# Helicopter-based emergency medical services for a sparsely populated region: A study of 42,500 dispatches

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**Background:** The Helicopter Emergency Medical Service (HEMS) in Norway is operated day and night, despite challenging geography and weather. In Western Norway, three ambulance helicopters, with a rapid response car as an alternative, cover close to 1 million inhabitants in an area of 45,000 km$^2$. Our objective was to assess patterns of emergency medical problems and treatments in HEMS in a geographically large, but sparsely populated region.
**Methods:** Data from all HEMS dispatches during 2004–2013 were assessed retrospectively. Information was analyzed with respect to patient treatment and characteristics, in addition to variations in services use during the day, week, and seasons.
**Results:** A total of 42,456 dispatches were analyzed. One third of the patients encountered were severely ill or injured, and two thirds of these received advanced treatment. Median activation time and on-scene time in primary helicopter missions were 5 and 11 min, respectively. Most patients (95%) were reached within 45 min by helicopter or rapid response car. Patterns of use did not change. More than one third of all dispatches were declined or aborted, mostly due to no longer medical indication, bad weather conditions, or competing missions.
**Conclusion:** One third of the patients encountered were severely ill or injured, and more than two thirds of these received advanced treatment. HEMS use did not change over the 10-year period, however HEMS use peaked during daytime, weekends, and the summer. More than one third of all dispatches were declined or aborted.

**Editorial comment: what this article tells us**
This report describes the pattern of utilization of a regional helicopter-based air ambulance system serving a sparsely populated large geographical area. With critical care personnel and resources on board, advanced care can be initiated early for severely ill or injured patients.

Vast rural areas, a long coastline, fjords, high mountains, and great distances make the Helicopter Emergency Medical Service (HEMS) an important supplement to ground services in Western Norway. In particular, HEMS is a key component of meeting the declared political goal of equal access to advanced medical care, regardless of location. The unofficial national standard for emergency missions is that 90% of the population should be reached by a physician-staffed ambulance within 45 min.[1] The Norwegian health care system has become more centralized with increased specialization, and several smaller hospitals consequently





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have closed. General practitioners (GPs) on call in municipalities may be responsible for a large geographic area, as municipalities often share services.[2] The result is an increase in both ambulance missions and transport distance.

Norwegian HEMS operate day and night, despite challenging factors related to weather, geography, and light conditions (night and winter darkness). A rapid response car is available on every base. Missions include primary and secondary (inter-hospital) missions for both medical emergencies and trauma, but also search and rescue (SAR), patients with minor injuries in the mountains, and inter-hospital incubator transports of newborns.[3] This role is in contrast to many international HEMS that are limited only to operating during daytime, responding to trauma, or performing inter-hospital transfers.[4–6] Several HEMS have published their experiences,[4,5,7–11] but comparing such services is challenging.[12] Some publications have described the Norwegian and Scandinavian emergency medical services,[3,13–16] and the Norwegian National Air Ambulance Service publishes a short annual report based on data from each HEMS base.[17]

Anesthesiologists in pre-hospital emergency services are common in Scandinavia, and Norway has a long tradition of staffing HEMS with an anesthesiologist as the emergency physician. Triaging and careful use of HEMS are important to avoid both under- and overuse of the service. Competing missions, bad weather, logistic challenges, and other factors can lead to declined dispatches or aborted missions (cancelations). Knowledge about the temporal variations and occurrence of cancelations is lacking, despite its importance for planning services. Hence, more information is needed to evaluate medical priorities, patient outcome, and patterns of use. We hypothesized that our HEMS responded to severely ill or injured patients and a large part of these patients needed advanced medical treatment.

The objective of the present study was to assess patterns of emergency medical problems and treatments in the pre-hospital system, in a geographically large but sparsely populated region, where helicopter emergency medical services were involved.

## Methods

This retrospective study presents analysis of patient records from all dispatches during the period 2004–2013 for the three HEMS bases in Førde, Bergen, and Stavanger.

### Population and geography

Western Norway has a population of 1,087,000 and is 45,000 km$^2$ in area.[18] One third of the population lives in Stavanger and Bergen; outside these cities, population density is only 15 persons per km$^2$. The rural area consists of islands, long fjords, high mountains, rough terrain, and low quality roads, resulting in prolonged response and transport times by ground ambulances.

