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Rapid response systems

Description of the prehospital emergency healthcare system in Norway



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Abstract

Background: Norway has a long coastline, steep mountains, and wide fjords, which presents some challenges to the prehospital emergency healthcare system. In recent years, the prehospital emergency medical services (EMS) have undergone significant changes, structurally, in terms of professionalisation of the services and in the education level of the personnel. In this article, we aim to describe the current structure for handling prehospital medical emergencies.

Methods: For healthcare, Norway is divided into four Regional Health Authorities, consisting of 19 Health Trusts, where 18 have an EMS. There is a dedicated medical emergency number, 113, that terminates in 16 emergency medical communication centres. The use of air and boat ambulances, in addition to traditional ambulances, seeks to meet the challenges in the EMS system.

Strengths and limitations: The Norwegian EMS is an advanced system with highly educated staff; however, this level of care comes with an equally high cost.

Conclusion: The Norwegian EMS can handle emergencies nationwide, providing advanced care at the scene and during transport. The geography and demography challenge the idea of equal care, but the open publishing of data from national quality registries seeks to identify and address potential differences.

Keywords: Emergency medical services (EMS), Out-of-hospital cardiac arrest (OHCA), Cardiac arrest registries, Emergency medical communication centres (EMCC), Dispatch, Prehospital

Background

Prehospital care is evolving and has developed from a transport service to advanced medical treatment of patients. Emergency Medical Services (EMS) vary considerably worldwide and between European countries.¹ Several previous studies have described EMS systems in different European countries,^{2–6} but the latest description of the Norwegian EMS system was in 2004 by *Langhelle et al.*⁷

The EMS has undergone significant professionalisation in organisation, level of education and capability to assess and treat acutely sick or injured patients. As early as 1889, the first horse-drawn carriages started transporting patients in Norway.⁸ Oslo municipality bought its own car – ambulance in 1916, and just a few years later, the horses were replaced by cars.⁹ The ambulance service was considered a pure transport service, but during the 1960s, one began focusing on treating patients before arrival at the hospital.^{10,11}

In 1970 new regulations introduced requirements for the content and equipment of the cars. Hence, the use of “ordinary” station wagons was prohibited, and the cars were now called ambulances.¹² In 1976, the first regulation on the qualifications of the ambulance personnel stated that they should have an automotive-, rescue technical- and medical education.¹³

The automation of the telephone network was carried out in the seventies.^{14–16} This was the forerunner for today’s emergency notification service, and the first Emergency Medical Communication Centre (EMCC) was established in Bergen in 1984.¹⁷ Air transport of patients has been carried out since the 1920s, but it was not until 1988 that the National Air Ambulance Service was established by the Norwegian state.^{18,19}

During the 1990s, a committee proposed that professional, full-time Emergency Medical Technician (EMT) should be trained, and in 1996 EMT became an authorised healthcare profession by the Norwegian Directorate of Health.²⁰ This assures the provider has

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the required education and qualification to use a specific professional title, protected by law and imposes their practice to be in accordance with the Health Personnel Act. A vocational education program and curriculum for upper secondary education in ambulance subjects was adopted in 1997.²¹ Around the same time, the state took over responsibility for the hospitals, the EMS and air ambulance.²⁰ From 2008, nurses in the ambulance service and EMTs could pursue further education to become paramedics. The first bachelor's program in paramedicine was established in 2014,²² making paramedics a new, separate authorised profession.²³

In this article, we aimed to describe the current Norwegian healthcare system for prehospital emergencies, focusing on EMS. Examples of how the system handles severe prehospital emergencies are described using out-of-hospital cardiac arrest (OHCA) data from the Norwegian Cardiac Arrest Registry (NorCAR).

Method

Geography

Norway is a democratic constitutional monarchy covering a total land area of 304.282 km², stretching 2.271 km from the island of Svalbard (78° north) to Lindesnes (58° north) on the mainland. There were 5.4 million inhabitants in 2022, and the population density was 17 inhabitants per km², with considerable variation between the north (4.3 per km²) and the southeast (28.2 per km²).²⁴ Most of the population lives along the coast, and 57% live in the south-eastern part. The mountains, fjords, more than 230.000 islands, and temperatures ranging from -40° to +35 °C²⁵ challenge the EMS healthcare system.

