

# A helicopter emergency medical service may allow faster access to highly specialised care

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## ABSTRACT

**INTRODUCTION:** Centralization of the hospital system entails longer transport for some patients. A physician-staffed helicopter may provide effective triage, advanced management and fast transport to highly specialized treatment for time-critical patients. The aim of this study was to describe activity and possible beneficial effect of a physician-staffed helicopter in a one-year trial period in Eastern Denmark.

**MATERIAL AND METHODS:** This was a prospective observational study of all missions related to a daylight operating, physician-staffed helicopter. We recorded information about the activity during 12 months, focusing on dispatchment, diagnoses, medical interventions, admission patterns and 30-day mortality.

**RESULTS:** There were a total of 574 missions resulting in 609 patient contacts. Activity ranged from 22 to 76 missions per month. The helicopter was grounded 6% of its operating time, mainly due to weather conditions. The primary patient categories were trauma (43.5 %) and cardiac disease (26.1%). The physician acted as Medical Incident Officer at three major incidents. A total of 53 endotracheal intubations, 13 intraosseous cannula insertions and four tube thoracostomies were performed. The median hospital length-of-stay was four days, 30-day mortality was 6.1% and 86 patients were transferred to intensive care units.

**CONCLUSION:** The physician-staffed helicopter had approximately two missions per day the first year, mainly in relation to trauma and cardiac patients needing specialized treatment. Advanced medical interventions were commonly performed.

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Centralization of Danish healthcare is associated with longer transport to primary hospital care. This calls for effective triage and fast transport, which challenges the prehospital emergency medical services (EMS) to adapt. A helicopter EMS (HEMS) may be an important component as it can provide fast transportation of patients to highly specialised care. Although HEMS is used in many parts of the world, every system is unique. Different staffing, protocols, geography and climate conditions make it difficult to extrapolate experiences from one system to another. A HEMS was introduced in a one-year trial period in Eastern Denmark in 2010, and the

present study aimed to describe the activity and any beneficial effects of the implementation; focusing on dispatchment, diagnoses, medical interventions, admission patterns and 30-day mortality.

## MATERIAL AND METHODS

This was a prospective observational study. We included all HEMS missions in the period from 1 May 2010 to 30 April 2011. The HEMS operated in the daylight hours from a base located centrally in a flat rural area in the eastern part of Denmark (**Figure 1**), covering 8,400 km<sup>2</sup> with a population of approximately 1.1 million. The main purpose of the HEMS was to assess, treat and transport time-critical patients. The dispatch protocol stated that HEMS should be dispatched in case of:

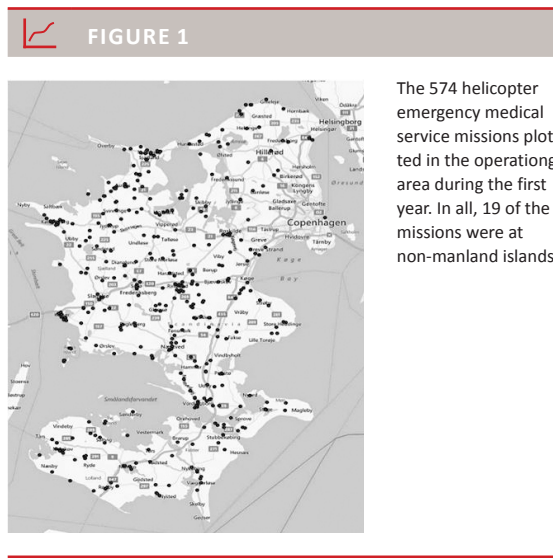
- 1) Suspected major trauma, including drowning and severe hypothermia – based on the alarm call.
- 2) Trauma patients with clinical conditions indicating major trauma, ST-segment acute myocardial infarction (STEMI) patients for percutaneous coronary intervention, ischaemic stroke patients for thrombolysis, severe burns, aortic aneurism, intracranial bleedings and critically ill children – based on information from EMS physician or health providers on scene.
- 3) Interhospital transfers of patients with time-critical conditions.

