to 14.0 points (NS). The number of points on GCS divided into 4 ranges for patients transported between hospitals was the following: <9: 205 (30.9%), 9–12: 58 (8.7%), 13–14: 61 (9.2%), and 15: 340 (51.2%), while the corresponding numbers for the HEMS missions were the following: <9: 1,582 (31.4%), 9–12: 459 (9.1%), 13–14: 712 (14.1%), and 15: 2,286 (45.4%). The evaluation of patients on the RTS was 12.0 points (NS).

One fatality was registered in each of the groups analyzed (AMI and AT patients). Moreover, cardiac arrest occurred in 9 (0.6%) patients with AMI in the course of interHtransport, while among patients flown from the scene

Table 1. Characteristics of the group of patients with AMI in the study

Variables	N	Inter-Htransport	N	HEMS missions	p-value
Sex, n (%)					
F	1,438	464 (32.3)	4,002	1,239 (31.0)	0.573
M		973 (67.7)		2,758 (68.9)	
NN		1 (0.1)		5 (0.1)	
Age, median (Q1–Q3)	1,435	65.9 (58.0–75.4)	3,975	63.6 (56.5–73.1)	<0.001
GCS, median (Q1–Q3)	953	15.0 (15.0–15.0)	2,642	15.0 (15.0–15.0)	0.037
GCS					
<9	27	2.1%	105	2.8%	0.009
9–12	13	1.0%	51	1.4%	
13–14	24	1.9%	130	3.5%	
15	1,230	95.1%	3,479	92.4%	
RTS, median (Q1–Q3)	953	12.0 (12.0–12.0)	2,639	12.0 (12.0–12.0)	0.073

AMI – acute myocardial infarction; interHtransport – interhospital transport; HEMS – Helicopter Emergency Medical Service; GCS – Glasgow Coma Scale; RTS – Revised Trauma Score; F – female; M – male; NN – non notus.

Table 2. Characteristics of the group of trauma patients analyzed in the study

Variables	N	Inter-Htransport	N	HEMS missions	p-value
Sex, n (%)					
F	916	221 (24.1)	5,231	1,361 (26.0)	0.038
M		691 (75.4)		3,804 (72.7)	
NN		4 (0.5)		66 (1.3)	
Age, median (Q1–Q3)	895	42.1 (23.5–57.8)	4,683	33.1 (19.2–53.5)	<0.001
GCS, median (Q1–Q3)	472	14.0 (3.0–15.0)	3,313	14.0 (6.0–15.0)	0.007
GCS					
<9	205	30.9%	1,582	31.4%	0.002
9–12	58	8.7%	459	9.1%	
13–14	61	9.2%	712	14.1%	
15	340	51.2%	2,286	45.4%	
RTS, median (Q1–Q3)	471	12.0 (8.0–12.0)	3,309	12.0 (9.0–12.0)	0.011

InterHtransport – interhospital transport; HEMS – Helicopter Emergency Medical Service; GCS – Glasgow Coma Scale; RTS – Revised Trauma Score; F – female; M – male; NN – non notus.

Table 3. Medical rescue procedures carried out by the HEMS (patients with AMI)

Variables	N	InterHtransport	N	HEMS missions	p-value
Defibrillation, n (%)					
no	1,439	1,433 (99.6)	4,002	3,950 (98.7)	0.008
yes		6 (0.4)		52 (1.3)	
CPR, n (%)					
no	1,302	1,296 (99.5)	3,745	3,672 (98.1)	<0.001
yes		6 (0.5)		73 (1.9)	
Intubation, n (%)					
no	1,439	1,426 (99.1)	4,002	3,947 (98.6)	0.215
yes		13 (0.9)		55 (1.4)	
Sedation, n (%)					
no	1,439	1,343 (93.3)	4,002	3,819 (95.4)	0.002
yes		96 (6.7)		183 (4.6)	
Neuromuscular block, n (%)					
no	1,439	1,423 (98.9)	4,002	3,977 (99.4)	0.098
yes		16 (1.1)		25 (0.6)	
Oxygen therapy, n (%)					
no	1,439	848 (58.9)	4,002	1,991 (49.8)	<0.001
yes		591 (41.1)		2,011 (50.2)	
Respirator, n (%)					
no	1,439	1,380 (95.9)	4,002	3,900 (97.5)	0.004
yes		59 (4.1)		102 (2.5)	

AMI – acute myocardial infarction; HEMS – Helicopter Emergency Medical Service; interHtransport – interhospital transport; CPR – cardiopulmonary resuscitation; GCS – Glasgow Coma Scale; RTS – Revised Trauma Score.