Laws and regulations

Laws and regulations guarantee equal access to healthcare services.²⁶ Norway has universal health coverage funded by taxes. It covers all aspects of healthcare, including primary, ambulatory, mental health, and hospital care. Hence, using ambulance services in Norway is free of charge.

The municipalities organise Primary healthcare,²⁷ whereas the hospitals and EMS are part of the specialist healthcare service.²⁸ The primary and specialist healthcare systems are joined together by the regulation on requirements for, and organisation of, municipal emergency medical services, including ambulance and emergency call services.²⁹

Several nationwide laws and regulations regulate the care given by EMS personnel.^{30–32} Ambulances adhere to the European Union's (EU) standard for ambulances and medical vehicles³³ regarding design, safety, and equipment, in addition to international and Norwegian regulations for medical devices. Ambulances in Norway are yellow with green checkered, high-visibility markings.

Primary care

All emergency primary care centres in Norway can be reached by a common number: 116 117. Their role is to give advice, assess, and treat patients requiring urgent care within their area.²⁷ The general practitioner (GP) on call performs medical consultations in one of the 168 primary care centres, where 77 have a catchment area of less than 10.000 inhabitants, 11 have a catchment area of more than 100.000 inhabitants, 32% are staffed with one physician only, and 60% have a physician response vehicle.³⁴ A paramedic or a nurse can crew the Emergency primary care vehicles in addition to the GP on-call. The regulations require the GP on call to be able to con-

duct home visits and respond to medical emergencies or accidents.²⁹ Emergency primary care services frequently collaborate with EMS on scene and have an important gatekeeper function towards the specialist healthcare system. Referral from a GP is mandatory for admittance to hospital. However, unstable patients and patients with certain time-critical conditions like cardiac arrest, can be admitted directly to hospital by ambulance personnel.

Specialist care

Specialist healthcare is financed through universal health coverage, and no private EMS or EMCC providers exist. A few private hospitals specialise in elective treatments and procedures, and the national health authorities also contract out specific treatments. There are no volunteers involved in specialist care.

There are four Regional Health Authorities (RHA) and 19 local Health Trusts (HT) of whom 18 operate an EMS. The HT employs all personnel in EMCC, EMS and at the hospitals. There are 50 hospitals with an emergency department and critical care unit,³⁵ of them, three are non-profit diaconal hospitals. Every RHA has at least one major referral hospital that offers 24/7 percutaneous coronary intervention and cardiac surgery. Each RHA has one trauma centre with a complete range of surgical specialities.³⁶ Some conditions are treated at national treatment centres, like severe burn injuries,³⁷ or advanced pelvic injuries.³⁸ Bypass protocols are implemented for several conditions, like severe trauma and cardiac arrest.

Emergency medical call centres

The dedicated medical emergency number 113 terminates at the nearest of 16 Emergency Medical Call Centres (EMCC). If the generic European emergency number 112 is used, the call is routed to the nearest police dispatch centre, who will transfer the call to 113 if needed. Most EMCCs cover the same geographical area as the EMS, but two EMCCs dispatch resources in two EMS areas.

The EMCC manages critical incidents and acute medical situations and coordinates urgent and planned transfers. The EMCC medical operators, educated as EMTs, paramedics or nurses, are responsible for answering emergency calls. They perform triage, giving advice and first-aid guidance using a criteria-based dispatch protocol.^{39,40} Low-acuity calls are often transferred to the local 116 117 for further evaluation. Resource coordinators educated as EMTs or paramedics dispatch ambulances and other resources and are responsible for communication, coordination and follow-up of ambulance and air ambulance missions. Calls and radio communication involving the EMCC are recorded. Four EMCCs have flight following for the air ambulance. (Fig. 1) A physician, competent in emergency medicine, is always on-call and is available by telephone, should the medical operator or the EMS wish to consult.

