



Alarming sound; a case study on noise in an Emergency Ward

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ABSTRACT

This study aimed to investigate the impact of noise in the workplace of a healthcare facility and its effects on the health of healthcare workers. The study's objectives were to find out the effects of noise in the workplace and to see if modifications to the sound environment changed the workplace experience and any potential adverse effects. In order to achieve these objectives, a combination of methods was used to gather data. Additionally, the study employed an interactive workshop for healthcare workers to create awareness about the issue and encourage them to take an active role in finding solutions. Results of the study indicate that noise in the workplace can have detrimental effects on the health and social sustainability of healthcare workers. Over 80% of employees experienced noise in the workplace. The study concludes that there is a need for increased awareness and action to improve the sound environment in healthcare facilities to benefit both healthcare workers and patients.

Keywords: *Noise, Healthcare, Workplace, Well-being, Sound environment, Perception, Hearing loss*

1. INTRODUCTION

Research has shown that noise is a known stressor, a source of annoyance and fatigue, as well as limiting communication and, in acute cases, severely impacting health [1]. This case study, therefore, sought to investigate if any of these adverse effects influenced healthcare providers' experience of their workplace and whether

methods to reduce noise could improve their outcomes. This paper describes a case study conducted at an Emergency Department (ED) in the Jeroen Bosch Hospital located in 's Hertogenbosch in the Netherlands to improve the working environment by addressing the effects of noise on people. Excessive noise can negatively affect concentration, communication, and overall health, impacting the quality of care [2]. The case study consists of a survey, a workplace observation, interviews, and an interactive workshop to raise awareness about the effects of noise on people and involve healthcare workers in finding solutions. The aim is to improve the sound environment, benefiting healthcare workers and patients by enhancing concentration and communication and reducing fatigue, mistakes, and stress.

Eindhoven University of Technology (TU/e) conducted measurements in the past to investigate the sound environment of the ED. A reverberation time of 0.49 seconds was measured [3]. The measured reverberation time of 0.49 seconds is a good reverberation time for an open workspace according to the standard "Acoustic quality of open office spaces" (ISO 22955:2021) when considering activity based on a small amount of collaborative work (space type 4 in the standard), and the measured Speech Transmission Index (STI) is 0.82, which indicates excellent speech intelligibility according to the standard "Measurement of room acoustic parameters — Part 3: Open plan offices" (ISO 3382-3:2022). Based on the findings of this case study and their surveys, the hospital implements interventions, followed by new acoustic measurements and surveys to assess the impact.

2. METHOD

The study employs a dual-faceted approach to explore the influence of sound within the ED. The first component of the methodology involves a survey that seeks to capture the experiences of healthcare workers with sound in their work environment. This survey incorporates a range of questions that probe into the

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types of sounds and the workers' reactions to these sounds. The findings from this survey will equip us with a nuanced understanding of healthcare workers' lived experiences and perceptions, thus illuminating areas that require intervention.

Subsequent to the survey, interactive workshop is set up with the healthcare workers. The objectives of this workshop are as two-fold:

- First, it seeks to foster awareness among healthcare workers about the role of sound in their work environment and its potential impacts on their work performance and overall health, including awareness of possible hearing loss or sensitivity to certain sounds.
- Secondly, the workshop aims to stimulate an active participatory process, where healthcare workers are encouraged to share their insights, ideas, and potential solutions for managing sound levels and enhancing their work environments.

Merging the data collection and consciousness-raising potential of the survey with the participatory, solution-driven approach of the workshop enables a comprehensive and effective engagement with the role of sound within healthcare facilities.

2.1 Sound Perception Survey

The survey was designed and distributed using Typeform, a software platform known for its user-friendly interface and flexibility. This platform allows for creation of dynamic online forms and surveys, which can be conveniently accessed and completed on various devices, including computers and smartphones.

In this study, Typeform was particularly beneficial as it allowed staff members to respond to the survey at their convenience, whether during a break at their workstation or off-site on their mobile devices. This accessibility likely increased the response rate, contributing to the comprehensiveness of the data collected.

The survey consisted of 13 questions aimed at understanding the staff's perception and experience of sound in their working environment. It was sent to staff members via a Typeform link provided by their manager, with a request to fill it out anonymously and an explanation of the research's purpose.

The questionnaire began with general inquiries about the respondent's feelings, age, self-assessed hearing ability, and whether they experience tinnitus. That was followed by more specific questions about noise disturbance in the

workplace, which could be supplemented with open-ended responses.