Table 4. Medical rescue procedures carried out by the HEMS (patients with trauma)

Variables	N	InterHtransport	N	HEMS missions	p-value
Defibrillation, n (%)					
no	916	914 (99.8)	5,231	5,208 (99.6)	0.490
yes		2 (0.2)		23 (0.4)	
CPR, n (%)					
no	869	864 (99.4)	5,102	4,858 (95.2)	<0.001
yes		5 (0.6)		244 (4.8)	
Intubation, n (%)					
no	916	818 (89.3)	5,231	4,324 (82.7)	<0.001
yes		98 (10.7)		907 (17.3)	
Sedation, n (%)					
no	916	457 (49.9)	5,231	3,958 (75.7)	<0.001
yes		459 (50.1)		1,273 (24.3)	
Neuromuscular block, n (%)					
no	916	788 (86.0)	5,231	4,753 (90.9)	<0.001
yes		128 (14.0)		478 (9.1)	
Oxygen therapy, n (%)					
no	916	755 (82.4)	5,231	3,316 (63.4)	<0.001
yes		161 (17.6)		1,915 (36.6)	
Respirator, n (%)					
no	916	529 (57.8)	5,231	3,631 (69.4)	<0.001
yes		387 (42.2)		1,600 (30.6)	
Spinal board, n (%)					
no	916	759 (82.9)	5,231	1,780 (34.0)	<0.001
yes		157 (17.1)		3,451 (66.0)	
Cervical collar, n (%)					
no	916	770 (84.1)	5,231	1,916 (36.6)	<0.001
yes		146 (15.9)		3,315 (63.4)	

HEMS – Helicopter Emergency Medical Service; interHtransport – interhospital transport; CPR – cardiopulmonary resuscitation; GCS – Glasgow Coma Scale; RTS – Revised Trauma Score.

there were 53 (1.3%) such cases. In patients with multi-organ trauma, cardiac arrest was observed in 19 (0.3%) patients transported from the site of the event.

sions (n = 5 (0.6%) vs n = 244 (4.8%), respectively; p < 0.001) and defibrillation (0.2% patients transported between hospitals and 0.4% transferred by HEMS missions; p = 0.490).

A comparison of the medical procedures undertaken during the transport of patients with AMI is presented in Table 3. Clinical events that occurred before and during transport in the interhospital group and in flights from the scene of the event included chest compressions (n = 6 (0.5%) vs n = 73 (1.9%), respectively; p < 0.001). As far as defibrillation is concerned, it was carried out in 0.4% of patients transferred between hospitals and in 1.3% carried by HEMS missions (p = 0.008).

During the transport of patients in the state of a sudden health risk, medical procedures relevant to each group were implemented. There were 13 instances (0.9%) when intubation was carried out in the group of patients transported between hospitals, while in the group transported from the scene there were 55 (1.4%) such cases (NS). Ninety-six patients (6.7%) were given sedation during interHtransport, while in the group of patients transported from the scene there were 183 (4.6%) such cases (NS). The number of instances when neuromuscular block was used in patients transported between hospital was 16 (1.1%), while it was administered to 25 (0.6%) patients transported from the scene (NS). Oxygen therapy was carried out in 591 (41.1%) of patients transported between hospitals, while it was performed in 2,011 (50.2%) patients taken from the scene (p < 0.001). In the same group, respiratory therapy was implemented 102 times (2.5%), and in the group transported between hospitals – 59 times (4.1%) (NS).

A comparison of the medical procedures undertaken during the transport of patients with AT is presented in Table 4. For AT patients, clinical events that occurred before and during transport in the interhospital group and during flights from the scene of the event included chest compressions

Table 5. Analysis of HEMS time and distance (patients with AMI)

Variables	N	InterHtransport	N	HEMS missions	p-value
Time until reaching the patient, median (Q1–Q3)	1,412	36.0 (30.0–44.0)	3,942	23.0 (19.0–27.0)	<0.001
Time from reaching the patient until arrival at the target medical institution, median (Q1–Q3)	1,423	45.0 (37.0–54.0)	3,951	38.0 (32.0–44.0)	<0.001
Total time of operation, median (Q1–Q3)	1,401	81.0 (69.0–95.0)	3,896	61.0 (54.0–70.0)	<0.001
Distance of transport, median (Q1–Q3)	1,433	59.4 (49.8–42,107.5)	3,910	52.1 (37.1–42,116.5)	<0.001

AMI – acute myocardial infarction; HEMS – Helicopter Emergency Medical Service; interHtransport – interhospital transport.