Medical operators are trained to rapidly identify cardiac arrest and start telephone-guided Cardiopulmonary Resuscitation (T-CPR) instruction.⁴¹ The on-call GP is always alerted if an OHCA is suspected, but it is up to the GP to decide whether they respond to the call or not. In addition, first responders like the local fire department, police or primary care nurses can be dispatched. Non-governmental organisations (NGOs) like the Alpine Climbing Group, the Red Cross and the Norwegian Search and Rescue Dogs can also be called upon to assist both as first responders and for search and rescue missions.

The national automated external defibrillator (AED) registry is integrated into the EMCC map, allowing the medical operator to guide bystanders to the nearest available AED.⁴² NorCAR reports

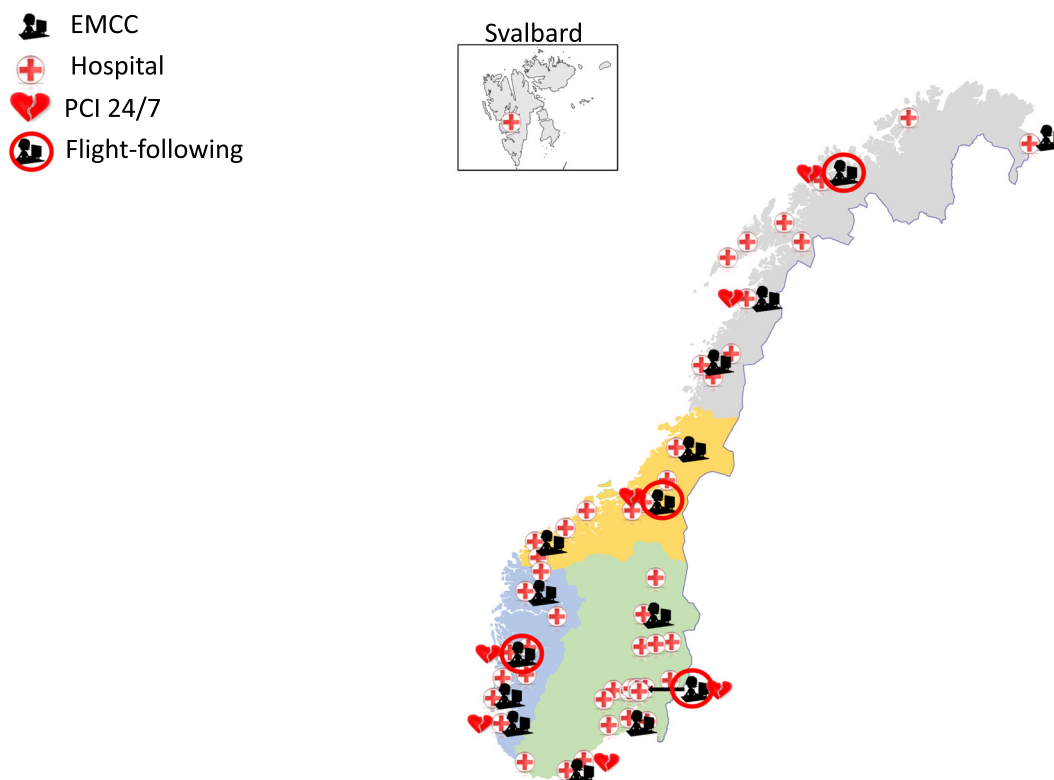


Fig. 1 – The colours indicate the four Regional Health Authorities (RHA). Grey; Northern Norway RHA, Yellow; Central Norway RHA, Blue; Western Norway RHA, Green; South-Eastern Norway RHA. EMCC for Svalbard is in Tromsø, the northernmost EMCC centre with flight following.

patients successfully resuscitated by an AED, where no further resuscitation is needed by EMS.³⁵ During lockdown due to the pandemic in 2020 and 2021, we saw a clear decrease in this group (Fig. 2), but the numbers are again increasing.

