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THE IMPACT OF NOISE IN THE OPERATING ROOM STUDY IN SEVERAL SURGICAL SPECIALTIES

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ABSTRACT

Background: Environmental noise pollution is regarded as a general stressor for all citizens. The noise levels recommended by the WHO are often exceeded in hospitals, mainly in the operating room. The objective of this study is to analyze noise patterns during 53 surgical procedures of 11 different specialties. **Methods:** During two months, the noise was observed in all the rooms. The noise level in the hospital's different OR was measured using the official application of NIOSH (National Institute Occupational Safety and Health) with a cell phone used exclusively for this function. No attempt was made to interfere with, record or control conversation or music during surgery. To assess the noise, the sound scale in decibels (dB) was used. The study evaluated different sources of equipment noise, as well as conversation and music. Data were descriptively analyzed by the quantitative method using Microsoft Excel spreadsheets imported to the R Commander platform of the R 4.1.0 software. **Results:** Eleven surgical specialties were evaluated. The average noise levels dB (A) were found between 53.10 and 69.70 dB. And the average maximum value dB (B) was between 90.30 and 118.50 dB. The highest average level and the maximum noise were found in oral-maxillary and orthopedics surgeries. The least noisy specialty was vascular surgery. There is no significant difference between the mean noise and the mean maximum noise between the different specialties. There was a significant difference with the different devices used and also with conversation and music. **Conclusion:** It showed that the different categories of surgery examined in this study proved that buccomaxillary and orthopedic surgery have very different noises levels during the surgical time, and higher than the other surgeries studied.

KEYWORDS: Effects of noise, noise, operating room, operating room noise, surgery specialties.

INTRODUCTION

Unwanted noise or sound is recognized to negatively impact productivity and well-being in a wide variety of environments including health-related environments such as the operating room (OR).[1] In a review carried out in 2010, operating rooms across the continents are places known for their high noise levels, ranging between 51 dB and 79 dB.[2] Because noise is a general stressor, noise in the OR should be avoided whenever possible.[2] The World Health Organization (WHO) recommends noise levels to stay below 35 dB in operating rooms for facilitate a peaceful environment for patients and staff alike.[3]

In the OR, noise can be grouped into one of two categories: equipment-related or staff-generated noise. The first group may include anesthesia equipment and alarms, suction devices, surgical instruments such as drills, cautery devices and dissection tools. The second category might include employee conversations, doors opening and closing, and elective music. It has been shown that these sources contribute to a average ambient noise in OR suites of 65 dBA, with peak levels reaching 120 dBA in the orthopedic OR.[4] High sound levels in the OR can create stress for staff, reduced surgeon concentration, communication errors, leading to noise-induced hearing loss with long-term exposure to toxic sound levels.[5]

In 1972, the noise levels in the OR were recorded and showed that it was equal to that produced on a highway,[6] They defined OR noise as "the third pollution" and thus equated noise with air and water pollution.[6]

The music contributes to noise pollution and possible miscommunication between OR personnel. It has been shown that over 60% of staff listen to music on OR, and that the majority of staff believe that music has a positive effect on staff during their work, and prefer a low volume.[7]

Due to the damage that high levels of noise in the OR can cause to the entire surgical team and also to the patient, this research aims to evaluate the different types of noise during different types of surgeries. Likewise, noise levels were evaluated by scale in dB, the main noise sources and the various surgical specialties. The OR footage was also evaluated and correlated with the incidence of noise. The study also aimed to analyze the noise levels, the different main sources and the differences of noise between the surgical specialties during the operative procedure.

METHODS

The hospital where the study was carried out has 10 ORs for elective surgeries and an annex 3 ORs for outpatient surgeries. The ORs in the operating room are called from 1 to 10, with different lengths. The ORs in the annex are denoted with HD (Hospital Day) 1 to 3, with the same size.

Our study covered a 2-month observation period in an attempt to cover all ORs. Because this study was carried out by application and without the participation of human beings, it was not registered on the Brazil platform, nor presented to the Ethics and Research Committee, and the Free and Informed Consent Form was not filled out.

The noise level in the hospital's different OR was measured using the official application of NIOSH (National Institute Occupational Safety and Health) with a cell phone used exclusively for this function. The microphone was placed at half the distance between the surgeon's and the patient's ears, avoiding contact with surfaces to freely capture air and ambient sound. Extra care was taken so that the normal surgical situation was not harmed, so the surgeons and staff were not aware of the monitoring. No attempt was made to interfere with, record or control conversation or music during surgery.