The HEMS was implemented as a supplement to the existing prehospital system, which in the region of Zealand presently consists of paramedic-manned ambulances. The HEMS staff consisted of an anaesthesiologist experienced in trauma care and prehospital emergency medicine, a paramedic with special training in navigation and radio communication techniques and a pilot. The HEMS physician acts on scene as treating physician and is allowed to declare death and thereby withdraw treatment and potentially save resources. At larger incidents with many injured persons, the HEMS physician can act as Medical Incident Officer, which is the highest triaging authority on scene. The equipment on the HEMS included various items for advanced life support, e.g. a ventilator, an automatic chest compression device, a defibrillator, medication, packed red blood cells, equipment for

## ORIGINAL ARTICLE

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emergency tracheotomy, tracheal intubation, tube thoracostomy and a tourniquet.

The two receiving hospitals for specialised care had designated helicopter platforms that provided fast and smooth access to the treatment modalities. Rigshospitalet in Copenhagen is the regional trauma and percutaneous coronary intervention centre and the national burn centre, and Roskilde Hospital serves as regional stroke centre.

Data from the HEMS clinical patient database, the HEMS research database and additional data regarding the activity recorded by HEMS physicians were used. Based on diagnoses recorded by the HEMS physicians, all patients were classified into a number of pre-specified categories. Their severity grade was determined by the National Advisory Committee of Aeronautics (NACA) scoring system ranging from 0 (no injury/disease) to seven (death) for description of the severity in cases of medical emergencies [1]. Data on 30-day mortality, hospital length-of-stay including transfers and intensive care unit admission were gathered from the Danish Registration System. Data from specific patient groups have been reported elsewhere [2-5]. Response time was defined as the time from HEMS activation by the dispatch centre to arrival at the scene.

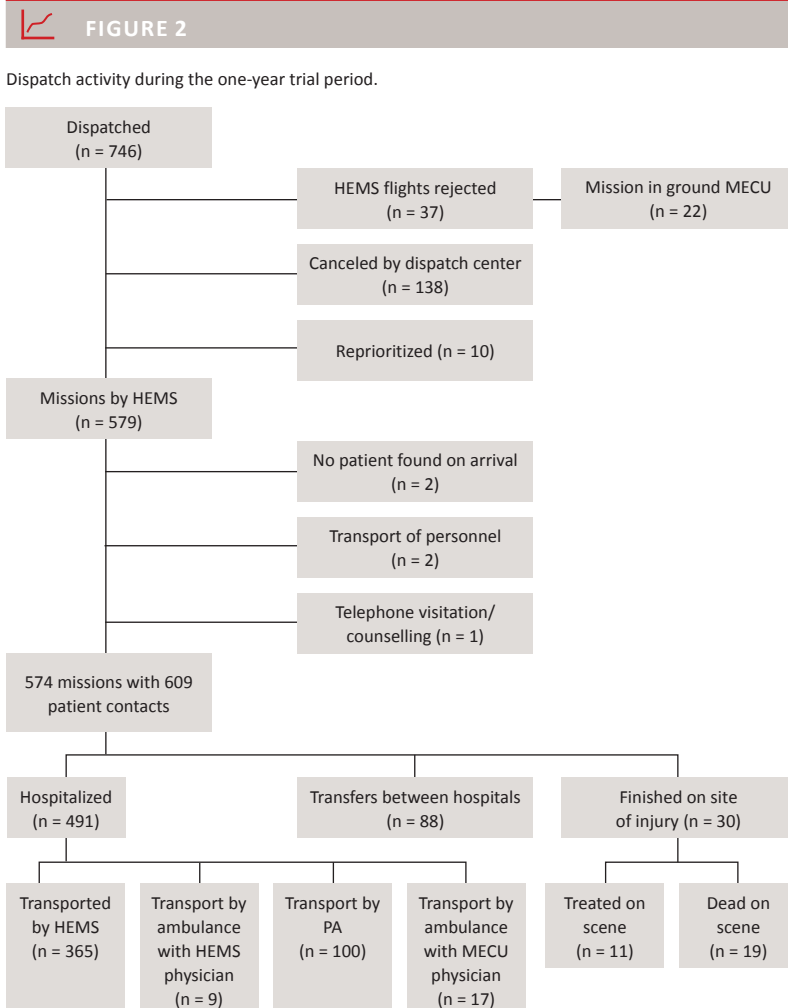
Continuous data were reported as medians with 5-95% percentiles and categorical data as proportions with 95% confidence intervals (CI). This project was reported to the Danish Data Protection Agency and permission for record access was granted by the Danish Health and Medicines Authority.