Table 6. Analysis of HEMS time and distance (patients with trauma)

Variables	N	InterHtransport	N	HEMS missions	p-value
Time until reaching the patient, median (Q1–Q3)	889	46.0 (35.0–58.0)	5,136	23.0 (19.0–29.0)	<0.001
Time from reaching the patient until arrival at the target medical institution, median (Q1–Q3)	895	66.0 (50.0–85.0)	5,043	45.0 (37.0–55.0)	<0.001
Total time of operation, median (Q1–Q3)	875	115.0 (90.0–141.0)	4,962	70.0 (58.0–83.0)	<0.001
Distance of transport, median (Q1–Q3)	911	135.9 (66.6–42,141.1)	4,920	56.3 (34.0–42,181.3)	<0.001

HEMS – Helicopter Emergency Medical Service; interHtransport – interhospital transport.

Table 7. Number and percentage of missions carried out to the TC as part of transport between hospitals and directly from the scene of the event

Variable	InterHtransport				HEMS missions			
	TCs in Poland – 14							
	no		yes		no		yes	
	N	[%]	N	[%]	N	[%]	N	[%]
T06	19	21.1	71	78.9	234	13.9	1,454	86.1

TC – trauma center; HEMS – Helicopter Emergency Medical Service; interHtransport – interhospital transport.

Intubation in the group of patients transported between hospitals was performed 98 times (10.7%) and in the group transported from the place of the incident – 907 times (17.3%) ($p < 0.001$). The number of times sedation was applied in the case of interHtransport was 459 (50.1%), while in the group of patients transported from the scene it was 1,273 (24.3%) ($p < 0.001$). The number of times neuromuscular block was used in patients transported between hospitals was 128 (14.0%), and 478 (9.1%) in patients taken from the scene ($p < 0.001$). Oxygen therapy and respiratory therapy were applied 161 times (17.6%) and 387 times (42.2%) in patients transported between hospitals, and 1,915 times (36.6%) and 1,600 times (30.6%) in patients taken from the scene of the incident, respectively ($p < 0.001$). Spinal board was used in 3,451 (66.0%) patients transported from the incident site, and in 157 (17.1%) patients transported between hospitals ($p < 0.001$). The cervical collar was placed in 3,315 (63.4%) and 146 (15.9%) cases, respectively ($p < 0.001$).

Information on the technical parameters of the flight – time till reaching and transporting the patient as well as the total time and distance of the mission – are presented in Tables 5 and 6. Median time from take-off until reaching the patient with AMI in the case of interHtransport was 36 min. In the case of HEMS missions, it was 23 min ($p < 0.001$). The time from taking the patient from hospital until arrival at the target medical institution

and then transferring the patient to the reference center was 45 min. In the case of HEMS missions, this was 38 min ($p < 0.001$). The total time of the operation was 81 min vs 61 min for interHtransport and the HEMS missions, respectively ($p < 0.001$). The median distance for interHtransport was 59.4 km, and 52.1 km ($p < 0.001$) for flights from the scene of the incident.

Median time from take-off until reaching the patient with AT in the case of interHtransport was 46 min and for the HEMS missions it was 23 min ($p < 0.001$). The time from reaching the patient until arrival at the target medical institution and then taking the patient to the reference center was 66 min for transport between hospitals, while in the case of HEMS missions it was 45 min ($p < 0.001$). The total time of interHtransport operations was 115 min and in the case of a HEMS mission it was 70 min ($p < 0.001$). The median distance of transport for interHtransport was 135.9 km, and for flights from the scene it was 56.3 km ($p < 0.001$) (Table 7).

Patients diagnosed with T06 were most frequently transported to TCs both from the scene of the incident (86.1%) as well as by interHtransport (78.9%). The median distance of transport of an AMI patient (I 20, I21 and I24) across Poland (all bases) is between 41.2 km and 49.8 km. It is noteworthy that 95% of HEMS missions are shorter than 68.8–86.0 km for relevant bases (Fig. 1).

Discussion

The present publication is the first one in Poland to assess the course and results of HEMS interHtransport and flights to the immediate scene of the emergency incident regarding AMI or AT patients.

