ORIGINAL RESEARCH

Helicopter Emergency Medical Services Response Times in Norway: Do They Matter?

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Abstract

Objective: The main objective of the Norwegian air ambulance service is to provide advanced emergency medicine to critically ill or severely injured patients. The government has defined a time frame of 45 minutes as the goal within which 90% of the population should be reached. The aims of this study were to document accurate flying times for rotor wing units to the scene and to determine the rates of acute primary missions in Norway.

Methods: We analyzed operational data from every acute primary mission from all air ambulance bases in Norway in 2011, focusing on the flying time taken to reach scene, the municipality requesting the flight, and the severity score data.

Results: A total of 5,805 acute primary missions were completed in Norway in 2011. The median flying time was 19 minutes (25%-75% percentiles: 13-28). The mean mission rate for the 17 bases was 7.5 (95% confidence interval, 7.4-7.8 per 10,000 inhabitants). The overall mean (standard deviation) National Committee on Aeronautics score for all missions was 4.07 (1.30).

Conclusion: The government's expectation of serving the entire population via HEMS within 45 minutes appears to be achieved on a national level. However, vast differences remain in the flying times and rates between bases.

Helicopter emergency medical services (HEMS) are an integral part in many health care systems in the developed world.[1] The effect of HEMS is still subject to debate although they have several theoretical advantages, such as bringing advanced medical care and medical competence to the scene, shortening the transport time, providing access to remote areas, and reducing the time elapsed until definitive care is available.[2-4] Several outcome studies have found positive associations with increased survival under the care of HEMS,[5-7] whereas the opposite effects have also been well documented.[5,8,9] However, many of these studies have been subject to methodological limitations, selection bias, and noncomparable study settings or designs.[5]

A position paper by several American air medical societies initiated the process of establishing national guidelines to facilitate the beneficial effects of HEMS implementation.[4] The paper stated that clinical benefit could be provided by minimizing the time to definitive care in time-sensitive medical conditions, providing necessary competence and equipment on the scene, and accessing patients who are otherwise inaccessible by other modes of transport.[4] These objectives are consistent with national guidelines in other countries.[10]

Based on international experiences, a Norwegian national air ambulance (AA) service was established in 1988.[11] A paramount principle in Norwegian health legislation is that all citizens should have equal access to publicly funded health care regardless of their residential pattern.[12,13] In that sense, well-developed air emergency services have a compensatory effect that adjusts for geographic dispersion and potential unequal access to advanced emergency medical care.[13,14] A time frame of 45 minutes, including up to a 15-minute reaction time from alarm to takeoff, has been defined as the national goal to reach 90% of the population.[15]

In 2002, Heggestad and Børsheim[14] published results on the accessibility and distribution of the Norwegian national air emergency service. In their study, the mean reaction time was 8 minutes in acute missions (from alarm until takeoff), and the mean total response time from alarm until scene arrival was 26 minutes.[14] Nearly 98% of the population was reached within 60 minutes.[14] Within the last decade, the population has increased, enhanced medical capabilities have been developed, and additional helicopter bases have been implemented. Hence, the aims of this study were to document the accurate flying times of rotor wing units to the scene as well as the rates of acute primary missions in Norway.

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Figure 1. The geographical location of the air ambulance and rescue helicopter bases in Norway.

Table 1. National Committee on Aeronautics (NACA) Score

Score Level	Patient's Status
NACA 0	No injury or illness
NACA 1	No acute disease or injury
NACA 2	Acute intervention not necessary; further diagnostic studies needed
NACA 3	Severe but not life-threatening disease or injury; hospitalization necessary
NACA 4	Development of vital (life-threatening) danger possible
NACA 5	Acute vital (life-threatening) danger
NACA 6	Acute cardiac or respiratory arrest
NACA 7	Death

