

RESEARCH ARTICLE



Potential cardiac arrest – an observational study of pre-hospital medical response

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ABSTRACT

Objectives: A previous study showed that Norwegian GPs on call attended around 40% of out-of-hospital medical emergencies. We wanted to investigate the alarms of prehospital medical resources and the doctors' responses in situations of potential cardiac arrests. **Design and setting:** A three-month prospective data collection was undertaken from three emergency medical communication centres, covering a population of 816,000 residents. From all emergency medical events, a sub-group of patients who received resuscitation, or who were later pronounced dead at site, was selected for further analysis. **Results:** 5,105 medical emergencies involving 5,180 patients were included, of which 193 met the inclusion criteria. The GP on call was alarmed in 59 %, and an anaesthesiologist in 43 % of the cases. When alarmed, a GP attended in 84 % and an anaesthesiologist in 87 % of the cases. Among the patients who died, the GP on call was alarmed most frequently. **Conclusion:** Events involving patients in need of resuscitation are rare, but medical response in the form of the attendance of prehospital personnel is significant. Norwegian GPs have a higher call-out rate for patients in severe situations where resuscitation was an option of treatment, compared with other "red-response" situations.

KEY POINTS

This study investigates alarms of and call-outs among GPs and anaesthesiologists on call, in the most acute clinical situations:

- Medical emergencies involving patients in need of resuscitation were rare.
- The health care contribution by pre-hospital personnel being called out was significant.
- Compared with other acute situations, the GP had a higher attendance rate to patients in life-threatening situations.

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Introduction

The pre-hospital emergency service in Norway consists of emergency medical dispatch centres (EMCCs), 18 in total, the ambulance service, and the air ambulance service manned with anaesthesiologists, all run by the regional health trusts (HT), together with the emergency primary health care service (casualty clinics and GPs on call) and the GP scheme run by the municipalities.[1] At the EMCCs, the operators, using the Norwegian Medical Emergency Index (Index), decide how quickly the patient needs help.[2] Based on the caller's information and use of the Index, the patient is allocated one of three emergency response types: red response (acute), yellow response (urgent), and green

response (non-urgent). A red response is a medical event defined as "a potentially or manifestly life-threatening situation for the patient". Despite the fact that all EMCCs use the Index, large differences are found between the EMCCs in both contact rates and the distribution of response types.[3]

The EMCC is responsible for alarming any relevant emergency services.[1] This is mainly done through the dedicated emergency radio network that all services are equipped with. Index includes a recommended response description. Both the ambulance service and GP on call should be alarmed in the event of a red response.[2] The ambulance personnel have two years in upper secondary school and two years in apprenticeship, a rather

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low level of education in the Norwegian health care system. The ambulance personnel and the GPs on call are defined as the local emergency teams. Among the Nordic countries, Iceland also has a system with GPs attending emergency patients in rural areas.[4] Previous studies have shown that the ground ambulances were alarmed by the EMCCs close to 100% in red response cases. An alarm of GPs on call occurred in about half of the same cases, but with significant variations between the EMCCs. An anaesthesiologist at the air and ground ambulances was alarmed in 8–10% of cases.[5,6] There is also a large geographical variation in the terms of radio use among GPs on call in the different municipalities in Norway.[7] A recent report showed that 81% of the emergency primary care services in the municipalities have a radio available.[8] It has also been shown that the GP on call had a turnout to the patients in around 40% of events when alarmed, and a multivariable analysis indicated that turnouts increased with increase in patient severity.[9] Still, the GPs out-of-hours spent 18% of their time dealing with minor ailments. The organisation of the pre-hospital emergency system is in accordance with the regulation from 2005, concerning the pre-hospital emergency systems. A new and modified regulation from May 2015 introduced stronger demands for GPs on call to take part in emergency situations than the one for the study period.

Important factors related to survival after cardiac arrest are well known, like witness arrest, bystander CPR and shockable first rhythm.[10] Still, there is a lack of knowledge about pre-hospital resources alarmed in Norway, and their response to potential cardiac arrest patients.

On this background, the purpose of this study was to retrospectively examine which pre-hospital medical resources were alarmed and their responses to potential cardiac arrests, with special emphasis on the GP on call.

Materials and methods

In a large main study,[5,8] a prospective data collection was performed at the EMCCs for Innlandet, Stavanger, and Haugesund HT for the period 1 October to 31 December 2007, when data were collected from all red responses. Data were collected based on the Emergency Medical Information System (AMIS), ambulance records, casualty, and primary care doctors' records and air ambulance records for all relevant patients. In 2007, the three EMCCs covered 816,000 inhabitants, 18% of Norway's population.

An AMIS form contains basic data about an event, e.g. which Index entry code was used, the degree of emergency, the number of patients involved, who was alarmed (primary care doctor, ground ambulance,

anaesthesiologist manning the air ambulance, and an hospital-based ground unit with an anaesthesiologist from Innlandet Hospital, where relevant), and the time when the various resources were alarmed. All records included data about the treatment given, plus the endpoint for the patient, e.g. hospital admission or pronounced dead at scene.