The ambulance service

The EMS is based on the Franco-German model that aims to treat and stabilise in the prehospital setting.⁴³ The Norwegian ambulance service is not physician-based but reliant on the knowledge and skills of the personnel, operating autonomously within guidelines and procedures set by the individual HTs. All EMS personnel can terminate resuscitation or abstain from starting advanced treatment.⁴⁴ However, death certificates must always be issued by a medical doctor.³⁰ There are some NGOs that have ambulances with EMTs. These ambulances might be requisitioned for ambulance assignments but are mostly used as standby ambulances at large events or for search and rescue missions.

Road vehicles

The ambulance service uses a variety of vehicles, including traditional ambulances, two-stretcher ambulances, and single-staffed response units such as motorcycles, bicycles, or smaller cars for rapid response. Some ambulance services have a dedicated tactical commander unit, either staffing a single-person unit or as part of the crew of a traditional ambulance.

For incubator transports or intensive care transfers, the ambulance is supplemented with additional equipment such as a ventilator, syringe infusion pump, transportable patient monitor supporting

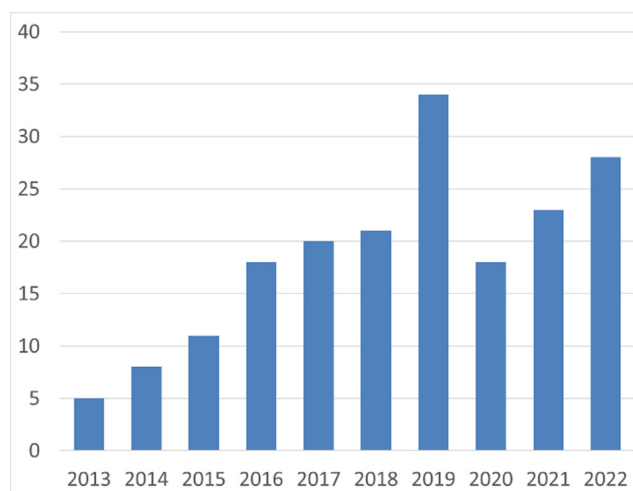


Fig. 2 – The number of patients (Y-axis) per year (X-axis) that have been successfully resuscitated by an automated external defibrillator (AED). The figure is a reprint from the yearly report from the Norwegian Cardiac Arrest Registry³⁵ and is used with permission from the registry.

intra-arterial blood pressure, etc., accompanied by an anaesthesiologist in addition to the ordinary crew.

Ambulance boats

The ambulance boat service is part of the EMS. The service must meet specific requirements in a separate regulation.⁴⁵ In addition to ambulance missions and transports of physicians, the boats can also be used as commuter boats, patient transport services, and transportation of fire personnel and veterinarians. The health authority or the municipality can operate ambulance boats. Where there is no distinct ambulance boat service, sea and island missions are conducted by transporting ambulance personnel by boats operated by the fire department, police, NGOs, etc.

Air ambulance

A well-developed air ambulance system strives to ensure equal care irrespective of where the patients live. The National Air Ambulance Services, owned by the RHA, is responsible for both fixed-wing aircraft (FW) and rotor-wing aircraft (RW) (helicopters). The aircrafts are owned and operated by private companies on time-limited contracts, but are staffed with health personnel from the HTs.

There are seven FW bases in Norway (Fig. 3). An anaesthesia or intensive care nurse staffs the FW ambulances in addition to the flight crew, and at some bases, they can also be staffed by an anaesthesiologist if needed. Gardermoen and Tromsø have extra corporal membrane oxygenation retrieval teams that use FW and RWs as needed. Norway has many airports with landing distances shorter than 1000 meters. These airports can be operated by turboprop FW ambulances. When immediate response is required, FW aircraft can start missions within 20–60 minutes of scramble, and RW missions start within 15 minutes.

