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Local emergency medical communication centres – staffing and populations

ORIGINAL ARTICLE

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BACKGROUND

There are several examples of inadequate staffing at local emergency medical communication centres (LEMCs) resulting in limited availability and long waits on the telephone. There are no guidelines for population size or the staffing of a LEMC. In the following, we present models of catchment areas and staffing.

MATERIAL AND METHOD

Traffic intensity on Saturdays and Sundays was based on data on figures for patient contacts at seven LEMCs in 2014 and 2015. We defined the minimum optimal population base as at least 50 % probability of ≥ 10 contacts in the course of a night duty. The Erlang-C formula was used to estimate service level and hence staffing requirements on the basis of population and response-time requirements. We have surveyed the combined staffing requirements of all the LEMCs in Norway.

RESULT

The minimum optimal population base was 29 134. In 2016, 48 of 103 LEMCs were smaller than this. In order to be able to satisfy the response-time requirements in the Norwegian Emergency Medicine Regulations, 112 LEMC night operators and 158 day operators would be necessary for the whole of Norway. A reduction of the response-time requirement from 120 to ten seconds would require 9.8 % more operators at night and 17 % more operators during the day.

INTERPRETATION

The models we have presented provide a basis for planning the population base and staffing of LEMCs. Significantly stricter response-time requirements will result in limited need for more personnel.

Main points

The staffing model based on population numbers that is being presented may be a useful tool for planning an acceptable telephone service level

A local emergency medical communication centre should have at least 30 000 inhabitants in its catchment area

Significantly stricter call response-time requirements will only result in a moderately increased total need for operators in local emergency medical communication centres in Norway

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LEMCs are a part of the national emergency notification service designed to receive telephone calls and handle requests to the out-of-hours emergency primary health care service (OOH service, *legevakt*) for emergency assistance (1). Collaboration between the LEMC and the OOH doctor is crucial, and in practice they are often co-located. As a rule, the telephone operators at the LEMCs are nurses who have other clinical responsibilities at the out-of-hours service. This is in line with the recommendation of the Norwegian Centre for Emergency Primary Health Care (2). In this study, the "operator" is defined as the person who carries out those nursing tasks that relate only to the LEMC.

In 2016, there were 182 out-of-hours districts in Norway, but only 103 LEMCs (3). A LEMC may thus cover more than one out-of-hours district. It is usual for small LEMCs in particular for the on-call doctor to have to communicate with a LEMC in another municipality. It is increasingly uncommon for the LEMC and the Emergency Medical Communication Centre (EMCC) to be co-located, with shared personnel (4).

LEMC operators must have a thorough knowledge of the municipal emergency services, such as home nursing, crisis team and psychiatric service. Local knowledge is the greatest advantage of the LEMC, but low contact numbers may lead to insufficient clinical experience, and operators may have difficulty in maintaining quality and expertise.

About three quarters of the calls to LEMCs concern minor illnesses (5). The operators can deal with many issues without involving the OOH doctor. The result for the public may be less time in the waiting room. The National Centre for Emergency Primary Health Care recommends that LEMCs should play a more central part in the health service (2). The results of questionnaire surveys among users of public services indicate that people are less satisfied with the OOH service than with their regular GP (5). One contributing factor is limited availability and a long waiting time on the phone due to understaffing.

There is no requirement regarding a minimum population in the catchment area of a LEMC. In 2016, there were major capacity problems in both Stavanger and Trondheim after the introduction of a requirement that all initial contacts with the OOH service must be by telephone to the LEMC (6, 7). By comparison with other emergency notification services, the minimum call response-time requirement for LEMCs is not particularly strict.

According to the Emergency Medicine Regulations, LEMCs must respond to 80 % of calls within 120 seconds. By comparison, the Emergency Medical Communication Centre must respond to 90 % of calls within ten seconds (1).

In the present study, on the basis of the intensity of LEMC traffic, we present methods for determining the optimal population base and the minimum staffing necessary to comply with the response-time requirement in the Emergency Medicine Regulations. In addition, we calculate how many

operators are needed for the whole of Norway, given the LEMC structure in 2016, and how large an increase in staffing stricter response-time requirements for LEMCs will entail.

