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Impact of a visual indicator on the noise level in an emergency medical dispatch center - a pilot study

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Abstract

Background A maximum of 52 to 55 dB(A) is recommended in order to prevent adverse events in call centres. We aimed at assessing the noise level and the impact of a visual noise indicator on the ambient noise level in a French Regional Emergency Medical Dispatch Centre (EMDC).

Methods We conducted an observational study in the EMDC of the SAMU25 (University Hospital of Besancon). We measured the noise level using a SoundEarII® noise indicator (Dräger Medical SAS, France). The measurement took place in two phases on three consecutive days from 00:00 to 11:59 PM. At baseline, phase 1, the device recorded the average ambient noise for each minute without visual indication. Secondly, phase 2 included a sensor mounted with a light that would turn on if noise ever exceeded 65 and 75 dB(A).

Results The sound level was greater than 52 dB(A) in 97.2% and 66.8% of the time in phases 1 and 2 respectively; this level was greater than 55 dB(A) in 84.9% and 43.9% of the time in phases 1 and 2 respectively.

Conclusions The noise levels were higher than recommended and sometimes close to legal limits, requiring preventive measures. The noise indicator had a positive effect on the ambient noise level. This work will allow the implementation of effective prevention solutions and, based on future assessments, could improve operators' well-being and better care for patient.

Background

The activity of emergency medical dispatch centres (EMDC) in France is constantly increasing due to the ageing population, decrease in the healthcare professionals number, lack of resources, but also the environmental and industrial changes that lead to an increase in major disasters and health crises. Moreover, people constantly seek for more performant emergency care. In response, the number of emergency medical dispatchers (EMD) was increased [1]. EMDs are working with emergency physicians in a limited space and in an increasingly noisier environment.

The noise effects have been mainly studied in call centres. Noise is a primary hazard threatening human health [2]. It can affect physical and mental health [3–5]. Noise can cause hearing loss, stress, discomfort and musculoskeletal disorders [6–14]. A noisy environment is incompatible with undisturbed intellectual work [15]. Moreover, 16% of adult hearing loss worldwide is related to noise exposure [16]. Call centres operators may also be subject to accidental high-intensity noises associated with the use of headsets (i.e. acoustic shocks) [17], which could induce a startle effect and a temporary hearing loss [5, 18]. Standards and guidelines recommend a maximum noise level of 52 to 55 dB(A) for call centres to prevent adverse events [19–21]. However, the French National Research and Safety Institute (INRS) has shown that call centres operators may be exposed to noise levels that exceed these recommendations [5].

The impact of noise on the health of call centres operators has been widely studied and it is even considered as one of the harmful hazards, but little attention was given to noise assessment in EMDC especially since they are not really comparable to these call centres. Indeed, the French National Authority for Health (HAS) defines medical regulation as a medical action performed over the telephone [22]. EMD and emergency physicians deal with potentially life-threatening situations. In addition, the evaluation of the patient's condition can only be done indirectly. It is therefore a very stressful and complex intellectual activity. Stress is moreover significant because of the degree of urgency and the impact of each decision on the evaluation and management of patients. Thus, our study aimed to assess the noise level in the regional EMD Centre (EMDC) of the SAMU25 as well as related factors. We also assessed the impact of a visual noise indicator on the ambient noise level.

Methods

This single centre observational study was conducted in the EMDC at the Besancon University Hospital (France).

Noise Level Measurement in the EMDC of the SAMU25

The ambient A-weighted noise level was measured using a SoundEarII® noise indicator (Dräger Medical SAS, France) approved for indoor and outdoor noise level measurement (frequency: 20 Hz to 16 kHz, scope of measurement: 40 dB(A) to 115 dB(A), deviation: +/- 3 dB(A)). This device can generate light alerts, when the sound level exceeds predetermined thresholds. The device was located at a central point of the EMDC room in order to be visible to the whole room. The average ambient noise level was continuously measured for each minute during a 6-day period, from 00:00 to 11:59 PM, with two phases of three consecutive days. At baseline, in phase 1, the device measured noise level without visual indication. In phase 2, the indicator was visible for each one in the room and the sensor warned the staff when the noise level exceeded the pre-set thresholds: the light is green below 65 dB(A), orange when it exceeds the first predetermined threshold (65 dB(A)) and red when noise intensity exceeded the second threshold (75 dB(A)). The 65 dB(A) threshold is a recommended limit to ensure proper working conditions in call centres [15]. The 75 dB(A) is the value bellow which continuous and/or repetitive exposure is unlikely to have adverse effect on the health and safety of workers [23]. The acoustic data were analysed using the software SoundLog®.