There are 13 RW bases in Norway. All helicopters are staffed by one pilot (operator), one crew member (operator) and one anaesthe-

siologist. The crew member is trained as both a rescue technician and a healthcare professional and supports the pilot in the cabin during flight and the anaesthesiologist once on the ground. Mid-sized helicopters can have two patients on stretchers, while smaller helicopters only have two stretcher patients under exceptional circumstances. RW-ambulances are also used for search and rescue missions and can fly with a crew member in a static rope under the helicopter, but this person cannot be winched up or down. Two Joint Rescue Coordination centres in Bodø and Stavanger coordinate search and rescue operations.

Search and rescue (SAR) helicopters operate from seven bases on the mainland. They are staffed by a crew of six, including an anaesthesiologist and are used in some air ambulance missions.

The Svalbard archipelago, with its largest settlement, Longyearbyen (2400 inhabitants, 78°N), is also a part of Norway. There is a small hospital in Longyearbyen and a SAR base with two helicopters. Longyearbyen Airport can be reached with jet and turboprop FW-ambulances from the mainland but are often inaccessible for turboprop aircraft due to weather-dependent range limitations.

Activity in the EMS system

The EMCCs received almost 750.000 emergency calls in 2022 (Table 1). The average number of calls per 1.000 inhabitants was 137, varying from 115 to 150. The number of missions per ambulance in 2022 had an almost 4-fold difference between Northern Norway RHA (252) and South-Eastern Norway RHA (971). The RW and FW have assignments in all RHAs and HTs. For the RW air ambulances, Northern Norway RHA had a slightly lower number of missions per helicopter (506) compared to Central Norway RHA (710), Western Norway RHA (704) and South-Eastern Norway RHA (727).

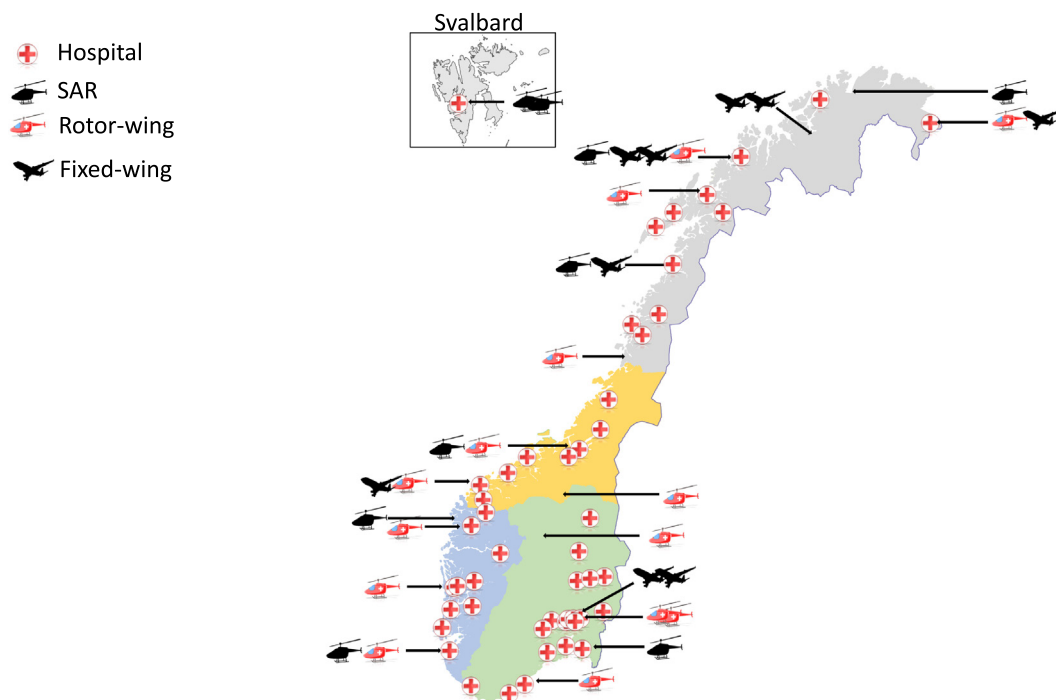


Fig. 3 – Placement/distribution of hospitals and airborne resources. The colours indicate the four Regional Health Authorities (RHA). Grey; Northern Norway RHA, Yellow; Central Norway RHA, Blue; Western Norway RHA, Green; South-Eastern Norway RHA.