Materials and Methods

Study Setting

Norway has a scattered and low population density that covers 323,779 km^2 (518,000 miles^2), with a straight-line distance from north to south of 1,752 km (2,880 miles).[16] In 2011, Norway consisted of 430 municipalities with a total population of 4,985,510, with 50% living in the southeastern region of Norway near the main capital.[17,18] The current prehospital emergency service is similar to 2011 and consists of dispatch centers/emergency medical communication centers (EMCC), ground ambulances, primary care doctors on-call, and AAs. The rotor wing–based part of the service consists of 12 primary AA helicopters, which are manned by a pilot, anesthesiologist, and paramedic/rescuer. Six search and rescue helicopters operated by the Royal Norwegian Air Force perform regular ambulance missions and include an anesthesiologist as an integrated part of the national AA services (Fig. 1). Twelve fixed wing–based emergency medical services (EMS) operating in Norway perform a substantial number of medical missions.[18] In northern Norway, fixed wing units are an important part of the survival chain in performing primary acute care missions. In the South, they primarily perform elective interfacility transfers.[13,18] Four regional health trusts are responsible for the medical staffing, and the National Air Ambulance Services (NAAS) is responsible for the helicopters, fixed wing airplanes, pilots, and HEMS crewmembers.[18,19] It is a national service and includes common guidelines for requisition by the EMCCs.[19] The helicopter-based EMS provides advanced emergency medicine to trauma patients and patients with acute illness and injury.[10]

Material

This study is cross-sectional and included all primary acute missions in 2011 performed by the air ambulance (AA) service and rescue helicopters (RHs). A primary mission is defined as a mission where AA and/or RHs attend the patient directly at the scene and perform transport from the scene to a health care facility.[20] The level of severity is categorized by the EMCC. If the clinical situation on the scene is critical relative to substantial abnormal vital functions (ie, cardiovascular status and respiration), it is defined as an acute mission.[20] All Norwegian AA and RH bases record every mission prospectively, and the data are sent to the NAAS. Official national activity statistics are published annually. In 2012, detailed operational data (not medical) from every acute primary mission in 2011 were provided by the NAAS. The data included the municipality where the mission was flown, the flying time taken to reach the scene from where the helicopter was positioned when requested, and the National Committee on Aeronautics (NACA) score for each patient.[21] NACA is an international severity score that is often used within the air medical society to grade the severity of the illness using values ranging from 0 (no health problems) to 7 (death) (Table 1).[21] The score assigned to every transported patient within the National Air Ambulance service gives an estimate of the level of patients' clinical severity as evaluated by the treating physician. The aforementioned data provide the exact number of missions to different municipalities, accurate durations of the flying times taken to reach the scene on every mission, and a general overview of the clinical severity level.

HEMS is considered to be an integral part of Norwegian preparedness and the emergency medical system. Helicopters within the Norwegian AA system do not have strict geographic primary operating areas but deliver their service to a broader range of municipalities depending on necessity. A consequence is that over the course of a year, different bases will undertake missions to the same municipalities, and the estimated population covered by all AA and RH bases will be larger than the total population in Norway. The reason for this is that the municipality and its inhabitants will be

Table 2. Air Ambulance Bases, Population Covered, Numbers of Acute Primary Missions, Rates, and Median Flying Time to Sites in 2011

Bases	Population	Number of Missions	Rate of Missions per 10,000	CI	Median Flying Time (min)	25th-75th Quartile
Tromsø (AA)	221,100	320	14.5	12.8-16.0	23	18-30
Br.sund (AA)	137,500	260	18.9	16.6-21.2	23	14-31
Trondheim (AA)	485,500	538	11.1	10.1-12.0	20	15-27
Dombås (AA)	279,900	281	10.0	8.9-11.2	22	15-32
Ålesund (AA)	330,700	328	9.7	8.7-10.8	15	11-21
Førde (AA)	432,500	496	11.7	10.5-12.5	22	16-29
Ål (AA)	320,800	332	10.3	9.2-11.5	20	13-30
Bergen (AA)	681,800	636	9.3	8.6-10.0	18	11-26
Stavanger (AA)	563,000	699	12.4	11.5-13.4	17	10-23
Arendal (AA)	350,000	381	10.9	9.8-12.0	23	16-34
Lørenskog (AA)	2,261,500	989	4.4	4.1-4.7	16	12-24
Bodø (RH)	103,900	130	12.5	10.4-14.7	26	19-34
Banak (RH)	131,461	105	8.0	6.5-9.5	38	27-47
Florø (RH)	96,355	46	4.7	3.4-6.2	24	15-36
Ørlandet (RH)	313,437	123	3.9	3.2-4.6	17	10-27
Rygge (RH)	544,948	44	0.8	0.6-1.1	14	10-17
Sola (RH)	432,967	97	2.2	1.8-2.7	23	17-33
Total[a]	7,687,368	5,805	7.5	7.4-7.8	19	13-28

AA = air ambulance; RH = rescue helicopter.
[a]Total sum of all missions.

counted every time a helicopter from a new base performs a mission in that region. We present numbers for both the total population covered by all helicopter bases in 2011 and the actual Norwegian population.

