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Original Article

Noise pollution in a tertiary hospital and the impact on patient health and staff productivity

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Abstract

Background: Excessive noise production is a daily feature in many parts of the world, noise has also crept into hospital environments. Many factors are responsible for noise pollution leading to growing concern over high noise levels in hospitals and the effect on patients' health and staff's productivity. **Objective:** This study sought to determine the hospital personnel's perceptions on the effect of noise on productivity, and patients' perceptions on noise levels within a large tertiary hospital. **Methodology:** Focus Group Discussions (FGD) and Key In-depth Interviews (KII) were conducted to generate themes/issues/questions from hospital personnel and staff/relations, respectively. Participants in the FGD were selected from the wards using a multistage sampling technique. Stratified random sampling was used to select participants for KII. The FGD and KII sessions were transcribed, and a codebook was developed with broad codes, fine codes, and their definitions to reflect and describe the resulting themes. A thematic approach was used for the analysis. **Results:** Hospital sources of noise were grouped into two categories: noise originating within the wards, such as staff conversation and equipment like monitors, mechanical ventilators, and noise originating outside the wards, such as electricity generating sets and engineering works. Noise was identified as a disruptor of communication and concentration, leading to reduced productivity. Noise pollution also affected patients' health by causing headaches and sleeplessness.
Conclusion: Noise pollution within hospitals emanates from diverse sources, reducing staff productivity and impairing patients' health. A multi-pronged approach is required to reduce hospital noise pollution.

Keywords: *Hospital, Noise pollution, Perception, Productivity, Sleep disturbance*

Introduction

In any healthcare facility, the primary goal is to provide a conducive environment for patients to heal and for medical professionals to deliver effective care. But one often overlooked issue that significantly affects both patient well-being and staff productivity is noise pollution. Noise is an unwanted sound with well-known deleterious effects on health – a fact stated by Florence Nightingale about a quarter of a millennium years ago – "Unnecessary noise is the cruellest absence of care which can be inflicted on the sick or well".[1.]

Tertiary hospitals are bustling environments with constant activity, including medical equipment, communication systems, and human interactions. This confluence of factors contributes to high noise levels that often exceed the recommended standards of 40 to 45 dB (decibels) during the day and 35 dB at night. Common sources of noise pollution in hospitals include alarms, intercom systems, overhead paging, conversations, footsteps, and medical equipment operation. Furthermore, construction and maintenance activities within the hospital can amplify the noise levels, leading to a challenging soundscape for patients and staff alike, which can have detrimental effects on patients' health outcomes and the overall performance of healthcare providers.[2,3]

Excessive noise levels can disrupt sleep patterns, which are crucial for the healing process. Sleep deprivation due to noise can impair immune function, slow wound

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healing, and increase the risk of complications. [4,5] Additionally, noise can elevate stress levels in patients, resulting in increased blood pressure, heart rate, and the release of stress hormones such as cortisol. Prolonged exposure to high noise levels can also contribute to anxiety, depression, and decreased overall patient satisfaction. [6] Some other experimental and epidemiologic studies have investigated the association between environmental noise exposure to cardiovascular and metabolic diseases, such as hypertension, ischemic heart disease, and stroke.[7,8] These factors not only prolong hospital stays but also hinder the recuperation process, impeding the ultimate goal of restoring patients to health.
Noise pollution not only affects patients but also has a significant impact on the productivity and well-being of healthcare providers.[9] The constant barrage of noise can lead to high levels of stress, mental fatigue, and decreased concentration among staff members. This can compromise their ability to make critical decisions, accurately interpret patient information, and execute medical procedures. The increased noise levels can also disrupt communication among healthcare professionals, leading to potential errors in the coordination of care and jeopardizing patient safety. Furthermore, prolonged noise exposure can contribute to burnout and decreased job satisfaction, ultimately leading to a decline in staff retention rates.[10]

Several studies have found that noise is a precursor of decreased accuracy and performance on complex tasks. A study found that participants were 50% less accurate when undertaking complex tasks in a noisy environment compared to a quiet one.[11] It was also reported that noise aggravated communication shortcomings and is responsible for 70% of critical medical errors in emergency departments.[11] It is expected of hospital staff to give maximal care to patients, but high noise levels can cause reduced caring behaviour and burnout among the staff. [12] Furthermore, noise also comes with a consequent negative economic impact. In 2011, the World Health Organization estimated that the financial cost of lost workdays, healthcare treatment, and decreased productivity came to $30.8 billion a year in Europe alone.[13]

A recent systematic review revealed that despite the importance of noise pollution in the healthcare environment, this phenomenon is yet understudied across the world.[3] More concerning is that there was no study available from Africa that met the inclusion criteria for that systematic review.
To contribute to filling this critical gap, our study sought to determine the perception of hospital personnel and patients on the effect of noise on productivity, and noise levels in a Nigerian tertiary hospital.