In the years 2011–2016 a total of 7,645 transport operations were carried out between medical entities and 4,002 missions took place directly from the scene of the incident. Out of these, patients with AMI and AT constituted a vast majority. Similarly to the data published in other countries, men comprised a decisive majority of the AMI patients in both groups (67.7% were transported between hospitals and 68.9% from the scene of the event). Trauma patients were younger than AMI ones – aged 42.1 years for those transported between hospitals and 33.1 years from the scene, vs 65.9 and 63.6 years of age for AMI patients.¹³

The most frequent level of consciousness on GCS was on average 15 points (based on data on 953 patients transported between hospitals and 2,642 taken from the scene – there was a lack of data on the others). There were 27 patients with GCS below 9 points, which constituted 2.1%. In the range between 9 and 12 points, the number of patients was 13 (1.0%); 24 patients scored 13–14 points (1.9%), while 1,230 were given 15 points (95.1%). In the HEMS missions, the corresponding numbers were the following: <9: 105 (2.8%), 9–12: 51 (1.4%), 13–14: 130 (3.5%), and 15: 3,479 (92.4%). This means that the patients were in logical and verbal contact and there were no disorders of consciousness in both groups of AMI patients. In the case of AT patients, the GCS consciousness level was on average 14 points (on the basis of data regarding 472 and 3,313 patients, respectively – there was a lack of data on the others). The number of points on the GCS varied widely. There were 205 patients with GCS below 9 points, which constituted 30.9%. In the range between 9–12 points, the number of patients was 58 (8.7%); 61 patients scored 13–14 points (9.2%), while 340 were given 15 points (51.2%). In the HEMS missions, the corresponding numbers were the following: <9: 1,582 (31.4%), 9–12: 459 (9.1%), 13–14: 712 (14.1%), and 15: 2,286 (45.4%). Such results lead to the conclusion that a significant percentage of patients were unconscious or had moderately disturbed consciousness. While the assessment of patients on the RTS scale on average amounted to 12, this was also true in both groups of AT patients. Similarly to reports in the literature, the scales show that the status of the AT patients was significantly more severe in comparison to AMI patients.¹⁰ In another publication, the level of consciousness in patients with AMI was assessed at 13 points, while of those with AT at 11.9.¹³ In some cases, the implementation of additional medical procedures for the time of transport was necessary (sedation, intubation, respiratory therapy).

The clinical procedures undertaken due to the state of the AMI patients included the following: chest compression ($n = 6$; $n = 73$) and defibrillation 0.4% and 1.3%,

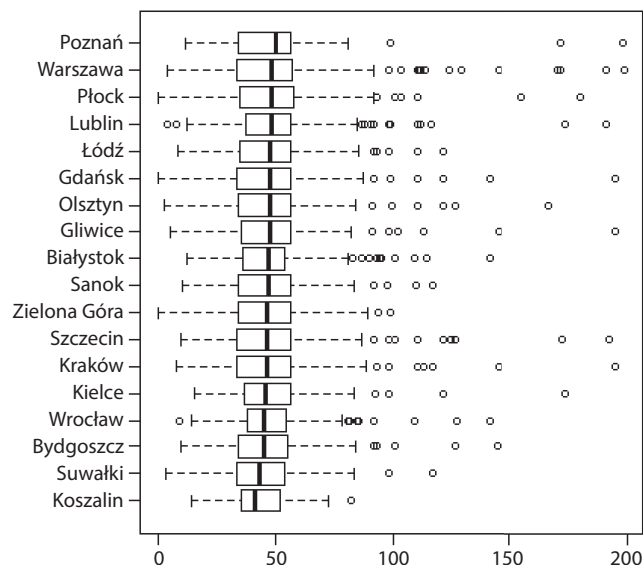


Fig. 1. Analysis of the distance of transport of patients with AMI to the departments of hemodynamics in Poland

while for patients with AT clinical procedures involved defibrillation 0.2% and 0.4%; and chest compressions ($n = 5$; $n = 244$). The disorders described occurred both before and in the course of the helicopter flight. The European Society of Cardiology guidelines recommends that patients transported between hospitals should be accompanied by personnel adequately equipped and trained to deal with life-threatening arrhythmias and cardiac arrest.^{14–16} There were no fatalities in the course of the flights between hospitals. Nevertheless, there was a fatality incident which one team experienced when flying an AMI patient from the scene of the incident. Analysis showed that the occurrence of cardiac arrest (146) was more frequent in patients with AMI (121) than in those with multi-organ trauma (T06). On the basis of the data they received, the authors are unable to determine the moment of cardiac arrest.

In McMullan's study, it was reported that in the course of interHtransport, cardiopulmonary resuscitation was necessary only in 2 patients.⁴ This may result from the proper preparation of patients before transport and accurate enrollment of patients who can benefit from aeromedical transport. Analysis showed that oxygen therapy was implemented in 591 and in 2,011 patients with AMI in interHtransport and transport from the scene of the incident, respectively, while sedation in was carried out in 96 and 183 patients, respectively, and respiratory therapy was necessary in 59 and 102 patients, respectively. In AT patients, on the other hand, the most frequently used therapy was sedation ($n = 459$; $n = 1,273$) and respiratory therapy ($n = 387$; $n = 1,600$) due to severe body injuries and the risk of secondary cardiopulmonary disorders. In this group, oxygen therapy ($n = 161$; $n = 1,915$), neuromuscular block ($n = 128$; $n = 478$) and intubation ($n = 98$; $n = 907$) were also frequent. The percentage of intubation in the American study was different than in ours: patients with AMI