Material and method

Data sources

The Watchtower Project. This project is a network originally consisting of seven representative OOH services with a total of 18 municipalities (8), at which the operators have been recording information about all contacts since 2007. In the present study, we have limited ourselves to traffic on Saturdays and Sundays, because information during the day on business days is very variable. This is because patients mainly contact their GP in the event of acute illness during office hours, and would therefore not be captured in the Watchtower material.

We collected data on time of registration and urgency, based on criteria in the Norwegian Index for Emergency Medical Assistance, for all contacts in the Watchtower Project from 1 January 2014 up to and including 31 December 2015. Owing to restructuring, we lacked data from one of the Watchtower OOH services for the first three months of 2014, and this OOH service was excluded.

Adjustment must be made for some underreporting in the Watchtower Project. An estimate of the extent of the underreporting was made on the basis of historical consultation rates in the project and in the statistics of the OOH services. These were based on reimbursement claims sent by OOH doctors to the Norwegian Health Economics Administration, Helfo (9). The discrepancy was ascribed to the difference between the consultation rate in the reimbursement claim statistics and in the Watchtower Project. This was multiplied by the discrepancy in the contact rate in the Watchtower Project that would have resulted if developments in traffic had been like developments in figures in the reimbursement claims in total. The contacts were considered "day duty" if they were registered between 8 a.m. and 3.59 p.m., as "afternoon/evening" between 4 p.m. and 10.59 p.m. and as "night" between 11 p.m. and 7.59 a.m.

National register of OOH services in primary health care. Data on which municipalities are participants in the different LEMCs in Norway were obtained from the last update of the National Register of OOH Services in Primary Health Care (4). With the aid of data from Statistics Norway on municipality population numbers as at 1 January 2016 (10), we calculated the population bases in all the LEMCs.

Outcome measures

One outcome measure was the number of contacts with the LEMC per clock hour per million inhabitants for the three degrees of urgency green, yellow and red. The likelihood (%) of ≥ 1, ≥ 5, ≥ 10, ≥ 20 contacts in the course of a night duty, broken down according to population number, was another outcome

measure. We used our assessment of what a reasonable minimum workload should be to define the minimum appropriate population base for the OOH service as the population with a 50 % likelihood of generating ten or more contacts in the course of a night duty. The number of LEMCs that were smaller than this with associated population numbers was also an outcome measure, as was the number of LEMCs with associated population that resulted in a less than 50 % likelihood of ≥ 1, ≥ 5 and ≥ 20 contacts in the course of a night duty.

The main outcome measure for staffing was the number of operators necessary according to population in the course of a day or night duty based on the clock hour with heaviest traffic in the course of the duty. This was used to calculate the minimum number of operators during the day or night necessary to serve all the LEMCs in Norway and meet the current response-time requirement (80 % of calls must be answered within 120 seconds) and for six alternative and more strict requirements.

Variables and statistical methods

The data were processed in Excel 2013. The sum of the contact rate from 11 p.m. to 7.59 a.m. together with cumulative Poisson distribution formed the basis for calculating the likelihood of various contact numbers in the course of a night duty for different population numbers.

We used the Erlang-C formula to calculate the number of callers who would receive answers within the time limit of 120 seconds (service level). The Erlang formulae play a central part in queuing theory. They were originally developed for staffing of manual switchboards (11).

We used an average call duration of four minutes as our basis. The number of operators necessary for various population numbers was the least number of operators who provided a service level of at least 80 %, in line with the Emergency Medicine Regulations. We used this to calculate the number of operators necessary at all LEMCs combined during the busiest hour and the least busy hour, and these totals yielded the personnel needed for the whole country. We did the same for other optional combinations of response-time requirements and service levels.

We constructed interactive figures, into which it is possible to insert population number, average call duration and response-time requirement and obtain modelled figures for contacts with different degrees of urgency, the likelihood of various contact numbers, numbers of yellow and red contacts in the course of a day, evening and night duty, service level achieved, average response time, percentage of callers who do not have to wait, and how much of their time the operators must use on active telephone work. The interactive material is available at http://modell.raknesresearch.net/.

The Watchtower Project has been approved by the Regional Committee for Medical and Health Research Ethics and the Norwegian Centre for Research Data, which is the Data Protection Official for research in Uni Research Health.