Because FW missions are registered in connection with the bases, no official assignments are recorded in Western Norway RHA.

Prehospital electronic patient journal

Norway has started implementing a national prehospital electronic patient journal that will be used in all health regions by the end of 2023. The system provides uniform documentation and the opportunity to transfer structural information within the treatment chain.

The patient journal receives continuously updated assignment information from the EMCC and communicates the resource's status through the assignment. It can import clinical parameters and electrocardiogram from most monitors. Documentation of treatments is performed in real-time on a mobile terminal. The system gives the ambulance personnel access to guidelines and, in one region, access to the patient's hospital records.

A system for transfer of data from the prehospital electronic patients' journal to national medical quality registries has recently been developed and is now tested on cardiac arrest registry data. The aim is automatic transfer of data directly from the EMS to the registry.

The Norwegian cardiac arrest registry

NorCAR is a part of the Norwegian Cardiovascular Disease Registry (NCVDR), established in 2012. Data is collected from public registries and relevant medical quality registries.⁵⁰ The online reporting system maintains the strictest level of patient privacy and data integrity per best practices and regulations. Mandatory reporting to NCVDR makes Norway the only country in Europe where cardiac arrest, myocardial infarction and stroke are reportable conditions.

There are 10 quality indicators from the prehospital emergency system published by the Norwegian Directory of Health, two are based on data from NorCAR;

Rate of bystanders Cardiopulmonary Resuscitation (CPR)

The indicator shows the proportion of patients who are unresponsive and not breathing normally, where bystanders have started CPR

before the ambulance arrives on scene. Bystander CPR is defined in accordance with the Utstein definition⁵¹; CPR performed by a person who is not responding as part of an organised emergency response system to cardiac arrest. People alerted by phone or text message are not considered to be bystanders. In 2022 bystander CPR rates were 83% for the entire country, ranging from 68% to 90% between HTs.⁵²

Number of patients successfully resuscitated by EMS after OHCA

The indicator shows the incidence per 100.000 inhabitants of patients with OHCA treated by the ambulance service, where the patient has return of spontaneous circulation (ROSC). The average incidence of ROSC per 100.000 inhabitants was 20, ranging from 5-34 between HTs. HTs covering few inhabitants vary greatly from year to year, but most are within expected normal variation.⁵³

Table 2 shows the median time from call to EMCC until an ambulance is at the scene, and the proportion of incidents where an ambulance arrives within 12 minutes in urban areas and within 25 minutes in rural areas.

In addition, NorCAR publishes the median response time for OHCA but does not differentiate between urban and rural areas. The results from the different HTs are published openly, comparing the HTs against each other and the national average (Fig. 4). The remaining quality indicators relate to primary care and time from call until the call is answered (Supplementary Table 1).

Strengths and limitations

Norway has a well-developed healthcare system. However, its landscape, demographics, and harsh weather conditions, especially during wintertime, present challenges for the EMS in Norway. Extensive use of both RW and FW air ambulances and ambulance boats, in addition to ambulance vehicles, seeks to solve the daily challenges of the EMS.

Table 1 – Demographic and general data from the EMS divided into Regional Health Authority (RHA).