Materials and Methods

Study setting and Inclusion criteria
This was a qualitative exploratory study of hospital personnel (clinical and non-clinical) and patients (outpatients and inpatients) at the University College Hospital Ibadan, Nigeria. The inclusion criteria for the study were: all cadres of hospital staff who had worked continuously in the hospital for a minimum of three consecutive years preceding the start of the study; all categories of patients who possessed physical and mental capabilities to participate in the study, and relations of patients on admission in the hospital.

Study design and Sampling
The study utilised a qualitative design method: Focus Group Discussions (FGD) and Key In-depth Interviews (KII) were conducted to generate themes/issues/questions from hospital personnel and staff/relations, respectively. Participants in the FGD were selected purposively from the wards based on their experience and knowledge related to the research questions. A multistage sampling technique was adopted. The first stage was the selection of the wards. Wards were grouped according to the hospital wings; one ward was randomly selected per wing. The second stage was the selection of participants in the previously selected wards. Complete lists of all personnel on the selected wards were obtained from the head of nursing staff and the chief resident doctor. Two personnel were conveniently selected from the nursing and medical staff based on their accessibility and willingness to participate. The outpatient clinics, emergency department, and administration block were counted as hospital wings for this exercise. Selected personnel were placed in FGD groups with a maximum of eight personnel per group. The FGD was conducted using a guide structured to determine the main sources of noise within the hospital, the perception of hospital personnel on the effect of noise on productivity, and any other relevant information.

Stratified random sampling was used to select participants for KII. The wards were stratified according to the hospital wings. The outpatient clinics and emergency department were counted as hospital wings for this exercise. One patient and/or patient relation was selected from the wards and outpatient clinics/emergency department. KII was conducted using a KII guide to determine the main sources of noise production within the hospital environment, the effect of noise on the health and sleep quality of patients, the perception of patients/ relations on noise levels in the hospital, and any other relevant information.

Data collection and analysis.
Data derived from the FGD and KII sessions were tape recorded, and verbatim transcription into text was done.

The transcripts were read and re-read to gain a deep understanding of the content. A reflection memo of the researcher was recorded immediately after each session. Accurate transcription was ensured, and a codebook was developed with broad codes, fine codes, and their definitions to reflect and describe the resulting themes. A thematic approach was used for the analysis. Themes identification and labelling were done, i.e. source of noise, attitude towards noise, effects on staff productivity, and effects on patients' health. The themes were interpreted in the light of the research question and literature. They are presented clearly and concisely using quotes and descriptions.

Results

Sources of Noise Pollution

Noise emanated from two sources: outside the ward and inside the ward. Outside the ward sources of noise include electricity generator sets, trolleys in motion, and other activities outside the ward. Generator sets provide a backup power supply of electricity to ensure constant electricity to the ward:

> *"The commonest source of noise pollution in the hospital environment is the generating plant. It is everywhere. There are too many [electricity] generators."* (FGDN03)
>
> *"Equipment like trolleys need to be oiled, to prevent the high-pitched sounds that they give when they are being used".* (FGDN04)

Noise-producing activities outside the ward but within the hospital premises include engineering works, social programs, celebrations, vehicular traffic, religious gatherings, etc.

> *"The construction work that is ongoing contributes a lot [of noise]".* (FGDD01)
>
> *"... people conducting social programs within the hospital environment and use microphones [and public address system]. I think the hospital environment should be a serene one, very quiet".* (FGDN01)

Inside the ward sources cause noise within the confines of the ward. These include staff conversations, patients' conversations with visitors, patients' response to pain, as well as ward equipment such as monitors, mechanical ventilators, fans, air conditioners, and uninterrupted power supply gadgets. Many of the respondents acknowledge a lack of staff civility in their conversations with colleagues and their response to phone calls.