The most common epidemiological indicators of noise exposure at the workplace are “equivalent continuous sound level” (LAeq.T) and percentile levels [24]. LAeq represents the average sound energy measured over a stated period of time T. For each phase, LAeq,T was calculated from 7:00 AM to 9:00 PM (LAeq,day) and from 9:00 PM to 07:00 AM (LAeq,night) according to French working time directives definitions and during the entire phase. Time spent above the INRS threshold (average background noise level at 52 dB(A)) and above the French and International organization for standardization (ISO) standards thresholds (55 dB(A)) were quantified.

Five additional conventional noise level indicators were calculated: minimum and maximum level achieved during the time of recording (Lmin or Lmax, respectively), background noise (L90, exceeded sound level 90% of the interval of time of the measurement), median noise (L50, exceeded sound level 50% of the interval of time of the measurement) and noise of crest (L10, exceeded sound level 10% of the interval of time of the measurement).

EMDC's Activity

The activity of our EMDC was estimated by the number of calls in progress during each recorded minute. These data came from Centaure 15®, a computerized software for file recording available in several EMDC in France. We also registered the number of persons on duty in the room at each t-time, based on the emergency medical dispatchers schedules.

We defined periods of activity according to the number of people present. A new period was defined for each variation of this number, with a total of 46 periods in 6 days.

A correlation between noise level and EMDC's activity estimated by the number of calls per minute and by the number of people on duty was tested in phase 1 and 2, i.e. without and with the sensor turned on.

Statistical analysis

The statistical analysis was conducted using SAS 9.4 (SAS Institute, Cary NC).

The basic statistical unit was defined for half-hour time blocks. All of the variables were assessed based on this time frame. The duration of exposure above thresholds was defined as the proportion of time spent above the thresholds over the course of each of these time blocks. A multilevel linear regression model was fitted (the measurement as level 1 and the phase (one or two) as level 2). The dependent variable was the ambient noise level, and the day/night period, the number of calls in progress and the number of people present. Phases 1 and 2 were introduced as independent variables.

Results

Ambient Noise Levels

Overall noise levels during the two phases are presented in Table 1 and Fig. 1. The sound level was greater than 52 dB(A) in 97.2% and 66.8% of the time in phases 1 and 2 respectively; this level was greater than 55 dB(A) in 84.9% and 43.9% of the time in phases 1 and 2 respectively.

Table 1
Overall A-weighted noise levels

Noise level (dB(A))	L_{Aeq}	L_{max}	L_{min}	L_{90}	L_{50}	L_{10}	Mode
Phase 1	60.3	76.5	48.5	54.2	58.9	62.8	48.5
Phase 2	56.9	71.6	47.8	48.5	54.2	60.4	48.5
P value	$P < 10^{-3}$	$P < 10^{-3}$	$P < 10^{-3}$	$P < 10^{-3}$	$P < 10^{-3}$	$P < 10^{-3}$	
L10: exceeded noise level for 10% of the measurement period (crest noise).							
L50: exceeded noise level for 50% of the measurement period (median noise).							
L90: exceeded noise level for 90% of the measurement period (background noise).							
The L10 and L90 are extensively used for impulsive sound levels and Background Noise respectively.							
LAeq = Equivalent Sound Level. It quantifies the noise environment to a single value of sound level for any desired duration. This descriptor correlates well with the effects of noise on people							
Lmax = Maximum Sound Level: a maximum level during the measurement period.							
Lmin = Minimum Sound Level during the measurement period.							

Estimation of Activity and Correlation with Noise Level

Table 2 presents the variables associated with the noise level in multilevel multivariate analysis. The difference between average number of calls per minute during phase 1 and 2 was not statistically significant. The LAeq.T increased with the number of people on duty in the regulatory room regardless of the workload (Table 3).

Table 2

Association between noise level (LAeq) and time period or EMDC’s indicators (multivariate analysis)

Variables	**LAeq**	**P-value***
Periods:	60.0	$< 10^{-3}$
Day (07:00 AM – 09:00 PM)	56.9	
Night (09:00 PM – 07:00 AM)		
Number of calls per minute:	58.3	$< 10^{-3}$
0	58.7	
1–2	59.9	
≥ 3		
Number of people on duty in the regulatory room	56.5	$< 10^{-3}$
8–9	59.1	
10–17	61.5	
18–20		
Negative interaction between the number of calls per minute		$< 10^{-3}$
and the number of people on duty in the regulatory room on noise levels LAeq		
Intervention effect	60.3	$< 10^{-3}$
phase 1	56.9	
phase 2		

Table 3

Negative interaction between the number of calls per minute and the number of people on duty in the EMDC on noise levels LAeq

	Number of people on duty			**p value**
Number of calls	8–9	10–17	18–20	$< 10^{-3}$
0	56.3	59.3	63.4	
1–2	56.5	59.0	61.5	
≥ 3	57.7	59.2	61.1	

Compared to phase 1, noise levels were significantly lower in phase 2, both during the day and night periods.