### Emergency medical services in Western Norway

Four emergency medical call centers (EMCCs) serve as dispatch centers for 94 ground ambulances and three HEMS in the region. GPs are on call and may respond together with ambulances in rural areas. Five local hospitals, two regional hospitals, and two university hospitals serve the area (Supplemental files, Fig. S1). The region also has two SAR helicopters, which in some cases are dispatched if HEMS declines or aborts a mission. Data on these missions were included as canceled missions in our study. All services are fully government funded (not per mission).

All of our bases are continuously open for operations and have a rapid response car as an alternative for local missions or when the helicopter is not available. The helicopters (EC135) have a standard capacity for one supine and one sitting patient and are staffed with a pilot, a rescue paramedic, and an anesthesiologist. The HEMS physician is responsible for triaging patients/missions based on information from the EMCC, but dispatch criteria at the three bases are not entirely identical. If a HEMS crew has worked 14 of the last 24 h, they will be out of service for 9 h according to Norwegian HEMS regulations.

### Data source, data cleaning, and variables

The HEMS in Western Norway register all activity in a database called "Airdoc" (Filemaker 8, Filemaker Inc., CA, USA). The data include administrative, time, and patient data; vital signs; treatment performed; and a free-text option. Unusual, extreme, or missing values were assessed by reading the free-text field and cross-checking other sources (e.g., EMCC records and pilot flight logs). Missing or obviously incorrect values were corrected when reliable data were identified, but otherwise, these values were excluded. A HEMS mission was defined as a dispatch from the EMCC, leading to a response with the rapid response car or helicopter. Cancelations were defined as either a declined dispatch (before helicopter take-off or car moving) or an aborted mission. Seasons were defined in 3-month units (e.g., December, January, and February as winter; March, April, and May as spring). Activation time were defined as time from dispatch to helicopter take-off or car moving, response time from dispatch to encountering the patient, on-scene time from encountering the patient to start of patient transport from the scene, and transport time from start of patient transport from scene to end of patient care. The National Advisory Committee for Aeronautics score (NACA, Supplemental files, Table S1) was modified to be used for pre-hospital medical emergencies and trauma in 1980.[19,20] This severity score from level 0 (no injury or disease) to level 7 (death) is used in Norwegian HEMS. Conditions with a NACA score of 5–7 were considered to represent patients with severe illness or injury.

### Statistical methods

All HEMS dispatches during 2004–2013 were included. Normally distributed data are presented as mean with standard deviation (SD); otherwise, median and inter-quartile range (IQR) are presented. The Chi-square test was used to examine proportions of advanced treatment between different groups of NACA scores, and between observed missions with patient encounter, declined dispatches, aborted missions, reasons for declining or aborting, and the total of the others. Linear regression models were applied to evaluate the association between continuous data, and $R^2$ for goodness of fit. Yearly incidence of missions was calculated by the ratio of total missions over the entire population in the area, divided by the number of study years. Population data were based on census data. Data were analyzed with IBM SPSS Statistics for Windows, Version 22 (IBM Corp., Armonk, NY, USA), and linear regression was performed in Excel 2010 (Microsoft Corp., WA, USA). A $P$-value of $< 0.05$ was considered statistically significant.

The Regional Committee for medical and health research ethics West (REK Vest 2010/2930, 15.12.2010, committee head Jon Lekven), waived the requirement for formal review, but had no objections to publication of the data. The Ministry of Health and Care Services (2011-02407), the Norwegian Data Protection Authority (12/00291-3), and Data Protection Officials for Research all approved the project.

## Results

All 42,456 dispatches registered during the 10 years were included (Fig. 1). Most dispatches were to primary missions, 82.6% ($n$ = 35,051), and the number of dispatches to primary missions did not change during the study period ($R^2 = 0.28$; Table 1). Consistently across the 10-year period, the busiest times were during summer, weekends, and daytime.

### Primary missions with patient encounter

Despite a 12.5% population increase,[18] the number of missions was constant ($R^2 = 0.12$). Table 2 gives the characteristics of the missions. The proportion of patients suffering from stroke increased from 4% to 7.5% ($R^2 = 0.76$), but other conditions showed only minor variation. About 10% of the patients were < 10 years old. Mean NACA score was 4.3 (SD = 0.8). Trauma and cardiovascular diseases (cardiac arrest, chest pain, and stroke) were the two major groups of conditions, each representing almost one third of the missions.