and AT who received intubation comprised 24% and 22% of those transported between hospitals and from the scene of the incident, respectively, which constitutes a significant difference with respect to the data reported in the present study (AMI 0.9% and 1.4%, AT 10.7% and 17.3%, respectively).¹² In the first case (AMI patients), the difference can result from the fact that Polish patients received intensive care protecting them prior to transport by the dispatching entities and were subsequently looked after by MARS teams. The group of patients with AT demanded more careful preparation for the flight, what was analyzed on the basis of the number of undertaken medical rescue procedures. It reflects their more severe condition.

The median of the distance of flight from the dispatching center to the target in the case of AMI or AT was 59.4 km (AMI – interHtransport) and 52.1 km (AMI – HEMS mission) vs 135.9 km (AT – interHtransport) and 56.3 km (AT – HEMS mission), respectively, while the median of the transport time was 45 min (AMI – interHtransport) and 38 min (AMI – HEMS mission), and 66 min (AT – interHtransport) and 45 min (AT – HEMS mission), respectively. The data from the literature differs: the average flight distance with AMI is 70 km and flight time – 31 min, while in the case of AT patients the flight time is 121 min, while there is a lack of data for flight distance.^{10,17} The reason for the differences observed is most likely due to the following factors: the density of HEMS bases and target centers, the kind of helicopters, and the organization of the land medical care that takes the patient to HEMS. Moreover, procedural differences between HEMS teams in different countries should not be excluded.

Trauma to multiple areas of the body or multi-organ injuries should ultimately be treated with therapy in TC. Therefore, at the stage of receiving the call for help, it is advisable to immediately dispatch HEMS to patients with multi-organ trauma to avoid unnecessary delay of proper treatment in a TC.

The paper presents a comparison of transport of AT patients to the hospital where there is a TC. Among AT patients, the criteria for treatment in a TC were met by patients diagnosed with T06 – injuries involving numerous body regions according to the ICD-10 codes. Patients with multiple-organ trauma most often came directly from the accident site.

Another analysis of HEMS missions between the years 2011–2013 in Poland also showed that the AT patients most often transported to a TC were those classified into the T06 group.¹⁸

The study also included an analysis of the distance over which patients with AMI were transported to hemodynamic departments. It was shown that in Poland there are no significant differences between the distances of transporting patients with AMI, which makes it possible

to conclude that the location of hemodynamic centers in Poland is optimal.

According to the author's analysis, patients with AMI before the arrival of HEMS received pain relief from the personnel of ambulances – it was probably administered after the examination of the patient. Analgesic drugs were also provided by the hospitals to which the patients were sent. The most commonly administered drug in both groups of transport was morphini sulfas. Air teams more often than ground teams administered fentanylum, which may result from their greater experience with pain relief therapy.

In AT patients, both ambulances and hospitals administered morphini sulfas, fentanylum and ketoprofenum. The HEMS units used fentanylum and morphini sulfas in fractionated doses. Drugs from other groups were administered occasionally (detailed tables are shown in the supplementary data).

Krzyżanowski et al. in a Polish study carried out in the Pomeranian voivodeship indicated that in ground emergency medical teams, only 16% of AT patients are treated with analgesics. The most frequent drug is ketoprofenum. It was shown that 84% of all patients were transported to the hospital without painkillers.¹⁹ The study became the reason for the Ministry of Health to implement guidelines for ground and air emergency medical teams in the area of proper pain management.

Limitations of the study

The main limitation of the study is its retrospective character and the lack of possibility to follow-up the further fate of the patients. Nevertheless, an analysis was done of all the patients transported by HEMS in the timeframe reported, thus minimizing the risk that a systematic error of the selection should occur.

Conclusions

In Poland, HEMS is more readily available and more frequently administered for transport from the place of the event than for interhospital transfer. The interhospital air transport of AMI patients compared to transport from the emergency scene requires less advanced life-saving procedures with the exception of neuromuscular block, sedation and respiratory therapy. Similarities in these areas are also observed in the group of patients with AT. Longer distances or longer transport times of AT patients reflect the existence of fewer TCs compared to hemodynamic TCs. The location of hemodynamic centers in Poland, according to the results of the study, is optimal.

Patients diagnosed with T06 carried both by interHtransport and from the scene of the incident are most often transferred to TCs.