Results

We registered a total of 67 227 Watchtower contacts on Saturdays and Sundays in 2014 and 2015. This is equivalent to 1 242 visits to OOH services per million inhabitants per 24-hour period. Green contacts accounted for 72.3 %, yellow for 25.1 % and red for 2.6 % of all contacts.

Estimated under-reporting in the Watchtower Project in 2015 was 26.7 %, and all contact rates were adjusted for this factor.

Data from the National Register of OOH Services in Primary Health Care show that there were 103 LEMCs in 2016. The distribution of populations in the catchment areas is shown in Table 1. Populations varied from 1 000 to 658 390; the median was 30 814.

Table 1

Number of LEMCs, municipalities and inhabitants by catchment area population

Population of LEMC catchment area	LEMC		Municipalities		Inhabitants	
	Number	Per cent	Number	Per cent	Number	Per cent
< 5 000	9	8.7	9	2.1	22 965	0.4
5 000–9 999	8	7.8	13	3.0	53 868	1.0
10 000–29 999	32	31.1	106	24.8	642 070	12.3
30 000–99 999	43	41.7	245	57.2	2 273 436	43.6
> 100 000	11	10.7	55	12.9	2 221 646	42.6
All	103.0	100.0	428	100.0	5 213 985	100.0

Figure 1 shows the traffic intensity each hour of the day, broken down by degree of urgency. Total traffic was most intensive between 10 a.m. and 11 a.m., with 114 contacts per million inhabitants. It was least intensive between 5 a.m. and 6 a.m., with 18 contacts per million inhabitants.

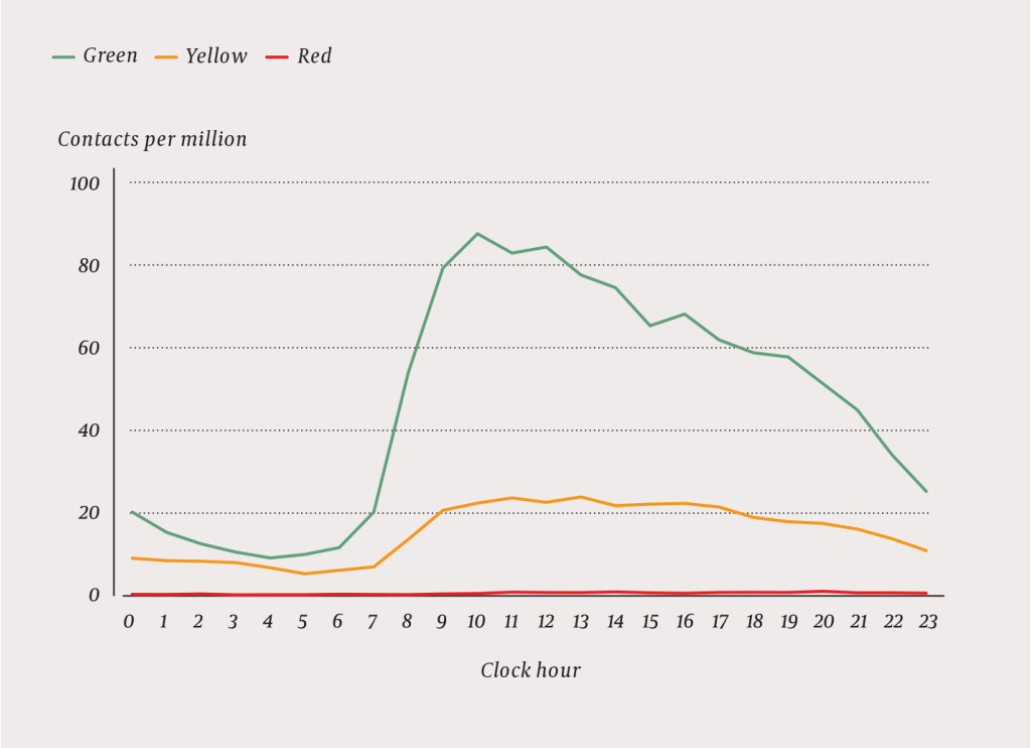

Figure 1 Contact rate at local emergency medical communication centres in seven representative out-of-hours services in 2014 and 2015 per million per hour, broken down by urgency pursuant to the Norwegian Index of Medical Emergencies

Figure 2 shows the probability of at least one, five, ten or 20 contacts with the LEMC in the course of a night duty, by population number. The population in the caption area must be over 29 134 in order for there to be ten or more contacts in more than half of the night duties.