### Medical treatment in primary missions

Advanced treatment was performed in 41.2% ($n$ = 8421) of all primary missions and basic treatment in 34.2% ($n$ = 6991). A severe illness



 

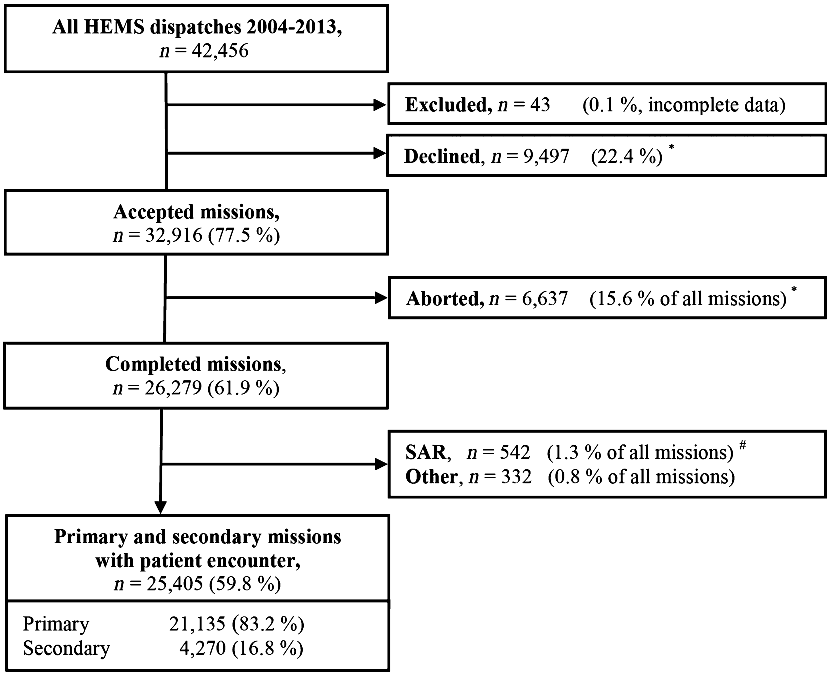


**Fig. 1.** Flowchart showing all HEMS missions, with excluded and declined dispatches, aborted and completed missions, and the proportion of completed primary and secondary missions with patient encounter. Primary missions were defined as responses to patients outside hospitals. Secondary missions were defined as inter-hospital transfers, transporting patients to a higher level of care. Search and Rescue (SAR) missions include searching for the patient or a missing person, or when rescue techniques were used (e.g., rope rescue operation). Examples of other missions are inter-hospital transportation of a patient to a lower level of care, and transporting blood products, surgeons, or fire crew. *470 declined, and 117 aborted missions (total 1.4% of all HEMS missions) were transferred to other HEMS in the area; hence, these incidents are counted as two dispatches. Some dispatches were declined or aborted with helicopter but completed (with patient encounter) using a rapid response car. #1/3 of the completed SAR missions included patient encounter (*n* = 175).

**Table 1** Population, emergency calls to EMCC, ambulance missions, and emergency HEMS dispatches in 2004 and 2013.

| | 2004 | | 2013 | | Increase | |
|---|---|---|---|---|---|---|
| | *n* | Per 10,000 | *n* | Per 10,000 | % | $R^2$* |
| Population[18] | 941,129 | | 1,058,994 | | 12.5 | 0.99 |
| Ambulance missions † | 79,681 | 846.7 | 119,493 | 1,128.4 | 50.0 | 0.95 |
| Emergency ambulance missions | 16,141 | 171.5 | 31,438 | 296.9 | 94.8 | 0.99 |
| All emergency HEMS dispatches | 3456 | 36.7 | 3513 | 33.2 | 1.6 | 0.36 |

*Linear regression, $R^2$ for goodness of fit. †All ambulance missions from EMCC data, including ambulance transports home from hospital. All types of emergency HEMS missions are included.

or injury (NACA = 5–7) was encountered in 33.3% (*n* = 6745) of primary missions. These patients received advanced medical treatment in 66.3% (*n* = 4474) of the missions while basic treatment was provided in 24.3% (*n* = 1642) (Fig. 2). A larger proportion of patients with NACA 5–7 received advanced treatment compared to patients with NACA 0–4 (z > 10, $P < 0.001$).