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Appendix – supplementary data

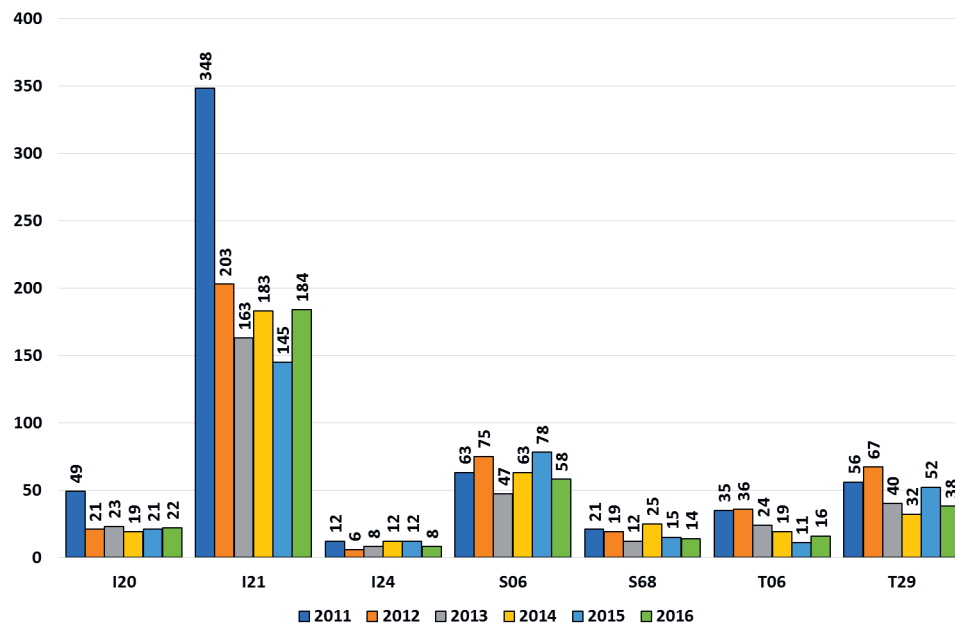


Fig. 2. The number of times interhospital aeromedical transport was used for patients with AMI and selected AT patients during the period analyzed

In the present analysis, the largest number of cases transported to interventional cardiology departments in order to implement the PCI procedure were those with the I 21 diagnosis (AMI). It is noticeable that over this timespan there is a decreasing tendency in the number of patients with AMI transported by air. The authors assume that in subsequent years interventional cardiology units were established in or near the hospitals ordering the air dispatch of such patients, which reduced the need for air transport. On the other hand, the number of times air transport that was used for AT patients remained on a similar level, probably due to the constant number of TCs. Since there are only over a dozen such centers operating in Poland now and a few replantation and burn centers, the transport of AT patients takes longer than that of AMI patients.

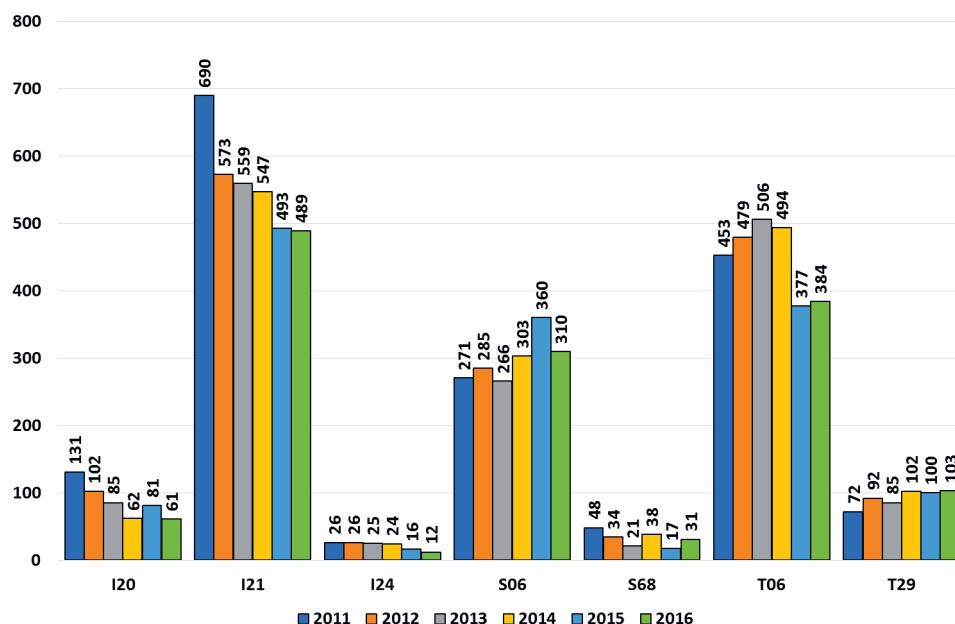


Fig. 3. The number of HEMS missions of patients with AMI and selected acute trauma patients by year

Among the patients transported directly from the scene of the incident, those diagnosed with I21, S06 and T06 were transferred mainly to interventional cardiology departments, replantation centers and TCs, respectively.