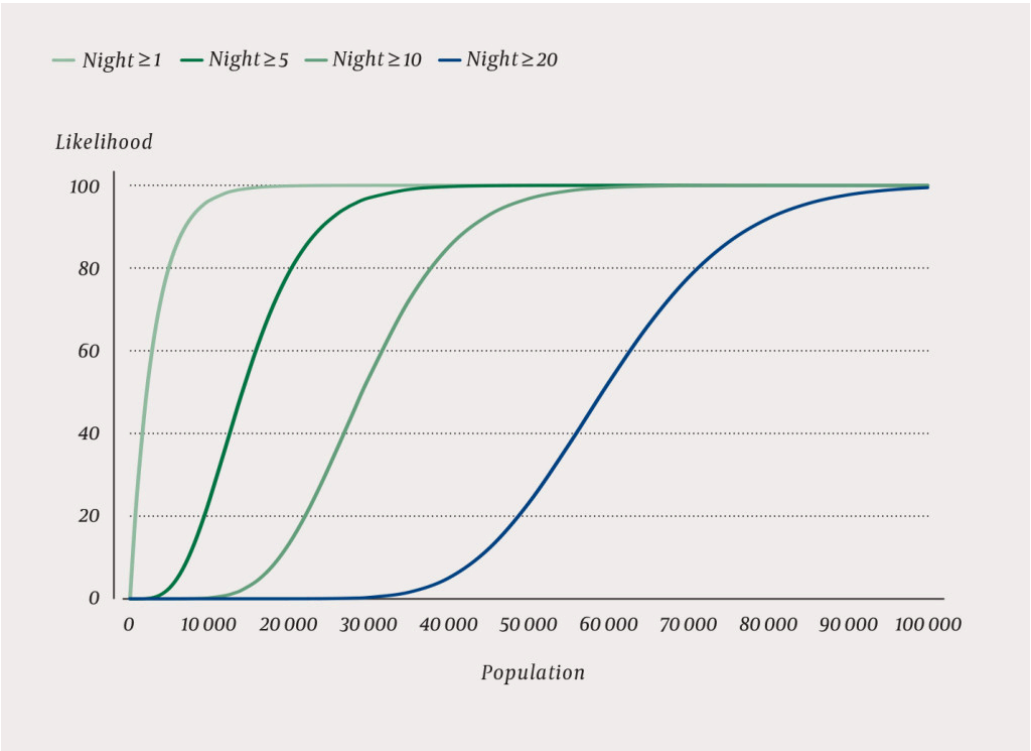

Figure 2 Estimated likelihood in per cent of various numbers of contacts with the local emergency medical communication centre in the course of a night duty (11 p.m.–8 a.m.) by catchment area population. Based on observation of seven representative out-of-hours services in 2014 and 2015.

Table 2 shows the number of LEMCs with populations where the estimated likelihood of at least one, five, ten or 20 contacts in the course of a night duty is less than 50 %. According to the model, only 25 LEMCs have an average of more than 20 contacts in the course of one night duty, but they account for 63.9 % of the population of Norway.

Table 2

Population where the likelihood of fewer than one, five, ten or 20 contacts in the course of a night duty is less than 50 % (critical population number). Number of local emergency medical communication centres, municipalities and inhabitants in catchment areas with less than the critical population number

Contacts in the course of a night duty	Critical population number	LEMCs		Municipalities		Inhabitants	
		Number	Per cent	Number	Per cent	Number	Per cent
< 1	2 089	3	2.9	3	0.7	4 039	0.1
< 5	14 075	21	20.4	42	9.8	128 736	2.5
< 10	29 134	48	46.6	138	32.2	718 903	13.8
< 20	59 263	75	72.8	282	65.9	1 882 320	36.1

Figure 3 shows how many LEMC operators are needed to satisfy response-time requirements, by population number. During the day at least two operators will be necessary if the population numbers more than 35 000. Between 5 a.m. and 6 a.m. one operator can provide service for a population of up to 236 000, but if the busiest time of the night (11 p.m.-midnight) is made the starting point, more than one operator is necessary if the population is larger than 126 000.