## Mission times in emergency primary missions

Regarding response time in emergency missions, 94.9% (*n* = 14,715) of the patients were reached within 45 min and 98.3% (*n* = 15,236) within the first hour, including both helicopter and rapid response car missions. Median times for helicopter mission stages were as follows: 5 min (IQR = 5 min) activation time, 24 min

**Table 2** Primary and secondary missions, with a total of 25,405 patient encounters.

| | All | | Primary missions | | | Secondary missions | |
|---|---|---|---|---|---|---|---|
| | *N* (%) | NACA, median (inter-quartile range) | *N* (%) | Incidence per 10,000 inhabitants per year* | NACA, median (inter-quartile range) | *N* (%) | NACA, median (inter-quartile range) |
| Missions with patient encounter | 25,405 (100.0) | 4 (2) | 21,135 (100.0) | 21.3 | 4 (2) | 4270 (100.0) | 4 (1) |
| Patients < 2 years | 1292 (5.1) | 4 (1) | 991 (4.7) | 1.0 | 4 (1) | 301 (7.0) | 4 (2) |
| Patients < 10 years | 2600 (10.2) | 4 (1) | 2179 (10.3) | 2.2 | 3 (1) | 421 (9.9) | 4 (1) |
| Patients > 75 years | 3,596 (14.2) | 4 (2) | 2833 (13.4) | 2.9 | 5 (2) | 763 (17.9) | 4 (1) |
| Missing | 974 (3.8) | 4 (2) | 891 (4.2) | | 4 (2) | 83 (1.9) | 4 (1) |
| Condition† | | | | | | | |
| Trauma | 7519 (29.6) | 3 (1) | 6932 (32.8) | 7.0 | 3 (1) | 587 (13.7) | 4 (2) |
| Cardiac arrest | 3264 (12.8) | 7 (1) | 3211 (15.2) | 3.2 | 7 (1) | 53 (1.2) | 6 (0) |
| Chest pain | 4044 (15.9) | 4 (0) | 2582 (12.2) | 2.6 | 4 (0) | 1462 (34.2) | 4 (0) |
| Acute neurology (excl. stroke) | 2312 (9.1) | 4 (1) | 2138 (10.1) | 2.2 | 4 (1) | 174 (4.1) | 4 (1) |
| Stroke | 1369 (5.4) | 4 (1) | 986 (4.7) | 1.0 | 4 (1) | 383 (9.0) | 5 (1) |
| Breathing difficulties | 1201 (4.7) | 4 (1) | 983 (4.7) | 1.0 | 4 (2) | 218 (5.1) | 4 (1) |
| Psychiatry including intoxication | 789 (3.1) | 4 (2) | 758 (3.6) | 0.8 | 4 (2) | 31 (0.7) | 4 (2) |
| Infection | 1044 (4.1) | 4 (1) | 733 (3.5) | 0.7 | 4 (1) | 311 (7.3) | 4 (1) |
| Obstetrics and childbirth | 756 (3.0) | 3 (1) | 491 (2.3) | 0.5 | 3 (1) | 265 (6.2) | 4 (1) |
| Other medical diagnoses | 2724 (10.7) | 4 (1) | 1985 (9.4) | 2.0 | 4 (1) | 739 (17.3) | 4 (1) |
| Missing | 383 (1.5) | | 336 (1.6) | | | 47 (1.1) | |

| | Primary missions, *n* (%) |
|---|---|
| Transport to scene | |
| Helicopter | 14,720 (69.6) |
| Rapid response car | 6400 (30.3) |
| No vehicle | 15 (0.1) |
| Transport from scene | |
| Helicopter | 10,747 (50.8) |
| Ambulance | 7375 (34.9), HEMS physician attending in 4,503 (61.1) |
| Not transported | 1927 (9.1) |
| Other | 118 (0.6) |
| Not reported | 968 (4.6) |

*Yearly incidence of missions was calculated by the ratio of total missions over the total population in the area, divided by the number of study years. †The pre-hospital medical diagnoses made by the physician on call were categorized into 10 medical conditions (main reason for response), according to the reporting recommendation.[12] All external impacts causing injury were classified as trauma, including drowning, foreign body airway obstruction, and cardiac arrest caused by trauma. Patients were already categorized according to the NACA severity score.[19,20] Missing NACA scores in table, 827 (3.3%).

(IQR = 16 min) response time, 11 min (IQR = 11 min) on-scene time, and 25 min (IQR = 19 min) transport time.