*Trial registration:* not relevant.

## RESULTS

The HEMS was dispatched 764 times and completed 574 missions (Figure 1), resulting in 609 patient contacts (multiple patients on scene) (Figure 2). Of these, 88 missions (14.4%) were interhospital transfers. The median (5-95% range) response time (n = 579) was 16 minutes (6-28 minutes). The lowest activity was observed in January (22 missions) and the highest in April (76 missions). Operating time (daylight hours) ranged from eight hours/day in December to 14 hours/day in May-July, on average 11.4 hours/day resulting in 0.15 missions per operational hour. Most patients (79%) were transported to Rigshospitalet, Copenhagen. Trauma patients comprised 43.5% (265/609), patients with cardiac disease 26.1% (159/609) and stroke patients 13.8% (84/609) (Figure 3).

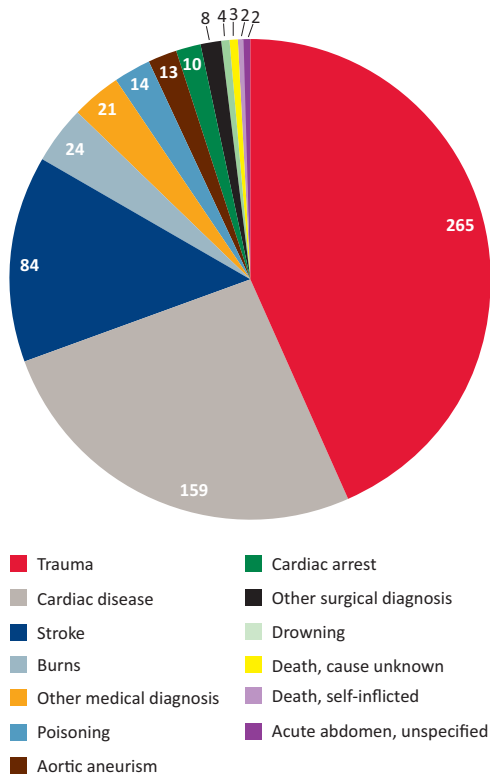
The physician performed a total of 53 endotracheal intubations, one emergency tracheotomy, 13 intraosseous cannula insertions and four tube thoracostomies. The HEMS physician acted as Medical Incident Officer at



HEMS = helicopter emergency medical service; MECU = mobile emergency care unit; PA = primary ambulance.


**FIGURE 3**

Number of patients (n = 609) treated by helicopter emergency medical service based on diagnoses.



three major incidents: in one case 11 teenagers had capsized in a boat, of whom eight developed hypothermic cardiac arrest. The two remaining incidents were road traffic accidents with several injured patients.