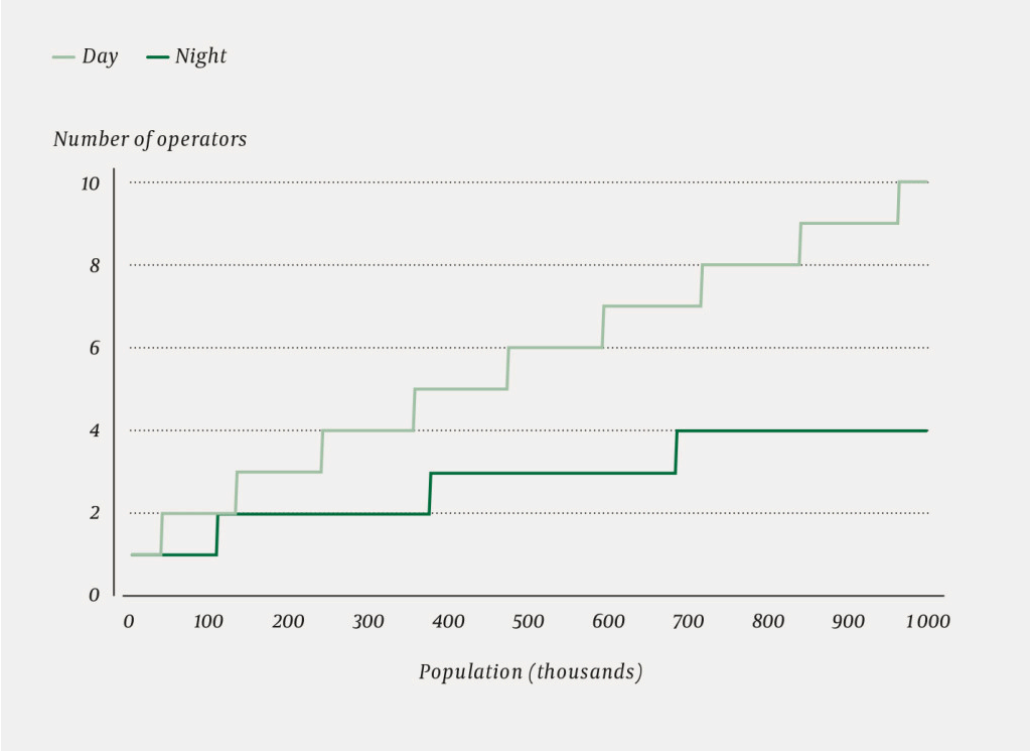

Figure 3 Minimum number of operators necessary at LEMCs on day duty and night duty according to the population in the catchment area of the LEMC. Model based on observation of seven representative out-of-hours services in 2014 and 2015

Figure 4 shows the need for operators given the out-of-hours service structure as at 1 January 2017. At the majority of LEMCs, one operator is enough both during the day and at night.