## Reasons for cancelations

More than one third (38.0%; *n* = 16,135) of all dispatches were canceled, with lower proportions in the summer and during daytime. "No indication", as evaluated by the HEMS anesthesiologist, was reported in 28.0% (*n* = 9808) of dispatches to primary missions, bad weather in 5.1% (*n* = 1774), competing missions in 3.5% (*n* = 1230), and other reasons in 3.1% (*n* = 1104). The proportion and nature of reasons for canceled primary missions did not change.

During nighttime, almost every second dispatch to primary missions was canceled (48.3%;



 

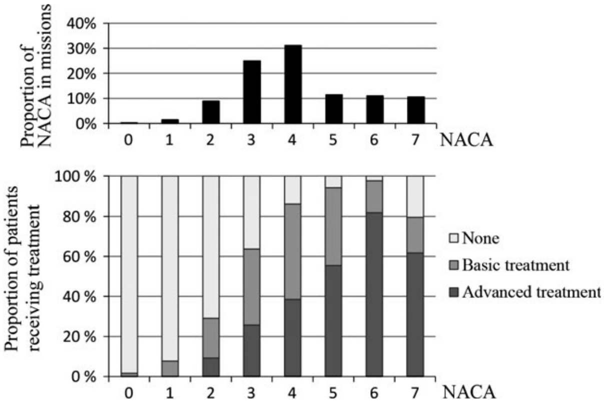


**Fig. 2.** Distribution of NACA in primary missions with patient encounter and level of treatment performed in the different NACA groups. Basic treatment: Basic airway procedures (manual airway opening/ oropharyngeal airway), suction, oxygen therapy, assisted ventilation, CPAP, defibrillation/electro-conversion, CPR, naso-gastric tube, ECG, immobilization (stiff neck collar, backboard, pelvic-sling, splint), or use of drugs available in the ground ambulance service; epinephrine (only during CPR), cyclizine, metoclopramide, glucose, sublingual glycerol nitrate, acetylsalicylic acid, crystalloids, inhalational ipratropium bromide and salbutamol, naloxone, flumazenil, and paracetamol. Advanced treatment: Intubation/tracheostomy, mechanical ventilation, thoracostomy, chest compression device, thoracic needle decompression, external cardiac pacing, anesthesia, central venous/arterial/intraosseus cannulation, use of neonatal incubator, nerve blocks, ultrasound, use of blood products, and use of drugs not mentioned in the basic treatment. NACA 4 are patients with a condition that can possibly lead to deterioration of vital signs, while NACA 5 and 6 are patients with deranged vital signs and a confirmed life-threatening injury or disease.[19] NACA scoring was missing (not reported) in 706 missions.

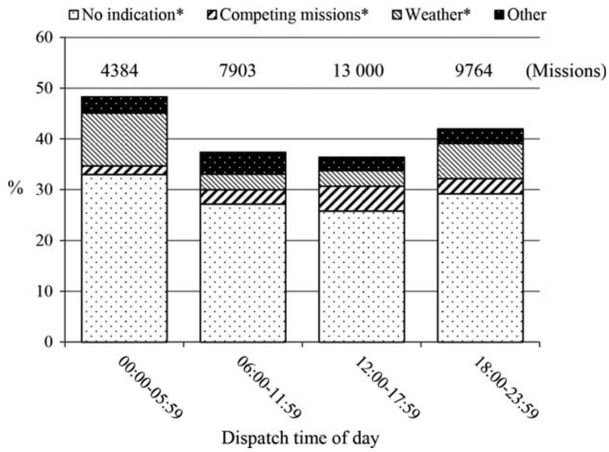


**Fig. 3.** Temporal distribution of reasons for declining or aborting primary HEMS dispatches with respect to time of day. **P*-value < 0.05 for difference between observed "no indication," competing missions, and bad weather, for declining and aborting dispatches (for time of day) and the total of the others compared by Chi-square test. "No indication" describes when HEMS was dispatched by the EMCC, but the HEMS physician on call decided no indication for advanced medical treatment or helicopter transport, and also includes "coordination" (e.g., other suitable ambulance/resource available). Competing mission specifies a dispatch occurring simultaneously with another mission. "Other reasons" for declining or aborting a dispatch includes patient deceased before arrival, technical problems, crew out of service due to flight regulations, or patient not suitable for transport.

