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**“AIR MEDICAL TRANSPORT AS AN ELEMENT OF THE THERAPEUTIC  
PROCESS – A DISCUSSION OF SELECTED DISEASE ENTITIES”**

**Abstract in English**

**Introduction**

The transport of patients with acute coronary syndrome (ACS) or acute trauma is an important component of the therapeutic process and can be conducted either by land or by air. The choice of the latter makes it possible to minimize the time that is necessary for the patient to reach the point of destination while under professional, specialist care. HEMS (Helicopter Emergency Medical Service) in Poland performs rescue flights both straight to the emergency scene and urgent missions between health care centers.

**Aim**

To do a comparative analysis of inter-hospital flight operations as well as HEMS missions performed in the years 2011–2018 regarding ACS patients and cases of severe trauma to demonstrate the safety and effectiveness of aircraft for the transport of patients with the disease entities under discussion. Analysis was also undertaken concerning the medical procedures undertaken, analgesic treatment and the time and distance of flights.

**Methods**

A case-control study. Medical history records of both inter-hospital rescue flights and transport straight from emergency scenes were examined. The medical and flight records had been collected in a Microsoft Excel (Microsoft Inc.) database. The groups of patients analyzed are homogenous and representative of the missions performed by HEMS. Those enrolled in the study comprised patients with the most frequent diagnoses among those transported by air, i.e. ACS and severe trauma. They were identified by means of the International Classification of Diseases ICD-10 codes. General information was obtained (age, sex, overall health condition, consciousness level on the GCS (Glasgow Coma Scale) scale, an assessment of the severity of the trauma: RTS (Revised Trauma Score) and NACA (National Advisory Committee for Aeronautics). Moreover, the study researched cases of fatalities during the flights, the medical procedures undertaken (chest compression, defibrillation, sedation, neuromuscular block, oxygen therapy, respiratory therapy, intubation, spinal immobilization

or putting on a cervical collar), the pharmacotherapy implemented, the time and distance of the flight, the missions carried out to reach the interventional cardiology department and the trauma center, the seasonal specificity of the missions, the workload of the regional bases as well as the missions performed in the bed-to-bed mode.

Descriptive statistics is presented as numbers and percentages for variables regarding categories and medians weighted with the 1st and 3rd quartiles for numerical data. Comparing the ACS patients with those suffering severe trauma was done using chi-squared and Mann-Whitney tests (for categorical and numerical data, respectively). Analyses were performed with R 3.4.1 software (R Core Team (2017). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL <https://www.R-project.org/>).

## **Results**

In the years 2011-2018 there were 66 522 HEMS flights out of which 11 663 were inter-hospital ones done in the rescue mode, and included: 1 821 ACS patients and 1 262 with severe trauma, i.e. 15.6% and 10.8% flights, respectively. Out of the 54 859 missions performed to rescue patients straight from the emergency scene, 5 201 were to ACS patients and 7 215 to ones with trauma, i.e. 9.5% and 13.2%, respectively. In the course of transporting ACS patients by air (on HEMS missions), there were two fatalities, while in the group of trauma patients there were no such cases. There was one fatality among the trauma patients transported by air straight from the emergency scene. In the course of inter-hospital transfers and HEMS missions, ACS patients had a higher result on the GCS scale than trauma victims: 15.0 vs. 14.0–15.0 (NS), respectively. In the group of patients with cardiac arrest during inter-hospital transport and during HEMS missions, appropriate medical procedures were recorded: cardiopulmonary resuscitation (CPR) 10 (0.6%) vs. 111 (2.3%) times ( $p < 0.001$ ); defibrillation 6 (0.3%) vs. 80 (1.5%) ( $p < 0.001$ ); sedation 120 (6.6%) vs. 231 (4.4%) ( $p < 0.001$ ); neuromuscular block 23 (1.3%) vs. 31 (0.6%); oxygen therapy 700 (38.4%) vs. 2415 (46.4%) ( $p < 0.001$ ). The distance median was 57.9 vs. 49.4 km ( $p < 0.001$ ); the flight time median 45.0 vs. 38.0 min ( $p < 0.001$ ). In the case of trauma patients transferred in the inter-hospital mode and during HEMS missions, medical teams used (respectively): CPR 6 (0.5%) vs. 406 (5.8%) ( $p < 0.001$ ); sedation 615 (48.7%) vs. 1648 (22.8%) ( $p < 0.001$ ); neuromuscular block 170 (13.5%) vs. 617 (8.6%) ( $p < 0.001$ ); intubation 73 (5.8%) vs 1564 (21.7%) times ( $p < 0.001$ ); oxygen therapy 193 (15.3%) vs. 2570 (35.6%) ( $p < 0.001$ ). The flight distance median was 111.0 km vs. 51.5 km ( $p < 0.001$ ), respectively; the flight time

median – 65.0 vs. 46.0 minutes ( $p < 0.001$ ). Patients with severe trauma, who were transported to a trauma center by means of inter-hospital and HEMS missions comprised 78.9% vs. 86.1%, respectively. In the case of missions carried out to ACS patients, 95% of all the flights were performed over a distance not shorter than 68.8 – 91.6 km.