Discussion

Our study highlights several issues. First of all, the sound levels were very high. The overall equivalent sound level (L_{Aeq}) was 60.3 dB(A) during phase 1. The maximum average per minute reached up to 76.5 dB(A). In phase 1, the thresholds of 52 and 55 dB(A) were respectively exceeded in 97.2 and 84.9% of the time whereas 66.8 and 43.9% of the time in phase 2. Second, the sound levels depended on the activity in the EMDC (number of working people and number of calls per minute). And, finally, the visual noise indicator proved itself very useful in reducing the noise level.

Noise Level assessment

The recommended limit for background noise level is 52 dB(A) for undisturbed intellectual work [5]. The values found were greater [2, 4, 5] regardless of the considered time slot.

However, ambient noise is not the only sound perceived by the EMDs, additional noise comes from headsets too. A 20 dB(A) margin is necessary for intelligible and quality conversation. The sound level perceived directly by the EMDs could be much higher than the measured ambient noise level and may exceed the 80 dB(A) threshold requiring hearing loss preventive actions [25].

The ambient noise level within an EMDC seems comparable to that found in other call centres within the tertiary sector. It exceeded recommended limits almost all the time and sometimes even exceeded legal limits requiring preventive measures. This is worrisome. In EMDC, quick decisions engaging prognosis and even survival have to be made. This requires utmost attention and focus. This is hardly compatible with a very high level of ambient noise and causes stress and exhaustion. Ambient noise can also make radio transmission less audible, leading to inaccurate assessment with possibly unfortunate repercussions.

Factors Involved in Variation of Sound Level

The difference in sound level between the day and night time slots seemed logical and mostly due to a decrease in activity. Our data suggested that the average number of calls per minute declined from 2.5 by day to 1 during night time slots in phase 1 ($p < 10^{-3}$). Accordingly, the increase in activity logically leads to an increase in the sound level. In the same way, the more the people, the louder the sound. This could have several reasons. First, the mere presence of a higher number of people will obviously entail a greater noise nuisance. Finally, within EMDC, there are additional parasite noises arising particularly from operators' interactions. There are indeed numerous exchanges between staff members ranging from simple verbal instructions without using communication headsets, to discussions mostly unrelated to work.

This partly explains the rise of the additional noise disturbances with the increase in the number of people present in the closed space of the EMDC. When a large number of employees were present in the centre, the noise level was lower when the workload was high rather than low. The reason is that an increased workload does not allow any slackness and forces the staff into focussing on work only.

A reduction of this parasite noises could be achieved by raising awareness and changing behaviours (such as forbidding off-microphone interactions) or by bringing in adjustments on work premises (less noisy material, installation or improvement of acoustic treatment solutions, enhanced office space layout …) or workstations (dual headsets, sound level controller, daily exposure time limitation).

Impact Assessment of the Noise Indicator

The visual noise indicator allowed a significant reduction of nearly 3 dB(A) in ambient noise and a 10% decrease in the proportion of time above the thresholds. This user-friendly device could lead to improved working conditions, therefore contributing to optimal call handling and better quality of work.

Bias and Limitations

This study has limitations. The use of a single sound level meter could inaccurately reflect the individual exposure to noise. Implementing different sound level meters could enhance accuracy in the measurments.

The sound level meter only gave equivalent continuous sound level for each minute. There are several fluctuating indoor and outdoor noise sources responsible for intense, punctual and significant short-term sound level increases in the EMDC: ambulances with sirens and helicopter landing and taking-off. They can exceed 120 dB(A) and be responsible of acoustics shocks. They are sources of stress but also of at least temporary hearing disorders. The most stressful and troublesome noises for the operators did not appear in our measures due to the time-averaged data processing. .

Another limitation is the short duration of recording (3 days for each phase). In addition to a possible problem regarding the representativeness of the recorded period, a possible "novelty" effect could not be ruled out. The staff’s attention, considerable at the beginning of the device installation, could have diminished over time and led to a return to the previous sound level.

Conclusion

To our knowledge, this pilot study is the first to consider the noise level in an EMDC. Such noise levels are higher than the recommended limits and sometimes close to legal limits, requiring preventive measures. The noise indicator was associated to a substantial reduction in ambient noise. This might have had a positive effect on staff behaviour. Further multicentric studies are needed using a more efficient noise measurement system to take into consideration many other acoustic factors and confirm our findings. This might allow the implementation of effective prevention solutions to improve operators’ well-being.