We found that 4.9% (30/609) (3.5-7.0, 95% CI) of the patients were not hospitalised: 1.8% (11/609) (1.0-3.2, 95% CI) were treated and discharged at the scene and 3.1% (19/609) (2.0-4.9, 95% CI) were declared dead at the scene (Figure 2). The NACA score was registered for 584 patients; 38.9% had a score of four (22.5% of the patients were trauma patients, 54.1% cardiac disease, 15.0% stroke and 8.4% other diseases) and 14% had a score > 4 (41.5% trauma, 14.6% cardiac disease, NACA score of 3.4). Hospitalisation > 24 hours was found for 83.2% (467/561) (80.0-86.1, 95% CI) of the cases and 15.4% (86/560) (12.6-18.6%, 95% CI) patients were admitted or transferred to an intensive care unit. The median (5-95% range) hospital length-of-stay (n = 561) was four days (0-58 days) and 30-day mortality was 6.1% (34/560) (4.4-8.4, 95% CI) (Table 1).

The HEMS was grounded 6% of its operating time, ranging from 33% in January to 0% in July, mostly due to weather conditions (87%). In 37 specific cases (5%), the crew rejected missions requested by the dispatch

centre: 25 due to weather conditions, five due to technical problems and in seven cases the cause was unspecified. "Missed missions" were registered in 38 cases as the HEMS was already occupied or another mission was given priority (Figure 2).

## DISCUSSION

The HEMS completed 574 missions resulting in 609 patient contacts with a median response time of 16 minutes during the trial period. The largest patient category was trauma (43.5%) followed by cardiac disease (26.1%). Advanced medical interventions were commonly performed, and 15.4% of the patients were admitted to an intensive care unit.

The data were collected prospectively. Owing to the patients' unique centrally registered personal identification number, we were able to follow the included patients during the hospitalisation and to collect information on 30-day mortality after discharge. Nevertheless, a number of limitations should be considered. This study was conducted to collect information over 12 months prior to a decision on whether the HEMS should be permanently implemented in Denmark or not. It was thus not possible to do a randomised study, as this would mean that the HEMS would only be used in about fifty per cent of the cases where its use was indicated. It was, however, decided to collect data on trauma, STEMI and stroke patients who underwent ground transportation in order to allow for comparison with the HEMS [2, 4, 5]. The HEMS was found to provide faster transport in trauma and STEMI patients, but no such benefit was seen for stroke patients.

We have no data documenting to which extent the dispatch operators used the dispatch protocol for decision-making and since this was a novel daytime operating HEMS, perhaps it was underused due to lack of dispatcher awareness [3]. It is also a limitation that we do not know the effect of having an anaesthesiologist on


**TABLE 1**

Demographics and outcomes.

Patient contacts, n	609
Men, n (%)	389 (64)
Age, yrs, median (5-95% range) <sup>a</sup>	54 (10-81)
30-day mortality, n (%) <sup>b</sup>	34 (6.1)
Intensive care unit admission, n (%) <sup>b</sup>	86 (15.4)
Hospitalization time, days, median (5-95% range) <sup>c</sup>	4 (0-58)

a) n = 604; 5 patients were not registered with a social security number, and the age was thus unknown.

b) n = 560; 30 patients were not hospitalised and 18 patients + 1 foreign patient were lost to follow-up.

c) n = 561; 30 patients were not hospitalised and 18 patients were lost to follow-up.

board, but this was not possible to investigate in our study.

It is generally believed that HEMS systems provide a number of benefits in the treatment of a selected group of severely ill or injured patients, as the time to highly specialised treatment can be reduced and out-of-hospital time shortened [3, 5-8]. More than 50% of the HEMS patients in this study had a NACA score  $\geq 4$ , suggesting severe and possibly life-threatening injury. Previous studies have also reported that the trauma patients transferred by air have a significantly higher injury severity score (ISS) than those transported by ground ambulance [7, 9-11]. A study from East Denmark describing the trauma population in 2006 documented that severely injured trauma patients were predominantly transported to local hospitals by EMS, resulting in an inappropriate delay to trauma centre treatment, and implementation of a physician-staffed HEMS was recommended as a possible solution to improve triage [12]. A large retrospective cohort study found that HEMS transport was associated with improved survival odds compared with ground transport [10]. Another study showed the same trend in patients with ISS > 15 and found that HEMS patients were admitted to intensive care units more frequently than other patients [11]. Nevertheless, only few prospective studies exist. A significant decrease in 30-day mortality from 29% to 14% for trauma patients with an ISS >15 after implementation of the HEMS in the present region was found, and the number of secondary transfers from local hospitals to the trauma centre was reduced from 50% to 34% as a result of a more direct triage by the HEMS at the scene [5]. Although patients in the control group were significantly younger, the additional analyses aiming to adjust for case-mix variation also showed that HEMS transport was associated with improved survival.