	Northern Norway RHA	Central Norway RHA	Western Norway RHA	South-Eastern Norway RHA
Land area ⁴⁶	112.000 km ² (+Svalbard 61.000 km ²)	56.300 km ²	43.432 km ²	110.000 km ²
Inhabitants, <i>n</i> (inhabitants per km ²) ²⁴	482.479 (4.3)	742.636 (13.2)	1.133.176 (261)	3.097.337 (28.2)
Hospitals with emergency department, ³⁵ <i>n</i>	11	8	10	21
EMCC centres, ⁴⁷ <i>n</i>	4	3	4	5
113/emergency calls, ⁴⁷ <i>n</i>	65.556	85.358	131.846	463.045
Operating vehicle ambulances, ⁴⁸ <i>n</i>	119	93	90	225
All missions, <i>n</i>	92.023	104.052	142.362	457.757
Acute missions, <i>n</i>	30.012	33.888	52.998	218.418
Missions by boat, ⁴⁸ <i>n</i>	3.162	900	2.837	109
Acute missions, <i>n</i>	785	264	786	80
Air ambulance rotor wing bases, ⁴⁹ <i>n</i>	4	2	3	4 (5 helicopters)
All missions, <i>n</i>	2.022	1.420	2.113	3.635
Air ambulance fixed-wing bases, ⁴⁹ <i>n</i>	5 (7 airplanes)	1	-	1 (2 airplanes)
All missions, <i>n</i>	5.928	1.252	-	1.362
SAR helicopter bases, ⁴⁹ <i>n</i>	3 (+1 LYR)	1	2	1
Ambulance missions, <i>n</i>	591 (+21 LYR**)	209	244	251

EMCC: Emergency Medical Communication Centre, LYR: Longyearbyen Svalbard Airport, RHA: Regional Health Authority, SAR: Search and Rescue.

Table 2 – Emergency incidents and response time in 2022 according to Regional Health Authority (RHA).

	Northern Norway RHA	Central Norway RHA	Western Norway RHA	South-Eastern Norway RHA
Urban emergency incidents, ⁵⁴ n	4.165	7.839	15.988	85.280
EMS on-site within 12 minutes, %	77	68	65	65
Response time, median	9 min	10 min	10 min	10 min
Rural emergency incidents, ⁵⁴ n	8.066	10.105	10.813	46.803
EMS on-site within 25 minutes, %	79	82	80	84
Response time, median	14 min	15 min	16 min	16 min
OHCA incidents, ⁵⁵ n	248	554	679	2039
Median response time*	9 min	10 min	9 min	9 min

* Excluding EMS witnessed. EMS: Emergency Medical Services, Min: minutes, OHCA: Out of hospital cardiac arrest, RHA: Regional Health Authority. Urban areas are defined as at least 10.000 inhabitants in the municipality. Rural areas are defined as less than 10.000 inhabitants in the municipality.⁵⁴

The use of air ambulances, ambulance boats and vehicles to the extent it is used in Norway comes with a cost. A report from 2014 shows that Norway in 2012 was the country in Europe that spent the most in Euros per person on healthcare. Compared to an EU citizen spending 2195 Euros, a Norwegian citizen spent 4610 Euros.⁵⁶

Medical professionals answer the two medical emergency numbers 116, 117 and 113, avoiding the potential delay of a general

answering point, where medical emergencies must be transferred to a medical operator. In the EU, the common emergency number 112 has been implemented, and it is up to the operator to identify if it is a medical emergency and transfer the call to the medical operator. This delay is avoided in the Norwegian system and makes it possible to measure the time from the call is first answered to the ambulance arriving at the designated address. Regardless, we con-