Focusing on the individual's autonomy, the final section of the survey inquired whether the respondent had the flexibility to work in different locations based on their need for concentration, silence, or discussion.

Insights from this survey, designed to elicit both qualitative and quantitative responses, significantly shaped the subsequent workshop. Moreover, it helped foster awareness and mutual respect regarding noise in the workspace. For example, one question in the survey was:

“Do you experience disturbance on the work floor due to sound? Please rate on a scale from 1 (Never) to 5 (Always).”

If the respondents answered with two or higher, the following question unfolded, giving the respondent multiple options to choose sounds or write up their own (see Figure 1).

En hiermee bedoel ik ...



Figure 1.

2.2 The Workshop

The workshop, attended by 120 participants, was spread over three sessions in three following weeks. Each session was 45 minutes long and held at the hospital. Before the workshop, the schedule included a lecture of 20 minutes presenting research on psychoacoustics. This

lecture highlighted the effects of noise on individuals' perception, cognition, and communication. Stating the impact of noise on stress levels, the natural hearing decline associated with aging, the concept of sensory processing sensitivity, the efficacy of communication in noisy environments, and the overarching influence on workplaces, staff health, and well-being. This foundational knowledge, rooted in scientific research, taught healthcare providers how noise can affect various aspects of their work and personal health.

Small groups of five participants each formed the organization of the workshop. The workshop format provided each group with a paper floor plan of the emergency room, facilitating a physical mapping of their auditory experiences (see Image 1).

The workshop format provided colored pencils to participants, enabling them to denote different categories of sounds encountered in their workspace. Red was used to indicate chaotic sounds, yellow for lively sounds, blue for sounds perceived as boring, and green for calm sounds. They also had pens to specify the sounds corresponding to the colored areas on the floor plan.

This exercise aimed to create a visual and tactile representation of the soundscape in the ED from the perspective of those who interact with it daily. This map served as a tool for discussing and understanding the complexity of the soundscape and its impact on healthcare workers' experience.

In the final stage of the workshop, participants brainstormed solutions to the issues of noise they had identified. A notepad served as the repository for these ideas, facilitating further discussion and potential development of interventions to improve the acoustic environment in the ED. The workshop, thus, provided a rich, qualitative source of data, supplementing the quantitative data gathered through the survey.



Image 1.

3. RESULTS

The results from the Noise Perception Survey and the ensuing workshops shed light on the sound interplay in the ED and its impact on the diverse staff cohort's professional tasks.

3.1 Results survey

The Noise Perception Survey was completed by a diverse group of 63 staff members working in the ED. The respondents were predominantly female (80%), with an age range from 25 to 66 years old, and the majority (60%) being between 26 and 35 years old. This group consisted of doctors & doctors in training, nurses, secretaries, and managers.

A significant 85% of these respondents reported experiencing noise disturbance in their workplace. The primary sources of this disruption were identified as social talk (70%), unattended alarms (60%), and the pneumatic tube system (50%).

Despite the high levels of noise disturbance, 95% of the respondents reported that they do not have any hearing loss. However, 20% reported that they experience tinnitus, a ringing or buzzing noise in one or both ears that may be constant or come and go, often associated with hearing loss.

The noise in the workplace had a notable impact on the respondents' work. About 60% reported having difficulty receiving information due to the noise, and 55% reported having difficulty understanding spoken information or instructions. That led to stress for 45% of the respondents.

The responses were mixed when asked about their ability to choose their workspace based on their need for concentration, silence, or consultation. About 35% reported being free to choose their workspace, while 65% reported that they do not.

The respondents also reported on the measures they take to reduce noise disturbance. The most common measures reported were using headphones (40%), moving to a quieter place (35%), and asking colleagues to be quieter (25%).

The survey also allowed for open-ended responses, providing a more nuanced understanding of the staff's experiences. These responses were analyzed qualitatively, identifying common themes and unique insights that further illuminated the impact of noise on the staff's work experience. Several themes emerged from the qualitative responses.

- One recurring theme was the impact of noise on communication. Many staff members described how noise, particularly from social talk and unattended alarms, made hearing and understanding spoken information or instructions difficult. Some staff members shared specific instances of confusion or mistakes, highlighting the potential patient safety implications.
- Another common theme was the stress and annoyance caused by noise. Staff members described feeling overwhelmed or irritated by the constant noise, particularly during busy periods. Some mentioned that the noise made it hard to concentrate or think clearly, affecting their ability to perform their duties effectively.
- The pneumatic tube system was frequently mentioned as a particularly disruptive noise source. Staff members described the system's operation as startling and disruptive, particularly because of its unpredictable nature.
- Face masks were also a significant concern, with staff members describing how they made communication more difficult. That was a unique insight that the quantitative questions may have yet to capture fully, highlighting the value of including open-ended responses in the survey.