For patients with STEMI, rapid treatment at a designated percutaneous coronary intervention centre is crucial, and reduced delay results in lower morbidity and long-term mortality [13]. The need for air transport of STEMI patients in East Denmark was indicated in a recent study [6], and a subsequent study after HEMS implementation found helicopter transport to be faster than ground transport [2].

The median hospital length-of-stay was four days and 15.4% were admitted to an intensive care unit. The relatively short hospital length-of-stay may be affected by the 26.1% of the patients with cardiac disease, since the majority of these were transported for percutaneous coronary intervention, resulting in discharge shortly after. Furthermore, the trauma patients with non-severe injuries had a short hospital length-of-stay. The 30-day mortality was 6.1%. We found no other case-mix studies for comparison, but in a study from the same region, the

overall mortality in trauma patients was 4.3% [12], and when transported by HEMS in the UK, the intensive care unit admission was 11.1% and hospital length-of-stay almost three days [14].

The guidelines from American College of Surgeons Committee on Trauma refer to an acceptable over-triage in trauma patients of up to 50% in order to reduce under-triage, when over-triage is defined as patients admitted to hospital < 48 hours, and not admitted to either intensive care unit or operating room [15]. Bledsoe et al found that 25% of all trauma patients transported by HEMS were discharged within 24 hours [16], and Melton et al found that 41% were discharged home directly from the emergency department without need for admission [14]. Our study found that 16.8% of the patients were discharged within 24 hours – suggesting an acceptable degree of over-triage. However, the number of trauma patients with an ISS < 15 transported by the HEMS was high (69%), indicating an over-triage [5].

An unresolved issue is to which extent the HEMS can reduce time to treatment at a highly specialised level. This is partly due to the fact that the HEMS often spends more time from activation by the dispatch centre to departure [7] and has longer on-scene times than ambulances [9]. An American study found that total transport time was shorter by HEMS than by ambulance between hospitals if the distance was 32-112 km despite the fact that the HEMS had longer response time and stayed longer at the local hospital [8]. Other studies suggest that appropriate location of the helipads is essential to achieve a benefit from HEMS transport [2, 7, 17]. The median response time was 16 minutes which indicates that the location of the HEMS base is appropriate, as our neighbour countries have reported response times of 12 and 26 minutes [18, 19].

An expansion of the system enabling operations in reduced visibility and darkness would enhance HEMS availability and utilisation. However, it is unclear what the effect of flying at night would be. Ringburg et al found that the most apparent need for the HEMS in the dark hours is between seven and 12 pm. [20]. During the entire day, most incidents in Denmark (Jutland) [17], Sweden [18], and Eastern Denmark (severe trauma) occur in the daytime [3]. Furthermore, the Danish aviation regulation states that HEMS is allowed to land only at designated rendezvous sites during the dark hours. The extra time needed for transfer of the patient from the scene to these helipads by ground ambulance [17] might offset a potential gain in time by the HEMS.

## CONCLUSION

We found that the physician-staffed HEMS was mainly dispatched to trauma and cardiac patients as determined by the dispatch protocol. Advanced medical inter-

ventions were commonly performed and a substantial proportion of patients needed highly specialised care.

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