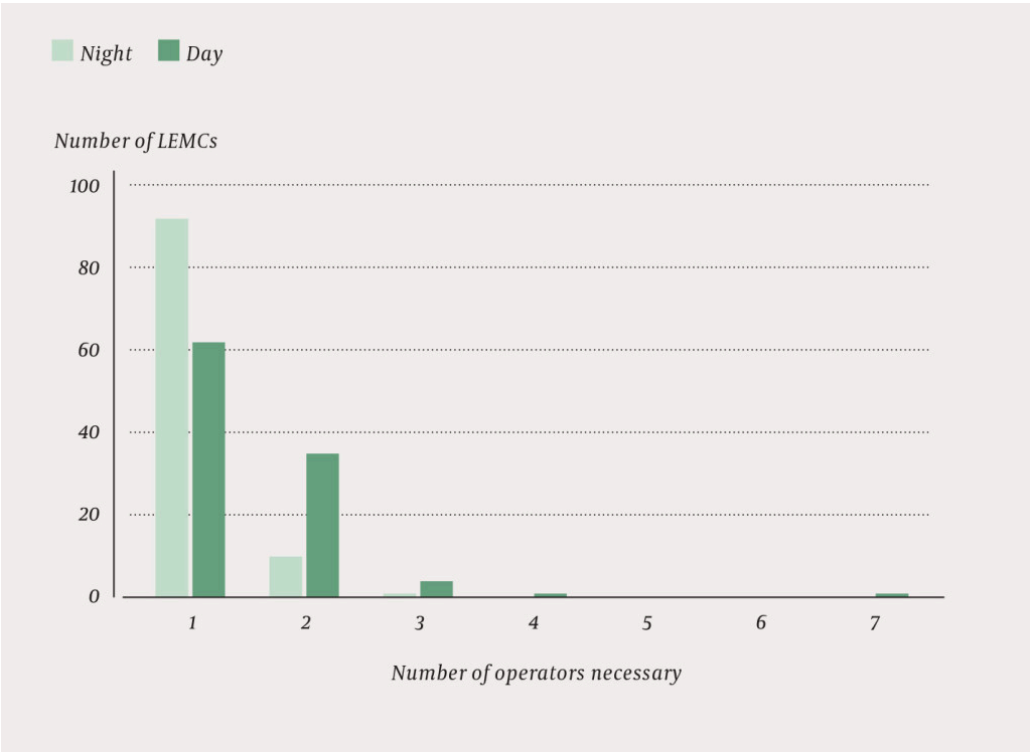

Figure 4 Number of LEMCs by minimum number of operators necessary to meet the response-time requirements in the Emergency Medicine Regulations. Day and night duty are shown separately. Model based on observation of seven representative out-of-hours services in 2014 and 2015.

Table 3 shows the total number of operators needed for all the LEMCs in Norway for different response-time requirements. With the current requirements, all the LEMCs could be served by 115 operators at night and 155 during the day. If 80 % of the calls must be answered within ten seconds, compared with the present 120 seconds, it will require 7.8 % more operators at night and 16 % more operators during the day. If the call duration increases from four to six minutes with the current requirements, the need for operators to cover the whole of Norway will increase by 11 % at night and 26 % during the day (data not shown).

Table 3

Different response-time requirements for local emergency medical communication centres (LEMCs) with the minimum number of operators necessary for the whole of Norway given the out-of-hours service structure in 2016 with current and alternative response-time requirements

			Minimum number of LEMC operators	
	Response-time requirement (secs)	**Calls that must be responded to within required time (%)**	**Night**	**Day**
Current requirements	120	80	115	155
Alternative 1: Requirement as in EMCCs	10	90	148	221
Alternative 1: Halving of response time, 95 %	60	95	173	231
Alternative 2: Halving, 80 %	60	80	119	167
Alternative 3: Stringent I	30	90	142	215
			Minimum number of LEMC operators	
	Response time requirement (secs)	Calls that must be responded to within required time (%)	Night	Day
Alternative 4: Stringent II	10	80	124	180
Alternative 5: No waiting time	0	90	149	221

Discussion

There is great variation in LEMC traffic in the course of the day on Saturdays and Sundays. The traffic is 6.3 times greater between 10 a.m. and 11 a.m. than between 5 a.m. and 6 a.m. The population base is less than 10 000 in 14 % of the LEMCs. We found that the minimum appropriate population for a LEMC is 29 134, and 47 % of the LEMCs with 14 % of the population of Norway were smaller than this in 2016.

Given the OOH structure in 2017, and the response-time requirements in the Emergency Medicine Regulations, this model requires at least 115 operators at night and 155 operators during the day throughout Norway. Significantly stricter response-time requirements will only bring about a moderate increase in the need for operators.

Interpretation

We have presented models for dimensioning of LEMCs with respect to population base and staffing, which may be useful in connection with planning of an OOH service structure. An example is the OOH service in Trondheim, which introduced the obligation to call in by phone in December 2015. The result was that for a certain period it was very difficult to get through by phone. It was particularly bad on the typically busy Boxing Day of 2015. There were only two operators answering the phones (7). Our model shows that at least four operators are necessary at the Trondheim LEMC in order to meet the response-time requirements during the day on an ordinary Saturday or Sunday.