Overall, the detailed analysis of the survey results provided a comprehensive understanding of the noise environment in the Emergency Department, highlighting key areas of concern and potential targets for intervention.

3.2 Results workshop

Spread over three weeks, all staff members of the ED participated in the workshops. Such an approach ensured a comprehensive inclusion of diverse experiences and perspectives in the analysis, contributing to the depth and breadth of our understanding of the soundscape in the ED.

The workshops generated valuable insights into the staff's perceptions of the sound environment in their workplace. Participants identified social conversations, unattended alarms, and the pneumatic tube system as primary sources of sound disruptions. These sounds, categorized as chaotic (red) and lively (yellow) on the floor plan, were prevalent in the team area.

On the other hand, areas marked as boring (blue) or calm (green) indicated lower sound intensity or less disruptive noises. Participants also expressed their difficulties in communication due to the use of face masks, with some reporting that it induced stress.

Group discussions and brainstorming sessions suggested potential solutions to these sound issues, ranging from behavioral changes to technical interventions. Overall, the workshops facilitated a more nuanced understanding of the impact of sound on staff well-being and job performance to promote effective communication and reduce mistakes due to fatigue.

4. DISCUSSION

The study findings corroborate the pervasiveness and impact of sound in the ED environment, as reported in previous studies [4,5]. Most staff reported experiencing disruptive noise in their workplace, with social talk, unattended alarms, and the pneumatic tube system being the primary sources. The latter two particularly resonate with findings from studies in other high-intensity healthcare settings, highlighting the universality of such challenges [6].

Interestingly, the case study underscored the additional dimension of face mask-induced communication difficulties, especially relevant in the current times of necessary pandemic-related precautions. The stress and potential errors resulting from such communication lapses call for immediate attention and innovative solutions.

The workshops provided a unique platform for staff to voice their concerns, articulate their needs, and participate actively in problem-solving. This participatory approach facilitated a deeper understanding of the sound environment and helped foster staff engagement and buy-in for potential interventions. The color-coded floorplans vividly depicted the 'sound map' of the ED and emphasized the need for location-specific sound management strategies.

Potential solutions ranged from behavioral changes to technical interventions. While some solutions, such as promoting quieter social conversations, can be implemented relatively cost-free, others, like modifying the pneumatic tube system, require more substantial resources and planning. The potential impact on staff well-being and job performance should guide the prioritization of these interventions.

In discussing the findings of this research, it is essential to acknowledge certain limitations that may have influenced the results. The data obtained from the Noise Perception Survey and the workshops are mainly subjective, relying on individual perceptions and experiences of sound in the ED. This subjective nature

may have introduced some degree of bias, as different individuals may interpret certain sounds differently. While 85% of respondents reported workplace noise disturbance, the survey's focus on noise may have biased these results. Future studies could benefit from more open-ended questions about the overall sound environment, including positive sound experiences, to provide a more balanced and comprehensive understanding of its impact on staff well-being and job performance.

Additionally, the use of color-coded floorplans, while effectively representing the sound environment, may have yet to capture the full complexity of the soundscape. For instance, certain sounds might change in nature over time or be perceived differently depending on other concurrent sounds or tasks. Increased listening effort in complex sound environments, characterized by distracting and unpredictable sounds, was a notable observation in this case study, reflecting findings from related research in the ICU [7].

The research also relied on the participants' availability and willingness to participate in the workshops, which may have resulted in an uneven representation of different staff roles or shifts. Future studies could aim for more structured sampling, ensuring equal representation of all staff roles and shifts, to obtain a more comprehensive understanding of the soundscape.

Furthermore, while the workshops provided a platform for brainstorming potential solutions, they needed to include an implementation or evaluation phase. Future research could focus on testing the suggested interventions and evaluating their effectiveness in reducing sound disruptions and improving communication and staff well-being.

Overall, while this study provides valuable insights into the impact of sound on the ED staff's work routine, it also highlights areas for improvement in the research design and methodology. Future research should address these limitations, deepening our understanding of the soundscape in emergency departments and guiding the development of more effective sound management strategies.

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