Table 8. The frequency of using selected medication by MARS teams in the course of interHtransport and HEMS missions in patients with AMI and AT

	AT				AMI			
	HEMS missions		interHtransport		HEMS missions		interHtransport	
Total number of patients	5,231	100%	916	100%	4,002	100%	1,439	100%
Sodium chloride	3,310	63.3%	368	40.2%	970	24.2%	180	12.5%
Acidum acetylsalicylicum	7	0.1%	2	0.2%	2,967	74.1%	747	51.9%
Clexane	0	0.0%	7	0.8%	101	2.5%	194	13.5%
Clopidogrelum	4	0.1%	1	0.1%	696	17.4%	80	5.6%
Heparinum sulfas	6	0.1%	4	0.4%	1,571	39.3%	474	32.9%
Morphini sulfas	1,437	27.5%	237	25.9%	2,668	66.7%	435	30.2%
Nitroglicerini	2	0.0%	1	0.1%	653	16.3%	154	10.7%
Ondasteronum	394	7.5%	36	3.9%	482	12.0%	119	8.3%
Midazolamum	1,447	27.7%	309	33.7%	207	5.2%	135	9.4%
Metoclopramidum	245	4.7%	22	2.4%	607	15.2%	48	3.3%
Rocuronium	573	11.0%	62	6.8%	26	0.6%	4	0.3%
Propofol	783	15.0%	91	9.9%	21	0.5%	5	0.3%
Ticagrelor	0	0.0%	0	0.0%	1	0.0%	0	0.0%
Ketoprofenum	603	11.5%	51	5.6%	49	1.2%	18	1.3%
Metamizolum	97	1.9%	28	3.1%	31	0.8%	8	0.6%
Tramadol	34	0.6%	16	1.7%	2	0.0%	0	0.0%
Ketamine	164	3.1%	18	2.0%	1	0.0%	1	0.1%
Paracetamolum	44	0.8%	8	0.9%	2	0.0%	0	0.0%
Fentanylum	2,727	52.1%	297	32.4%	159	4.0%	25	1.7%
Plavix	4	0.1%	2	0.2%	1,819	45.5%	666	46.3%
Compound electrolyte so	1,134	21.7%	194	21.2%	273	6.8%	65	4.5%
Suksametonium	445	8.5%	3	0.3%	8	0.2%	0	0.0%
Wekuronium	314	6.0%	41	4.5%	7	0.2%	5	0.3%
Atropinum	318	6.1%	19	2.1%	179	4.5%	7	0.5%
Epinephryne	306	5.8%	8	0.9%	114	2.8%	13	0.9%
Thiopental	309	5.9%	55	6.0%	8	0.2%	2	0.1%

MARS – Medical Air Rescue Service; HEMS – Helicopter Emergency Medical Service; AMI – acute myocardial infarction; AT – acute trauma; interHtransport – interhospital transport.

Table 9. The frequency of using analgesic medication by MARS teams in the course of interHtransport and HEMS missions to help patients with AMI