> *"[some] times when we are sleeping, [and] nurses are handing-over [their shifts], the noise wakes you up; when relatives come to see the person next to your bed, they make noise; when doctors are on a round, if they speak to the person beside you, you will hear the noise;".* (KIIO01)
>
> *"Some patients will scream, and [we] will not be able to sleep, you even hear the noise of patients from another ward, you can hear the noise of a patient from [below], the 2nd floor".* (FGDN03)

Attitude towards noise

Attitude to noise by the participants includes getting accustomed to the noise source or intervening. While many of the participants seemed accustomed to the noise generated from outside the ward sources they tend to intervene or address noise from inside the ward.

> *"If the noise is from an [electric power] generator like we have in this ward, there is nothing you can do, but if the noise is from people, you just tell them to go out or somewhere else". (FGDN01)*
>
> *"Sometimes people add to the noise by shouting at whoever is generating the noise to keep quiet". (FGDD01)*

Effect on Staff Productivity

Noise was reported to result in low staff productivity. Noise was noted as a disruptor of communication between hospital staff and between staff and patients. Noise results in ineffective communication between hospital staff and unawareness of patients' responses.

> *"I feel that when there is noise around, it will make your hearing distorted, it can even result in a failure in understanding when others talk, resulting in breakdown in communication, effectiveness will be reduced" (FGDN08)*
>
> *"If there is a noise, like the [electric power] generator by the side of the ward and a ward round is ongoing, not all instructions will be understood". (FGDD04)*

Most participants pointed out a lack of concentration in their responsibilities due to noise pollution.

> *"You require concentration in whatever you are doing. If you are calculating the dosage of a drug and a noise distracts your attention, you are prone to make a mistake in that calculation and then your productivity will be reduced because you become irritable. Some people cannot function perfectly in a noisy environment, such people become irritable, they will be worn out and lethargic, their productivity will be reduced, and they won't be able to perform optimally".* (FGDN04)
>
> *"...they will not concentrate, [the] lack of concentration will cause things to be done in an abnormal [way], recordings will be done in abnormal [way]... instead of writing Paul, he writes Peter... or even give the wrong drugs to the patient" (KIIPS01)*

Some participants stated that noise results in irritation and a negative impact on the staff's health and psychological well-being.

> *"It causes disorientation, agitation, and even frustration, and also psychological disturbance". (FGDD03)*
> *"I think it's the... hearing loss [caused by the noise] can affect the health of [hospital] personnel." (FGDN01)*

Effect on Patient's Health

The common effect of noise on patients' wellbeing pointed out was sleeplessness, but there were also complaints of other health issues such as headache, restlessness.

> *"I may like to sleep [quietly] as well, but I won't be able to because there is noise, someone may shout, or someone may raise his voice out, it can wake me up." (KIIAE01)*
> *"The effect of the noise causes headache too… it causes headache [for] me." (KIIO01)*
> *"It can contribute to sleeplessness and restlessness and [also] increase the blood pressure" (KIIPS01)*

Some participants mentioned hearing impairment could occur due to noise pollution.

"Noise can result in partial deafness, hearing loss, depression, irritability." (FGDN07)