Statistical Analysis

Flying times are presented as medians (quartiles), and the numbers of missions are presented as the rates per 10,000 inhabitants per year, along with a 95% confidence interval (CI). Differences in the mission rates between bases can be assessed by comparing whether the 95% CIs of 2 bases overlap. The overall NACA score difference between bases was assessed using the Kruskal-Wallis nonparametric test. Associations between the average NACA score and the average flight times for the 17 bases were assessed by calculating the Pearson correlation coefficient r. A P value $< .05$ was considered statistically significant. Analyses were performed using the data software R 2.12.

Ethics

The data did not contain any patient characteristics, and approval from committees for medical and health ethics was not deemed necessary.

Results

In the study period, 5,805 acute primary missions were completed, including missions to 425 of the 430 (98.8%) municipalities. Among the municipalities, 127 (29.5%) were served by 2 different helicopter bases, 34 (7.9%) were served by 3 different bases, and 7 (1.6%) were served by 4 different bases. Overall, helicopters served a population of more than 7.6 million people, considering all missions to all municipalities from all helicopter bases.

For the total population served, the rate (95 % CI) was 7.5 (7.4-7.8) missions per 10,000 inhabitants (Table 2). The mission rates for individual bases ranged from 4.4 to 18.9 per 10,000 inhabitants per year (Fig. 2). Based on the actual population in 2011 (4,985,510), the national rate (95% CI) of missions per 10,000 inhabitants was 11.6 (11.3-11.9).

The national median (quartiles) flying time to the scene was 19 (13-28) minutes. The flying time was 30 minutes or longer in 20% of the missions, which constituted approximately 1,160 patients. Figure 3 shows the median flying time to all municipalities and the cumulative number of inhabitants reached within the time frames.

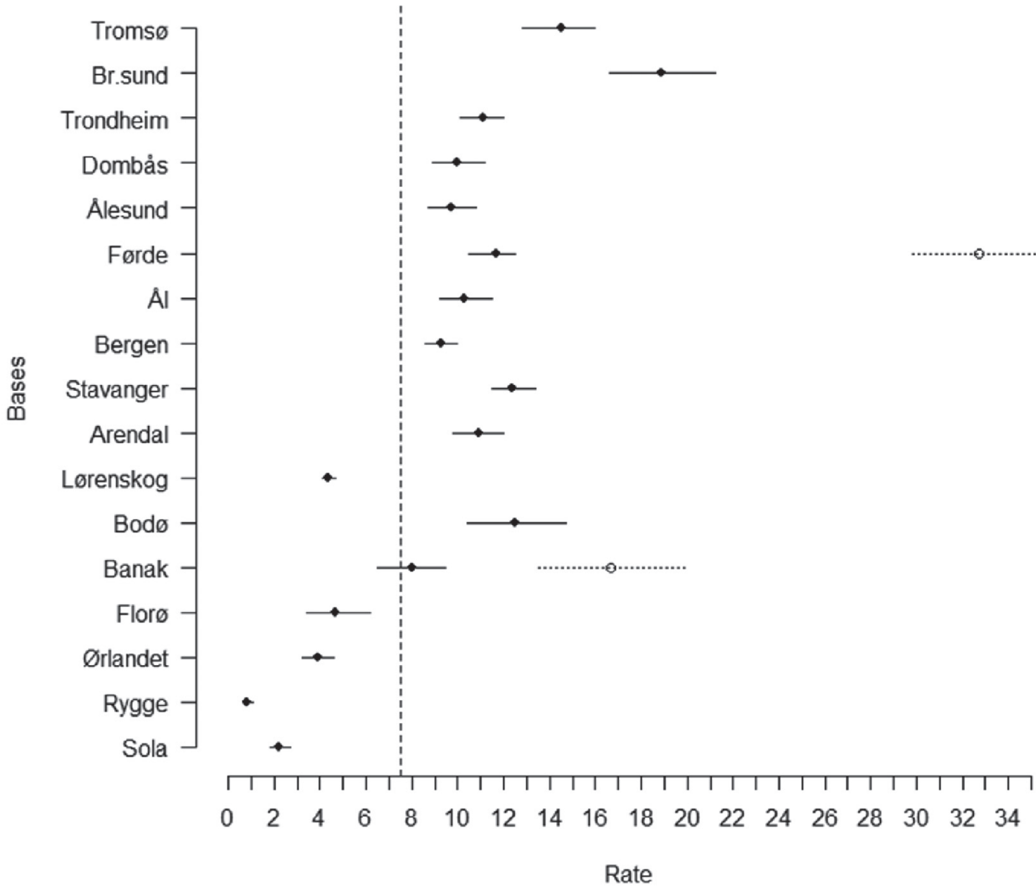
The overall mean (standard deviation) NACA score for all missions was 4.07 (1.30), with a significant overall difference between bases ($P < .001$). Of all missions, 59% were given a NACA from 4 to 6, whereas 39% had a NACA of 4. There was no association between the average NACA score and the average flight times for the 17 bases ($r = -0.21$, $P = .45$).