$n = 2116$), with two thirds classified as "no indication" (Fig. 3). Weather conditions precluding helicopter flights were reported more frequently at night (10.4%; $n = 457$) and during winter (8.4%; $n = 687$). To further explore the effect of nighttime on these two reasons for cancelations of primary missions, the declined dispatches and aborted missions were separated; revealing an increased nighttime rate of both declined and aborted helicopter missions as a result of bad weather conditions ($z > 10$, $P < 0.001$). The proportion of aborted missions due to "no indication" showed no variation, while the proportion of declined dispatches for the same reason increased during nighttime ($z > 10$, $P < 0.001$).

Additional data describing temporal distributions and reasons for canceling are available from the corresponding author.

## Discussion

Our study is a large evaluation of HEMS missions, with data from close to 42,500 dispatches over 10 years, using the NACA score to assess the severity of patient's condition. The NACA score is a crude scale but is reported to be useful for predicting mortality and the need for early respiratory therapy.[20] Applying NACA, we showed that one third of the patients in our primary missions were severely ill or injured (NACA 5–7). Advanced treatment was provided in more than two thirds of these missions, which cannot be expected from ambulance personnel or regular GPs. Indeed, many patients with serious conditions and a high rate of providing advanced medical treatment may indicate the need for an anesthesiologist or at least a physician well-trained in emergency medicine; however, the benefit of physician-staffed HEMS has been debated for decades.[9,13,15,21,22] In addition, the advantage of an experienced anesthesiologist capable of early and sound clinical judgment may be of more value than performing advanced interventions, as the avoidance of an intervention is best practice in some cases. Other researchers have found that advanced treatment was performed in only 23.1% of HEMS missions, but they included several rural services and used a different study design.[14] The use of HEMS has changed slightly in recent years, with a focus on rapid transport to a hospital with appropriate medical, high-tech interventions in patients suffering myocardial infarction or stroke. However, we report an increase only in the proportion of missions with patients suffering stroke. We observed an increase in myocardial infarctions, but this increase was absorbed into the large group reported as chest pain.

In our primary trauma missions, the median NACA score was low, with a questionable indication for HEMS and a lower median score than is associated with medical emergencies. This result may indicate a lower threshold for responding to trauma than to medical emergencies. The initial phase after an accident is often characterized by uncertainty, which may contribute to over-triage in HEMS, as others have reported.[23] A number of rescued hikers and skiers who sustain relatively minor trauma also reduced the median NACA for trauma patients in the current study.

Our service had a short median activation time and a median response time of 24 min. In primary emergency helicopter missions, 97.7% of patients were reached within the first hour after dispatch. This result compares well with Krüger et al., who reported 7 min of median activation time and 90% of patients reached within the first hour, but rural HEMS and large SAR helicopters were included in their studies.[3,14] A small helicopter with the crew residing at the HEMS base reduces activation time and thus response time. A location away from the nearest airport also avoids "air traffic jams". Reducing time on-scene has received great focus in our services, and we found a short median on-scene time (11 min) in helicopter missions. A German study reported close to 40 min on-scene time; however, many of their patients (65.7%) were intubated on-scene.[24]

The Norwegian HEMS use rate has been suggested to be as low as 11 primary missions with patient encounter per 10,000 inhabitants (obtained by extrapolating the incidence of patient encounters in a prospective registration during 4 weeks), and even lower, at 7.5, using data from the Norwegian Air Ambulance Service.[14,16] The discrepancy from our results (21.3) is most likely due to differences in study design, data definitions, and services included. Because HEMS is a limited resource, the decision about which dispatches to accept is critical. Our HEMS crews must try to anticipate when rapid transport and advanced medical care may benefit the current patient most. In rural settings, the local GP often accompanies the ambulance and may reduce the need for HEMS, particularly if well-trained in emergency medicine.

HEMS may be called a reliable resource, as 88.3% of the dispatches to primary missions either led to patient encounter or a deliberate cancelation ("no indication"). Our proportion of cancelations compares well with similar services.[10,11] Among several reasons for cancelations, the most common was "no indication," especially at night. If the EMCC dispatches HEMS to exactly the same type of missions at all times of day, the increased proportion of nighttime dispatches declined due to "no indication" is hard to explain. However, several factors influenced the decision to decline, including EMCC operator experience, HEMS crew experience, pilot concerns about weather conditions, and tiredness, which may have justified the use of other available emergency resources. As expected, we also found a higher prevalence of cancelations due to bad weather during nighttime, autumn, and winter. During late autumn and winter, our region has only 8 h of daylight and frequent storms and snow with low visibility. Helicopter flights at night and in low visibility are associated with a higher level of risk, and helicopter pilots follow stricter flight rules.[7] Our proportion of canceled helicopter flights caused by bad weather are only slightly more than half of what Lawless et al. reported, probably because of different helicopters, pilot experience, and local weather conditions.[11] However, our cancelations due to "no indication" were almost four times higher, which may indicate broader dispatch criteria in our service, differences in populations, and different levels of HEMS crew experience.