Patients with the I21 diagnosis were the largest group among those with ACS transferred between hospitals. The drugs used were morphini sulfas and fentanylum. Among those brought straight from the emergency scene, the predominant diagnoses were I21, S06 and T06. Patients were administered fentanylum, morphini sulfas and ketamine hydrochloride.

As far as patients with cardiological diagnoses are concerned (I20, I21, I24), most of the inter-hospital transport cases and flights to emergency scenes between March and September were carried out in 2011 and 2012.

Most missions (transport and flight to emergency scenes) to patients with the S06 diagnosis were performed between May and September and in the years 2013, 2015 and 2017.

HEMS teams flew out to trauma cases classified as S68 mainly in the months of May-June and August-September. Flights to cases of trauma with the T06 diagnosis prevailed from May to September.

Inter-hospital transport of patients with the T29 diagnosis were most frequent in the years 2012, 2015 and 2017-2018, in the months of March, May-June and July-August. Most flights to this group of patients were carried out in June and September. Among the cardiac patients, the largest number of flights were carried out to cases with the I21 diagnosis. The base in Warsaw performed the greatest number of flights ( $n=326$ ), while the one in Koszalin – the least ( $n=11$ ).

Concerning patients with the I21 diagnosis, the greatest number of flights to perform medical rescue operations were carried out by the bases in Warsaw, Białystok, Olsztyn, Płock and the one in Szczecin ( $n=639$ ). The bases located in the south of the country, in Gliwice and Cracow, implemented most HEMS missions to patients with traumatic head injuries, i.e. skull and intracranial trauma, i.e.  $n=929$  and  $n=282$ , respectively. As far as air sanitary transport is concerned, the most frequently dispatched teams were those from Cracow ( $n=149$ ), Warsaw ( $n=87$ ) and Olsztyn ( $n=73$ ).

The largest number of air sanitary transport flights of patients with traumatic upper extremity amputations were carried out by the bases in Warsaw ( $n=25$ ), Wrocław ( $n=24$ ), Cracow

(n=21), Gliwice (n=20), while in the HEMS missions the numbers were: Łódź (n=41), Szczecin (n=21), Gdansk (n=21) and Warsaw (n=17).

Patients with multi-organ injuries were usually transported by the Warsaw base both by means of inter-hospital transport, as well as on HEMS missions, (n = 35; n=557, respectively).

The teams most often transporting patients with extensive burns on their missions were those from: Łódź (n=43), Warsaw (n=42), Lublin (n=38), Gdansk (n=35) and Wrocław (n=34), while in the cases of flights to the emergency scenes to: Szczecin (n=89), Lublin (n=74), Cracow (n=74), Warsaw (n=64), Łódź (n=61) and Gdansk (n=53).

The study showed that Polish Medical Air Rescue teams transported 1572 (86.8%) patients with ACS directly from the wards of the commissioning hospitals and 994 (79.0%) patients with severe trauma. Out of this number, 1219 (77.5%) patients with ACS and 751 (75.6%) with trauma were transported directly to the appropriate ward of the receiving hospital, which means that LPR teams usually transported patients in the *bed-to-bed* (B2B) mode of service.

## **Conclusions**

In Poland HEMS is both more readily available and more often used for the transfer of patients in life-threatening situations from emergency scenes than it is for inter-hospital transport. Air transport is safe, and it rarely requires undertaking resuscitation. There are differences between the two groups of patients analyzed regarding the advanced rescue procedures that have to be implemented. Both the distances and the time required for transporting trauma patients can be a reflection of the fact that in Poland trauma centers are distributed less evenly than are interventional cardiology centers, whose number and location seems to be optimal from the point of view of LPR. Patients with the T06 diagnosis, both in inter-hospital transport, as well as transferred straight from the emergency scene, are usually managed in a trauma center. Most transport missions take place in the bed-to-bed mode. Using LPR helicopters is the proper way of transporting patients with ACS and severe trauma (burns, amputations, multi-organ injuries), making it possible to minimize the time from the moment the trauma or disease occurs to the implementation of specialized management procedures.