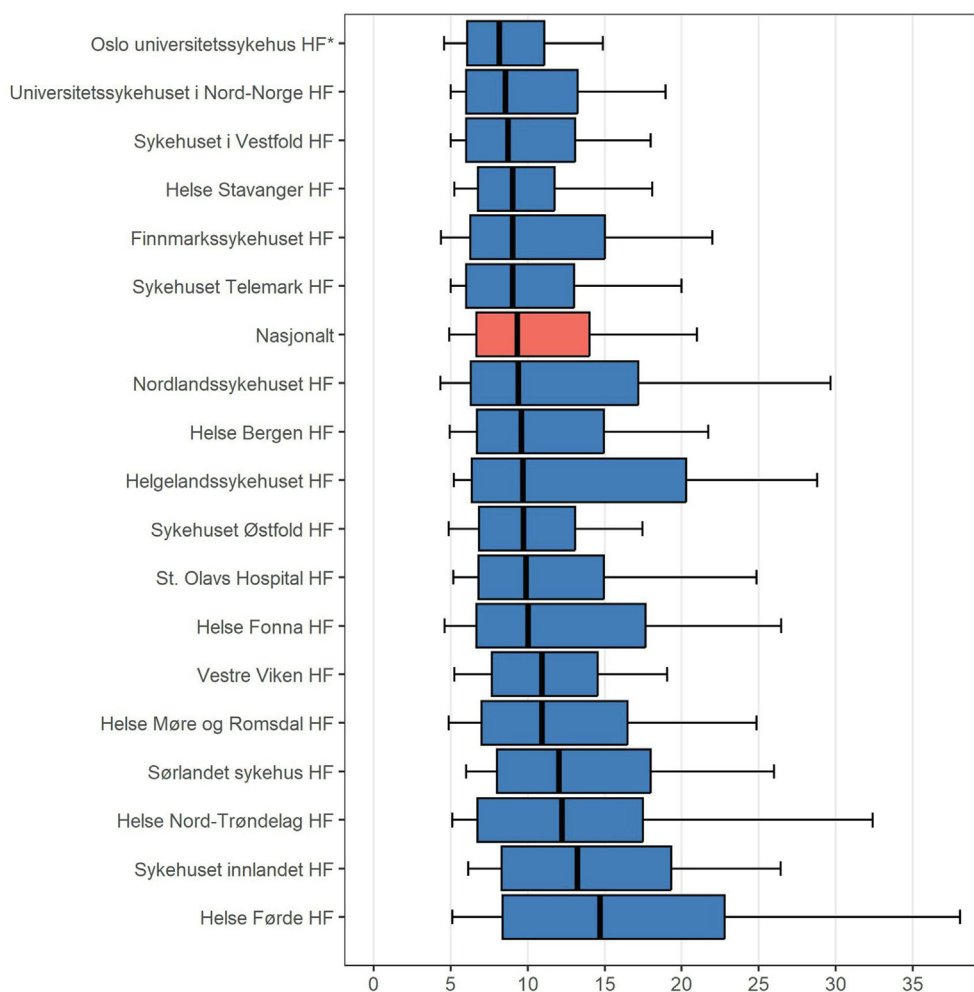


Fig. 4 – Response times in minutes for all the individual Health Trusts (Helseforetak (HF)) in Norway in 2022. Median response time was 9 minutes. The boxes are 25–75 percentiles, and the whiskers are 10 and 90 percentiles. The figure is a reprint from the yearly report from the Norwegian Cardiac Arrest Registry³⁵ and is used with permission from the registry.

tinue to fall short of the authorities' response time targets of reaching 90% of patients within 12 minutes in urban areas and 25 minutes in rural areas.⁵⁴ Even though the response time for cardiac arrest patients is slightly shorter than the overall response time for all emergency missions, we are still far from reaching this goal. First responders and GPs are alerted and attend to patients to reduce the time from call to qualified help being at the patient's side, but time of first responders arrival is not available.

Conclusion

The Norwegian EMS has changed considerably in recent years regarding structural changes and professionalisation of the services. One must consider legislation, geography, weather conditions, and resources when planning for healthcare services. Medical quality registries and indicators should be used to ensure good quality healthcare within the economic limits provided.

CRedit authorship contribution statement

Hege K. Kjærvoll: Methodology, Investigation, Writing – original draft, Writing – review & editing, Visualization. **Lars-Jøran Andersson:** Methodology, Investigation, Writing – original draft, Writing – review & editing, Visualization. **Karin E.N. Bakkelund:** Methodology, Investigation, Writing – original draft, Writing – review & editing, Visualization. **Astrid K.V. Harring:** Methodology, Investigation, Writing – original draft, Writing – review & editing, Visualization. **Ingvid B.M. Tjelmeland:** Conceptualization, Methodology, Formal analysis, Investigation, Writing – original draft, Writing – review & editing, Visualization, Project administration.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: **Ingvid B.M. Tjelmeland:** grants from the Lærdal Foundation for non-related research projects.¹

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Appendix A. Supplementary material

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