Discussion

The study examined noise pollution in a tertiary hospital in Nigeria and its influence on staff and patients. Electricity generating sets were a recurring source of noise due to the vibration of their engines and their proximity to many wards and offices. Almost every department in the hospital had a generator due to incessant power failures in the hospital. The importance of trolleys cannot be overemphasized as they help staff in delivering drugs, foods, drinks, as well as the movement of patients. The jangling sound caused by the trolley wheels was, however classified as noise. Noise from outside the ward activities, such as religious engagements, departmental programs, and renovation of facilities, were sources that were present in the hospital due to the cultural beliefs in the locality, the social ethics of the hospital personnel, and the model of maintenance culture, respectively. Staff and patient engagements were the dominant sources of noise inside the ward noise. Sounds from ward equipment were also identified as noise. Similar sources of noise such as staff and patient conversation, television, phone ringtones, patient moaning or crying, rolling of the trolley, in-ward renovation, ventilator, other medical equipment, and dropping of items were reported by previous studies.[14,15] The responses to the noise pollution included acclimatization to the noise, possibly because of the importance or indispensability of the noise source, such as medical equipment, or resignation due to noise pollution being beyond their control. Some of the responses were frank annoyance caused by reacting to the source [12]. Hospital staff concerns about the disruption of staff-to-staff communication during ward rounds and doctor-to-patient communication were reported by this study. A study in an emergency department within a hospital setting showed that about 85% of communication was verbal; [16] moreover, noise was reported to cause errors in communication with subsequent negative outcomes.[17,18] Another health effect of noise pollution noted was disruption of cognitive functioning and concentration when performing tasks thereby affecting decision making. Stress was reported in this study as a major negative impact on staff wellbeing. Operating room noises has been shown to elevate the stress level of the surgical staff and could cause distraction during work.[19] Other health-related complaints caused by noise pollution in the hospital setting including headache, irritability, restlessness which were among the major complaints highlighted by the study participants.[20] Psychological changes such as a decline in memory, tiredness, and reduced motivation were also reported as consequences of a noisy environment.[21]

The dominant complaints of the impact of noise on patient health were dominated by sleep deprivation or disturbance. Similar reports of the harmful relationships between sleep and noise have been shown by numerous studies.[22,23] Spasms in tetanus patients are set off by noise exposure,[24] cardiovascular changes such as increased heart rate and blood pressure were also reported in post-cardiac surgery patients in ICUs.[25] It has been suggested that exposure to loud noise in the Neonatal Intensive Care Unit could potentiate aminoglycoside ototoxicity in preterm infants with mitochondrial gene mutation.[26] Sleep deprivation and disturbance, a resultant effect of noise, has also been reported as an underlying cause of ICU psychosis.[27] Delayed recovery during the postpartum period is also known to be caused by noise,[28] significantly prolonging hospital stay. Therefore, hospital management should endeavour to minimise noise pollution by deploying measures to address both outside the ward sources and inside the ward sources of noise. Such measures can include staff training on noise pollution and its consequences, which will promote staff civility and proper disposition to noise. Other measures encompass strict adherence and monitoring of visitation schedules, and warning signs that caution against noise should be posted in strategic locations. Families and relatives of patients are also significant sources of noise pollution in hospitals. It is noteworthy that Interventions on noise pollution reduction without educating patients'

families on the negative outcomes of noise pollution in hospitals may yield little or no result. Another key strategy that could be adopted in reducing surrounding noise to a permissible limit in hospitals is soundproofing walls and doors.[29] Moreover, it has been shown that the concurrent use of soundproof metal doors and shutters can provide a noise reduction of 6 dB,[30] which can help alleviate the noise associated with the numerous alarms and alerts in the hospital. The constant exposure to these sounds can lead to alarm fatigue among the staff. The use of color-coded lights can provide visual cues that can reduce noise produced by alarms and resultant alarm fatigue.

Noise mapping of hospital environments should be conducted, and a hearing conservation program should be introduced in departments with elevated noise levels. Hierarchy of control should be deployed to curtail recognized sources of noise; this includes the elimination of unnecessary social events within the hospital environment and the replacement of noise-producing equipment. Isolation and containment measures should be applied as a last resort.

Conclusion

Noise within the hospital environment emanates from diverse sources, eliciting varied responses from patients and staff. Noise pollution in tertiary hospitals contributes to a decrease in patients' quality of care as well as a decline in staff productivity. Quality of care and staff productivity are important metrics in health system assessment; thus, creating measures to nullify or minimize noise pollution is imperative in optimising patient care and encouraging high staff productivity.

Declarations

Ethics approval and consent to participate.

Ethical clearance was obtained from the University of Ibadan and University College Hospital, Ibadan Ethical Review Board (UI/EC/13//0126). Informed consent was obtained from all the study participants.

Availability of data and materials

The datasets used and/or analyzed during this study are available from the corresponding author on reasonable request.

Conflict of interest

The authors declare that they have no conflicts of interest.

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Authors' contributions

AAA: conception, planning, data analysis, manuscript development, editing, and revision of the final manuscript. OMD: data analysis, manuscript development, editing, and revision of the final manuscript. AA: data analysis, manuscript development, editing, and revision of the final manuscript. EE: editing, and revision of the final manuscript.

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