Discussion

During the time frame of our study, 75% of the patients were reached within a flying time of 28 minutes, but there were considerable differences between the bases. There was a high proportion of severe medical conditions, as defined by NACA ≥ 4, and large differences between the bases in the use of HEMS based on the incident rates per 10,000 inhabitants.

The differences in rates between the bases per 10,000 inhabitants may be primarily caused by the population density in their surrounding geographic areas. Lørenskog

Figure 2. Rate (95% CI) of missions per 10.000 inhabitants for each of the 17 Norwegian helicopter bases Overall average superimposed (vertical dotted line). "Førde and Banak had two and one outlying mission, respectively, dramatically increasing the total population served, and corresponding lower rate. Rate estimates without these outlying missions superimposed (circle and dotted lines)"



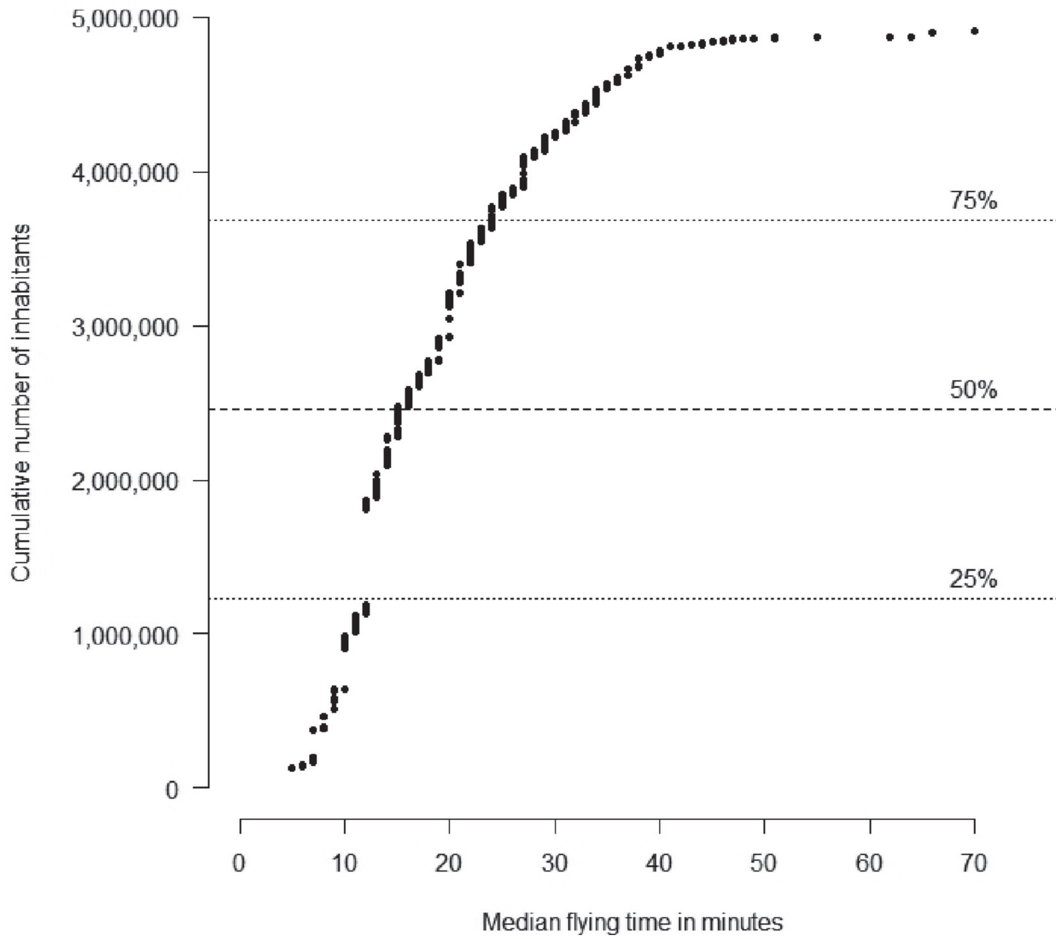
had the highest number of missions, the largest population covered, and the lowest rate of missions. In the area around Oslo (the capital of Norway), the distance to hospitals is short, and ground ambulances manned with an anesthesiologist can take care of the same patients as can the AA. This is in contrast to Brønnøysund, which has a lower population density and longer flying times. An unequal level of activation threshold by the many different EMCCs could partially explain the different rates. The RHs (except Bodø and Banak) are used as backup for medical problems; subsequently, their rates of utilization are low compared with the AAs.