A very long response time as a result of too few operators is a problem at several of the OOH services in Norway. As far as telephone response time at LEMCs is concerned, increased staffing will contribute more towards goal achievement than less strict response-time requirements. The response-time requirements for LEMCs in the Emergency Medicine Regulations are not strict and, as shown here, even a sharp tightening will result in a relatively limited need for more operators, provided the LEMCs are already adequately staffed. Measures to reduce call duration will improve capacity at LEMCs, but too much emphasis on bringing conversations to a rapid conclusion may increase the risk of missing important information, and may also negatively impact the important advisory function.

Findings also show that many LEMCs have such a small population base that we believe it is difficult to recommend them for professional and financial reasons if the operators do not have other responsibilities in addition. As many as 48 LEMCs have less than ten calls on most nights. On the basis of our findings here we believe there is reason to reduce the number of LEMCs by up to 20, from a purely operational perspective. The good response capacity of many LEMCs is one reason that stricter response-time requirements would result in only a limited increase in personnel requirements.

We do not know what the actual staffing of the LEMCs in Norway is today. Because most of them cover an area with a small number of inhabitants, many have good staffing if telephone activity alone is considered, even with only one operator. Differences in the other responsibilities required of operators may be just as relevant for the staffing situation as the number of operators. The essential thing is that these responsibilities must not impact on the ability to answer the phone. By way of comparison, the Directorate of Health has proposed that the centres for receiving signals from security alarms and welfare technology devices must always have a minimum staff of two nurses, who must not have other responsibilities (12).

Limitations

The estimates are based on figures only for Saturdays and Sundays, and it is uncertain how far they can be applied to weekdays. During the day in particular there are far fewer calls from Monday to Friday. Seasonal variations and special local circumstances may also cause deviations from the models we have presented here.

More personnel may be necessary during holiday seasons and on public holidays, when there is extensive traffic because of closed GP offices. For example, the number of reimbursement claims for OOH services on Easter Saturday in 2015 was 25 % higher than on an ordinary Saturday (Hogne Sandvik, personal communication). We have shown previously that the geographical distance to the OOH service strongly influences the extent to which the inhabitants use the service (13, 14), and in the results presented in this article, we have not taken this into account. It is possible to make adjustments for distance in the interactive material.

The population base consists of the municipalities that comprise the catchment area of the LEMC. LEMCs in areas with many students or tourists will, for example, have a higher activity level than that shown by these models.

We cannot exclude the possibility that the OOH services in the Watchtower Project were less representative in 2014 and 2015 than at the start of the project in 2006 owing to general developments and restructuring in the municipalities. Another problem is that we have estimated in this study that about every third contact in the Watchtower OOH services was not registered. We do not know of other reliable sources that can shed light on whether the large amount of missing data has led to systematic reporting bias. We conclude that biased reporting has been limited in extent, and that underreporting is random. Although under-reporting has increased since 2010, the proportions of the variables have remained stable, for example age, gender and urgency level (4).

In our modelling of operator needs, we have assumed an average call duration of four minutes. This is the standard used in training in the Emergency Medical Communication Centre, but the actual average call duration is not known. In the period September 2015 up to and including August 2016, the average duration of calls to the national the OOH service number (116117) was closer to five minutes (295 seconds, personal communication from Anita Østlund at HDO (the health service operating organisation for emergency networks)). It is also likely that the call duration varies through the day.

There are some factors that place constraints on the use of the Erlang-C formula (15). The condition that callers do not hang up before they get an answer also applies to the Watchtower Project. Erlang C also stipulates that the operators must be available to take calls all the time, and not have to do anything else. In practice, servicing the LEMC is only one of several responsibilities of nurses at OOH services. Nor does Erlang C allow for the prioritising of incoming calls. Apart from the fact that callers waiting for answers are requested to ring 113 in cases of acute, life-threatening illness, there is no prioritising at LEMCs before the operator answers the call.

Conclusion

The results of this study may provide a basis for calculating how many operators are necessary at LEMCs to meet the requirements of the Emergency Medicine Regulations. Significantly stricter response-time requirements would demand a small staffing increase. Increased staffing and shorter call duration are the measures that would most reduce waiting time on the phone.

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Interactive material for the article can be found at http://modell.raknesresearch.net.

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