Based on medical records, we identified all patients during the data collection who received cardiopulmonary resuscitation (CPR), or were pronounced dead at scene, considered as the most serious patient situations. Then, based on the AMIS form, we could retrospectively quantify different pre-hospital resources alarmed. Inclusion criteria are therefore all patients declared dead at the scene with or without CPR attempts, and all those transported to the hospital during ongoing CPR, or who recovered circulation following CPR.

PASW Statistics 18 was used for the analyses. Univariate analyses were performed. Comparisons between groups were analysed using Chi-square tests. Statistically significant differences were set at $p < 0.05$. Rates are presented with a 95% confidence interval (CI) and median age with 25–75% quartiles. Ambulance response time and delay in alarm of GP on call, is presented as median minutes, with 25–75 quartiles. Suicidal/drug misuse are merged with medical problems in [Tables 2](#) and [3](#). The study has been approved by the Ombudsman for Privacy in Research, the Regional Research Ethical Committee and the Directorate of Health.

Results

In total, 5105 AMIS forms were included in the study, with a total of 5180 patients. Of the 5180 patients, 193 met the inclusion criteria and the further presentation of results concerns these 193 patients.

The total rate of patients for the three-month period at the three EMCCs was 23.5 (20.2–26.8) per 100,000 inhabitants. After excluding patients for whom no resuscitation attempt was made (pronounced dead at site), the rate was 12.0 (9.6–14.4).

Relatives were the most frequent callers and represented over half of cases ([Table 1](#)). There were four times as many men as women in the 0–49 years age group of patients. There were no statistically significant gender differences in respect of main problem areas ($p = 0.46$). The majority of the cases had problems related to internal medicine, most frequent in daytime, decreasing during the course of the day and lowest at night. A large percentage of events occurred in private dwellings (69%); 18% occurred in a public location,

and the remainder in nursing homes and various other areas.

Table 2 gives an overview of alarmed medical resources. The GPs on call were alarmed more often than the anaesthesiologists (59% versus 43%, $p = 0.002$), but attended the patients in fewer cases (84% versus 88%, $p < 0.000$) after alarm. The primary care doctors were most commonly alarmed for internal medical problems, whereas the air ambulance was predominantly alarmed in the event of accidents. In the case of suicides or drug misuse, the GP on call was the only one alarmed in four out of seven cases and attended all four.

The ambulance median response time was 11.0 min (7.0–17.0). In 20 cases, the GP was alarmed after the ambulance had arrived at scene. In the other cases, the GPs on call were alarmed with a median delay time of 0 min (0–2).

The GP was the physician who in most cases decided to stop resuscitation (Table 3). A total of 168 (87%) of patients did not establish return of spontaneous circulation (ROSC) or died, 93 (55%) of them without the pre-hospital services starting resuscitation.

For 55 cases (29%), the caller thought that the patient probably was dead already. However, among patients assumed to be dead, resuscitation was started

on 12 patients (22%) of which two restored circulation, compared with 63% of cases where the caller did not express any opinion about death ($p < 0.001$). There were no statistically significant differences of resuscitation on the patients thought to be dead when a doctor was alarmed and attended, compared with when a doctor was not alarmed.

Amongst patients who restored circulation after CPR, the GP on call was alarmed more often compared with the air ambulance anaesthesiologist ($p < 0.002$), but there were no differences in the attendance between the two doctor types. Among patients who died, the primary care doctor was alarmed more often compared with the anaesthesiologist ($p < 0.03$).

Discussion

This study shows which health resources were alarmed in the most severe patient situations in Norway. The ambulance service was alarmed in almost all cases and among the doctors, GPs on call were most often alarmed. The anaesthesiologists were predominantly alarmed in most of the events involving accidents. After the initial alarm, the anaesthesiologists attended the patients more often compared with the GPs. In 29% of cases, it was recorded that the caller believed the patient to be dead. There was a significantly lower probability of resuscitation attempts in these patients.

The strength of the study is that all patients were included during the three-month period during the data collection. Data were collected from a population of 816,000 inhabitants, which gives an assumed

Table 1. An overview of patients included, by caller, age, and time of event. There are some missing data for callers ($n = 2$), gender ($n = 6$), and age ($n = 7$).

Patients				
Caller	Men	Women	Total	Percent
Relative	68	30	98	52
Public	29	8	37	20
Health care personnel	23	16	39	21
The patient	1	2	3	2
Police, fire, or rescue service	7	3	10	5
Age (years)				
0–39	19	5	24	13
40–59	32	12	44	23
60–79	48	20	68	36
≥80	28	22	50	26
Median age	65	73	69	
25% fractile	52	55	53	
75% fractile	77	84	83	
Time				
Daytime (0800–1529)	52	32	83	44
Evening (1530–2259)	48	20	68	36
Night (2300–0759)	29	8	37	20

Table 3. Patients divided between medical (including suicidal) and trauma, and start of resuscitation, numbers of ROSC, and who decided to stop resuscitation when not ROSC (75 cases).