Abbreviations

dB(A): A-weighted decibels; EMD: Emergency medical dispatchers; EMDC: Emergency medical dispatch centres; HAS: French National Authority for Health; INRS: French National Research and Safety Institute; ISO: International organization for standardization; L10: exceeded noise level for 10% of the measurement period (crest noise); L50: exceeded noise level for 50% of the measurement period (median noise); L90: exceeded noise level for 90% of the measurement period (background noise); LAeq: Equivalent Sound Level; LAeq.T; LAeq,day: LAeq.T from 7:00 AM to 9:00 PM; LAeq,night: LAeq.T from 9:00 PM to 07:00 AM; Lmax: Maximum Sound Level; Lmin: Minimum Sound Level; SAMU25: Service d'Aide Médicale Urgente de Besançon.

Declarations

Ethics approval and consent to participate

The study was not submitted to an ethics committee. No patient was concerned, only the dispatchers working in the EDMC were concerned. The study was designed to protect the privacy of the participants (it was conducted anonymously and no individual data was collected). The study was presented to all the staff of the EMDC who gave a verbal consent to participate.

Consent for publication

Not applicable

Availability of data and materials

The datasets generated and/or analysed during the current study are not publicly available, but are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interest.

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None.

Authors' contributions

JO contributed to data collection. SP, AB and FM were responsible for the statistical analyses. JO, JBP and AK drafted the manuscript. JML and CL helped in collecting the data, TD reviewed the manuscript and all authors revised the manuscript. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted. The authors read and approved the final manuscript.

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Figures

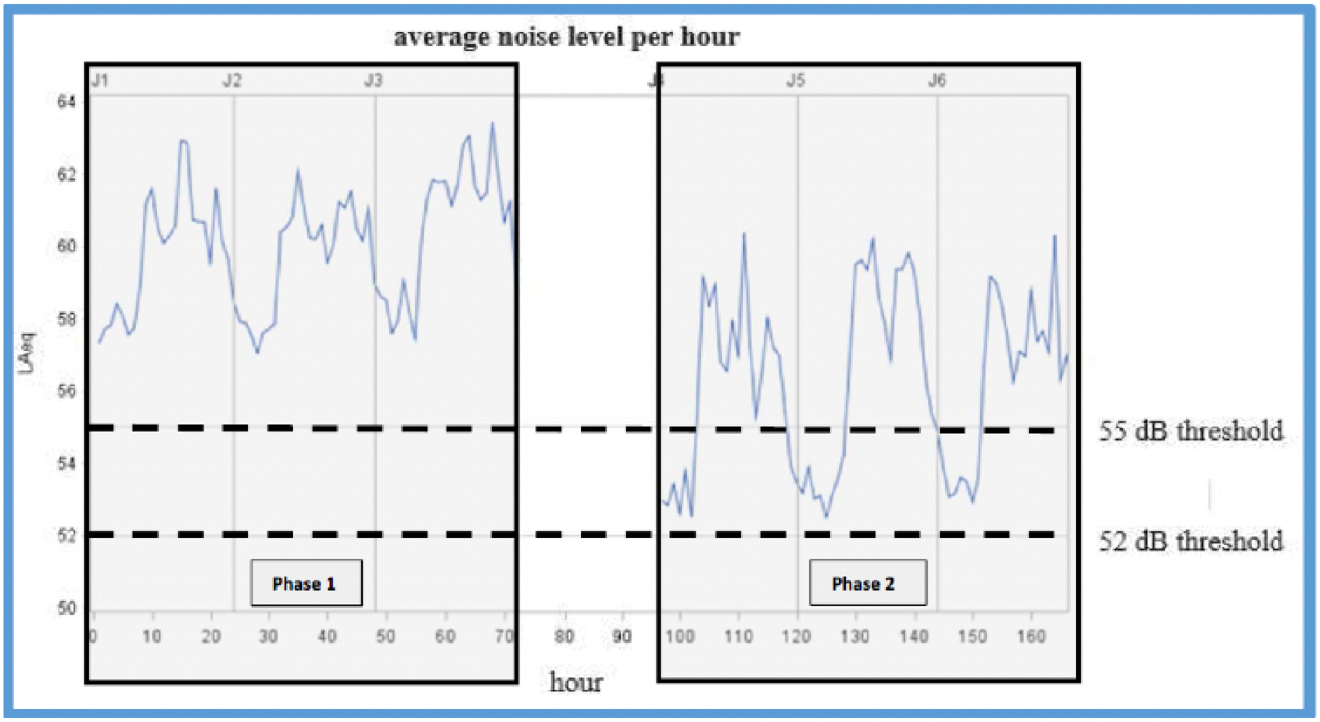

Figure 1

Average sound level per hour (LAeq) time evolution