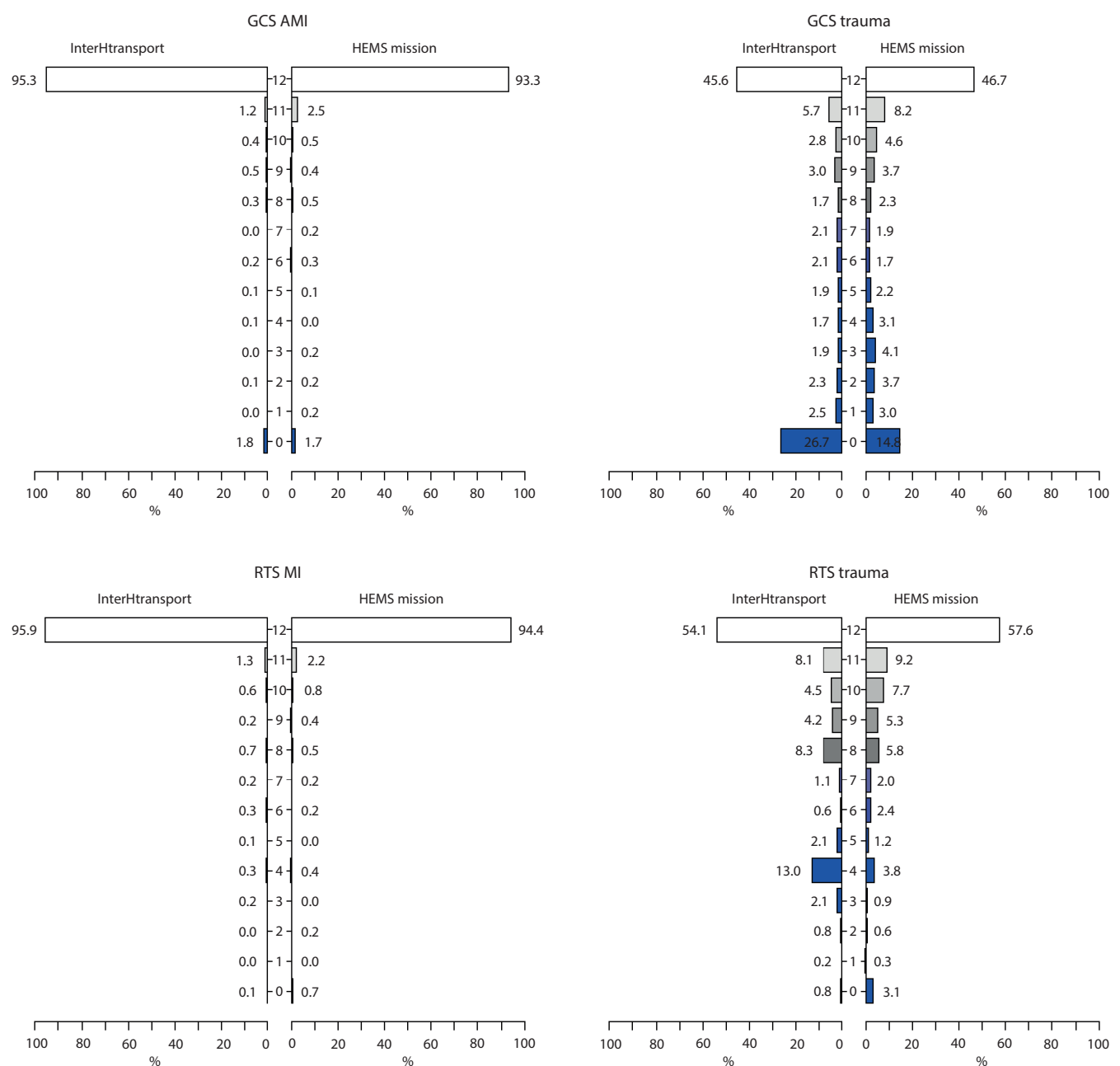
	HEMS missions				InterHtransport			
	ambulance – place of event		MARS		hospital		MARS	
Morphini sulfas	2,020	75.7%	648	24.3%	361	83.0%	74	17.0%
Ketoprofenum	42	85.7%	7	14.3%	17	94.4%	1	5.6%
Metamizolum natricum	21	67.7%	10	32.3%	8	100.0%	0	0.0%
Tramadol	2	100.0%	0	0.0%	0	–	0	–
Ketamine hydrochloride	1	100.0%	0	0.0%	1	100.0%	0	0.0%
Paracetamolum	2	100.0%	0	0.0%	0	–	0	–
Fentanylum	62	39.0%	97	61.0%	15	60.0%	10	40.0%

MARS – Medical Air Rescue Service; HEMS – Helicopter Emergency Medical Service; AMI – acute myocardial infarction; interHtransport – interhospital transport.

Table 10. The frequency of using analgesic medication by MARS teams in the course of interHtransport and HEMS missions to help patients with AT

Analgesic administered	InterHtransport				HEMS mission			
	ambulance – place of event		MARS		hospital		MARS	
Morphini sulfas	1,058	73.6%	379	26.4%	167	70.5%	70	29.5%
Ketoprofenum	469	77.8%	134	22.2%	45	88.2%	6	11.8%
Metamizolum natricum	73	75.3%	24	24.7%	24	85.7%	4	14.3%
Tramadol	34	100.0%	0	0.0%	16	100.0%	0	0.0%
Ketamine hydrochloride	20	12.2%	144	87.8%	12	66.7%	6	33.3%
Paracetamolium	44	100.0%	0	0.0%	8	100.0%	0	0.0%
Fentanylum	729	26.7%	1,998	73.3%	145	48.8%	152	51.2%

MARS – Medical Air Rescue Service; HEMS – Helicopter Emergency Medical Service; AT – acute trauma; interHtransport – interhospital transport.

**Fig. 4.** RTS and GCS scale distribution in the group of patients with AMI and AT