In our study, the unit response time was examined, which represents the time from the helicopter's takeoff until arriving at the scene.[20] EMCC and HEMS activation and response times are also essential in describing the actual time lapse from patient incident occurrence until the unit arrives on scene. Folkestad et al[22] found that the average EMCC response time in a Norwegian setting was approximately 3 minutes. In Norway, HEMS is required to respond within 15 minutes from alarm to takeoff. Published figures from 1 of the companies operating in Norway found an average activation time of 5.5 minutes (range, 4-7), but this likely differs among bases because of their operational structures and internal company procedures.[18] In a previous study, the total time (from alarm until scene arrival) was 26 minutes.[14] The median flying time in this study was 19 minutes, and most patients were reached within 60 minutes, showing only a minor difference in flying time.

When discussing the establishment and performance of EMS, including HEMS, time is often used as a surrogate quality measure and is universally linked to improved outcome.[23] However, the question remains whether there is sufficient evidence to draw this conclusion. From a logical perspective, it appears reasonable that a rapid response to critically ill or injured patients should improve outcomes.

What constitutes timely patient access? As previously noted, this remains a matter of debate and can lead to different local, regional, and national organizational HEMS structures. Some European systems advocate significantly shorter HEMS response times, citing the beneficial effect of early arrival on the scene.[24,25] The potential outcome of critical illness and injury is a dynamic state that depends on the nature of the incident, the patient's preinjury morbidity status, the capabilities of the prehospital EMS, and the time intervals to definitive treatment. This makes it challenging

Figure 3. Median flying time to all 430 Norwegian municipalities along with cumulative number of inhabitants reached within the timeframes.



to describe accurate threshold time frames for those situations that lead to fatalities, increased morbidity, or total rehabilitation. Many studies that describe time factors in relation to outcome base their outcome measures on crude mortality. However, this may be inaccurate because the mortality rates, even in large patient cohorts, are low. This could lead to a perceived beneficial or negative effect based on which outcome measures are used. Blackwell et al[26] found that, in general, there are only a limited number of studies describing a definite relationship between response time and effect on morbidity and mortality. Alternative means of transportation and available competence should also be part of the process when evaluating the potential beneficial effects of HEMS. For example, would a ground ambulance supported by a general practitioner be able to deliver good medical care for a set group of patients?

Additionally, local health system designs and public expectations influence the definition of potential benefit. From a public, community, and patient perspective, functional outcome, the reduction in long-term morbidity, immediate situational pain, and symptom reduction are of greatest importance. Therefore, these factors should be included in future analyses of the efficiency and effect of HEMS.

In our study, we found that 59% of the patients were categorized into NACA 4 to 6. This categorization describes a high level of severity, which could indicate the need for timely evacuation and/or early interventions. The validity of the NACA score has previously been reported and described in several studies.[21]

Patients are accessing HEMS with several varied medical presentations. In 2002, the European Emergency Data Project defined the "first hour quintet" as a group of time-sensitive medical emergencies that may cause considerable morbidity and mortality if patients are not given timely and adequate care.[27] The quintet consists of cardiac arrest, respiratory failure, trauma, acute coronary syndromes, and stroke.[27] More recently, some gynecologic, obstetric, and pediatric emergencies have also been considered time sensitive.[27] Thus, it seems reasonable that when designing EMS systems and improving the current systems in relation to time factors, these conditions should be considered.

The study's strength is that it includes information from all acute primary missions from all Norwegian bases over the course of a year. It would have been useful to link the NACA score data to the flying time data, but this information was not available. A clear limitation of the study to evaluate the total response and activation time of the service is that the time lapse between when the service was alarmed by the EMCC and the unit initiated takeoff was not recorded.

Conclusion

The government's expectation of population served by HEMS within 45 minutes appears to be achieved on a national level. However, vast differences remain in the flying time and rates between the different bases. This could indicate a substantial difference in the accessibility of HEMS within and/or between varied different geographic regions.

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