The annual number of dispatches to primary HEMS missions did not change, despite the increase in regionalization, population, number of emergency calls, and emergency ambulance missions. It is interesting that while the number of emergency ambulance missions doubled during the period, we found no increase in primary HEMS missions. This stability could be a result of an unchanged number of patient conditions requiring HEMS, more ambulance dispatches defined as emergency missions, or stricter HEMS dispatch criteria. Most dispatches occurred during daytime, especially in the afternoon. A German study reported a similar pattern, although their peak proportion of missions per hour was before noon.[25] The summer is a busy period, probably because of more outdoor-related activity, and the frequency of competing missions increased in these periods. Our low incidence of competing missions indicates that our HEMS capacity has not reached its upper limit. Seasonal variation was unchanged during the study years. This unchanged HEMS dispatch profile provides important information for future governmental planning.

The fate of patients who cannot be reached by HEMS, the selection when prioritizing among competing requests, and in-hospital morbidity and mortality, deserve further exploration. Differences in acceptance policies among the Norwegian HEMS bases are interesting. In comparison to others, our study results are transferable to similar physician-staffed HEMS operating during day and night.

The paper-based standardized report forms were in some cases filled in after the mission and therefore prone to recall bias. However, we have no reason to believe that this process led to a systematic bias. The quality of data (definition and compliance) is important for implementing results from retrospective studies. All procedures performed are probably not registered; hence, the rate of advanced treatment performed might be underreported. Finally, some dispatches may not be registered if an EMCC has avoided scrambling a crew already busy with another mission or being out of service.

In conclusion, one third of the patients were severely ill or injured, and more than two thirds of these patients received advanced treatment. HEMS use did not change over the 10-year period, however HEMS use peaked during daytime, weekends, and the summer. More than one third of all dispatches were declined or aborted, primarily because of no longer medical indication or due to weather conditions.

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## Author contributors

ØØ and GB conceived and ØØ designed the study. ØØ prepared the figures, conducted the data analysis, and drafted the initial manuscript. All authors interpreted the data and critically revised the manuscript. All authors read and approved the final manuscript.

## Guarantor

Guttorm Brattebø.

## References

1. Øgar P. NOU 1998:8 Air ambulance service in Norway (Document in Norwegian). SHD 1998: 161.
2. Zakariassen E, Hansen EH, Hunskaar S. Incidence of emergency contacts (red responses) to Norwegian emergency primary healthcare services in 2007–a prospective observational study. Scand J Trauma Resusc Emerg Med 2009; 17: 30.
3. Kruger AJ, Skogvoll E, Castren M, Kurola J, Lossius HM. Scandinavian pre-hospital physician-manned Emergency Medical Services – same concept across borders? Resuscitation 2010; 81: 427–33.
4. Kaufmann M, Moser B, Lederer W. Changes in injury patterns and severity in a helicopter air-rescue system over a 6-year period. Wilderness Environ Med 2006; 17: 8–14.
5. Leaman AM, Nutbeam T. Trauma systems and medical helicopters in the UK. Injury 2011; 42: 12–4.
6. Tiamfook-Morgan TO, Kociszewski C, Browne C, Barclay D, Wedel SK, Thomas SH. Helicopter scene response: regional variation in compliance with air medical triage guidelines. Prehosp Emerg Care 2008; 12: 443–50.
7. Chesters A, Grieve PH, Hodgetts TJ. A 26-year comparative review of United Kingdom helicopter emergency medical services crashes and serious incidents. J Trauma Acute Care Surg 2014; 76: 1055–60.