	Medical <i>n</i> (%)	Trauma <i>n</i> (%)	Total <i>n</i> (%)
All cases	181 (94)	12 (6)	193 (100)
Resuscitation started ($N = 193$)	100 (52)	0	
ROSC ($N = 193$)	25 (13)	0	
Who stopped Resuscitation (75 cases)			
Next of kin	2 (3)	0	2 (3)
GP	30 (40)	0	30 (40)
Anaesthesiologist	8 (11)	0	8 (11)
Unknown	24 (32)	0	24 (32)
Ambulance personnel alone	11 (15)	0	11 (15)

Table 2. Numbers and percentages of patients, alerts, and attendances, by type of doctor and type of primary problem. Cases in which the primary care doctor (PC) was alarmed after the ambulance had attended the patient are excluded. Response data are missing for seven cases.

	Number of patients	PC doctor alerted	PC doctor attended	Anaesthesiologist alerted	Anaesthesiologist attended
Primary problem					
Medical	181 (94)	108 (60)	86 (80)	74 (41)	66 (89)
Accident/trauma	12 (6)	5 (42)	5 (100)	8 (66)	6 (75)
Total	193 (100)	113 (59)	91 (81)	82 (43)	72 (88)

All values are expressed as n (%).

representative sample of Norwegian conditions. The three EMCCs covered 85 municipalities (35 different out-of-hours districts) which strengthens the representativeness of the GPs' responses. The 193 patients are a sub-group of all red responses from the three EMCCs for the period. Out-of-hospital death and CPR is a relatively rare event, and statistical analyses of 193 patients will produce wide confidence intervals. The point estimates are, therefore, somewhat uncertain. Data from 2007 can to a certain extent limit the validity of the results. However, between 2005 and 2015, the regulation of the pre-hospital emergency system [1] has been unchanged and no significant changes have occurred that should effect the GPs' rate of call-outs.

The rates we recorded for patients in a pre-hospital situation and whom it was attempted to resuscitate (48/100,000 per year) correspond to previously recorded national rates, where attempts at resuscitation have been found to be between 40 and 70 per 100,000 inhabitants per year, with a median of around 54.[11] The male majority of cardiac arrest in younger age groups is well known, as well as male majority in trauma patients.

The difference in alarming of doctors in different situations may mean that the EMCC staff differentiated between the patients and their assumed need for a doctor. The anaesthesiologist was primarily alarmed in accidents, often together with a GP, whereas for psychiatric problems, the GP was alarmed exclusively. One explanation may be a perception that GPs had insufficient expertise to manage trauma patients,[12] a perception not necessarily mirrored by the GPs as they attended all trauma situations to which they were alarmed. An analysis of all red responses from the same material showed that only 30% of patients were in a potentially or manifestly life-threatening situation.[9] For all red response patients, GPs attended in 43% of cases in which they were alarmed,[5] whereas for the 193 included patients, the GPs attended in 84% of cases of which they were alarmed. The GPs were significantly more likely to attend when the patient was definitely in a manifestly life-threatening situation. The GP has important decision-making authority in medical treatment as well as giving practical support to ambulance personnel in a resuscitation situation.[13] This is an important argument for the EMCCs to always alarm the GPs and not distinguish between different emergency cases. The anaesthesiologist had a similarly high call-out frequency, and this may be important for patients' potential survival following resuscitation.[14,15]

The ambulance response time in this study was higher compared with the ambulance response time in the Stavanger area for the same period and patient

group.[10] Median response time in the Stavanger area was 9 min.[6–12] ROSC and survival to discharge were not associated with response time in that study.[10] Still, the association between response time and shockable rhythm initially is probably stronger in rural areas. The GPs were alarmed in most cases at the same time as the ambulance. This indicates that the EMCC expects the GPs' participation during resuscitation. We think that some GP alarms after ambulance arrival are due to the need of a physician to write a death certificate.

When the caller thought the patient was dead, doctors and ambulances were also alarmed. In two cases, the patient's circulation was restored following resuscitation. This is an indication that the EMCC personnel must be careful when relying on the caller's view of the patient's condition. A good questioning of the caller, based on the Index, is necessary to make the right decision. Uncertainty should lead promptly to alarm of both ambulance and a physician. Still, the findings indicate somewhat more uncertainty in relation to alarming resources. It is not possible from our data to discern what differentiates cases in which the doctor was alarmed from cases where the ambulance was the only resource alarmed. Resuscitation was not started more frequently when a doctor attended, compared with when they did not attend this patient group. If the EMCC personnel felt that an attempt to resuscitate the patient was to be made, then all resources should be alarmed. If the EMCC personnel felt that it was too late to attempt resuscitation, then in principle, they did not need to send any emergency medical resources at all.

Conclusion

Medical emergencies involving patients in need of resuscitation, or who were declared dead at site were rare, but the health contribution – in the form of pre-hospital personnel being called out – was significant. The GPs on call have a higher attendance rate for patients in a severe life-threatening situation compared with other red-response situations.

Disclosure statement

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the article.

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