 

8. Littlewood N, Parker A, Hearns S, Corfield A. The UK helicopter ambulance tasking study. Injury 2009; 41: 27–9.
9. Roberts K, Blethyn K, Foreman M, Bleetman A. Influence of air ambulance doctors on on-scene times, clinical interventions, decision-making and independent paramedic practice. Emerg Med J 2009; 26: 128–34.
10. Giannakopoulos GF, Lubbers WD, Christiaans HM, van Exter P, Bet P, Hugen PJ, Innemee G, Schubert E, de Lange-Klerk ES, Goslings JC, Jukema GN. Cancellations of (helicopter-transported) mobile medical team dispatches in the Netherlands. Langenbecks Arch Surg 2010; 395: 737–45.
11. Lawless J, Tallon JM, Petrie D. Aborted air medical missions: a 4-year quality review of a Canadian province-wide air medical program. Air Med J 2005; 24: 79–82.
12. Kruger AJ, Lockey D, Kurola J, Di Bartolomeo S, Castren M, Mikkelsen S, Lossius HM. A consensus-based template for documenting and reporting in physician-staffed pre-hospital services. Scand J Trauma Resusc Emerg Med 2011; 19: 71.
13. Wisborg T, Guttormsen AB, Sorensen MB, Flaatten HK. The potential of an anaesthesiologist-manned ambulance service in a rural/urban district. Acta Anaesthesiol Scand 1994; 38: 657–61.
14. Kruger AJ, Lossius HM, Mikkelsen S, Kurola J, Castren M, Skogvoll E. Pre-hospital critical care by anaesthesiologist-staffed pre-hospital services in Scandinavia: a prospective population-based study. Acta Anaesthesiol Scand 2013; 57: 1175–85.
15. Lossius HM, Soreide E, Hotvedt R, Hapnes SA, Eielsen OV, Forde OH, Steen PA. Prehospital advanced life support provided by specially trained physicians: is there a benefit in terms of life years gained? Acta Anaesthesiol Scand 2002; 46: 771–8.
16. Zakariassen E, Uleberg O, Roislien J. Helicopter emergency medical services response times in Norway: do they matter? Air Med J 2015; 34: 98–103.
17. Norwegian Air Ambulance Service annual reports 2004–2013 (Document in Norwegian). [www document] Available at: http://www.luftambulanse.no/aarsrapporter.aspx (accessed 20 April 2015).
18. Statistics Norway. [www document] Available at: http://www.ssb.no/en/ (accessed 20 April 2015).
19. Tryba M, Brüggemann H, Echtermeyer V. Klassifizierung von Erkrankungen und Verletzungen in Notarztrettungssystemen. Notfallsmedizin 1980; 6: 725–7.
20. Raatiniemi L, Mikkelsen K, Fredriksen K, Wisborg T. Do pre-hospital anaesthesiologists reliably predict mortality using the NACA severity score? A retrospective cohort study. Acta Anaesthesiol Scand 2013; 57: 1253–9.
21. Moecke H, von Knobelsdorff G. The anesthesiologist in prehospital and hospital emergency medicine. Curr Opin Anaesthesiol 2008; 21: 228–32.
22. Hesselfeldt R, Steinmetz J, Jans H, Jacobsson ML, Andersen DL, Buggeskov K, Kowalski M, Praest M, Ollgaard L, Hoiby P, Rasmussen LS. Impact of a physician-staffed helicopter on a regional trauma system: a prospective, controlled, observational study. Acta Anaesthesiol Scand 2013; 57: 660–8.
23. Ringburg AN, de Ronde G, Thomas SH, van Lieshout EM, Patka P, Schipper IB. Validity of helicopter emergency medical services dispatch criteria for traumatic injuries: a systematic review. Prehosp Emerg Care 2009; 13: 28–36.
24. Andruszkow H, Lefering R, Frink M, Mommsen P, Zeckey C, Rahe K, Krettek C, Hildebrand F. Survival benefit of helicopter emergency medical services compared to ground emergency medical services in traumatized patients. Crit Care 2013; 17: R124.
25. Schuster M, Pints M, Fiege M. Duration of mission time in prehospital emergency medicine: effects of emergency severity and physicians level of education. Emerg Med J 2010; 27: 398–403.


## Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's web-site:

**Figure S1.** Map of Europe and Western Norway showing the hospitals and the HEMS bases. Size of hospital symbols indicates university hospitals (large), regional hospitals (medium), and local hospitals (small). Helicopter symbols indicate a HEMS base close to hospital.

**Table S1.** The NACA scale; a severity scoring used by the Norwegian Air Ambulance Service.[19,20]



 