To assess the noise, the sound scale in decibels (dB) was used. The use of a filter applied to the microphone was designated as dB (A) so that the intensity of the sound captured was equivalent to human hearing, between 1 and 4 kHz. A more suitable dB (C) filter was also used to capture high intensity sounds.

The study evaluated different noise sources such as: (1) equipment-related noise sources: drill, electric scalpel, vacuum cleaner, thermal blanket or scopy motor, and (2) noise sources related to the team's behavior: music and conversations. The conversations in OR were numbered according to the scale: (1) limited conversation, only what is necessary for the smooth running of the surgery; (2) free conversation, in a moderate tone and (3) free conversation, in high tone.

The A scale was used, as it is similar to human physiology, which is more sensitive to high sound frequencies, in addition to the fact that it is the most commonly used in noise research and in legal controls. Using the slow configuration of measures A, in octave bands from 16 Hz to 16kHz, the average was extracted at intervals of 5 minutes and 30 minutes, monitoring starting from the beginning of anesthesia until the end of surgery.

Statistic Analysis

Data were descriptively analyzed by the quantitative method using Microsoft Excel spreadsheets imported to the R Commander platform of the R 4.1.0 software. Data will be displayed graphically and in a table with simple and absolute percentages. To analyze whether population ranks differ between samples, we used the Wilcoxon test. The Wilcoxon test is a non-parametric method for comparing two paired samples. Values of $p < 0.05$ suggest statistical significance.

RESULTS

Of the 13 rooms in the hospital, only one in the annex (HD 3) could not assess the degree of noise. The sizes of the various ORs are shown in Table I. There is no significant difference between the rooms' footage (Figure 1).

To ensure comparability between types of surgery, we've included 11 types of operations in our sample. The sample consisted of 53 surgeries is described in Table II. All surgery was finished as planned. The number of records and the main descriptive parameters for these 11 surgical specialties are presented in Table II. There is no significant difference between the type of surgery and the noise level (Figure 2).

The noise-level distributions in dBA for the most-frequent operation types are presented in Table III. The sound reverberation factor was not analyzed, since all rooms have hard surfaces, containing objects and furniture without proper material for sound absorption. The average noise levels dB (A) were found between 53.10 and 69.70 dB. And the average maximum value dB (B) was between 90.30 and 118.50 dB. The highest average level and the maximum noise were found in oral-maxillary surgeries, 65 and 117 dB, respectively, with orthopedics being in second with 62 and 108 dB. The least noisy specialty was vascular surgery, with an average of 57 dB and a peak of 100 dB (Table III).

There is no significant difference between the mean noise and the mean maximum noise between the different specialties (Figure 3).

Mean noise levels in all operating rooms were 60.55±3.90 dB and the mean noise maximum levels were 105.64±7.57 dB (Figure 4).

The statistically significant difference was observed in relation to the average or maximum noise level with the use of different equipment (Table IV, Figure 5). The significant difference was found with the presence of conversations or music (Table IV, Figure 5). The graph shows that the difference is significant using the Wilcoxon test for music, scalpel, and all others (p = 0.0000).

Table I: The sizes of the various operating rooms.

OR NUMBER	SIZE
1	37.52 m^2
2	38.86 m^2
3	38.19 m^2
4	38.19 m^2
5	36.45 m^2
6	35.20 m^2
7	35.20 m^2
8	36.30 m^2
9	37.52 m^2
10	39.21 m^2
HD 1	36.80 m^2
HD 2	36.80 m^2
HD 3	36.80 m^2

Table II. The number of records and the main descriptive parameters for these 11 surgical specialties.

SURGICAL SPECIALTIES	NUMBER RECORDS
Buccomaxillo	2
Head and Neck	1
General	10
Neurosurgery	6
Orthopedics	17
Otorhinolaryngology	2
Pediatric	4
Plastic	1
Thoracic	1
Urology	5
Vascular	4

Table 3: Mean noise in surgical specialties.

SPECIALTIES	AVERAGE NOISE	AVERAGE MAXIMUM
Buccomaxillo	65.3 dB	117.5 dB
Head and Neck	60.4 dB	99.5 dB
General	58.8 dB	102.8 dB
Neurosurgery	60.8 dB	105.4 dB
Orthopedics	62.9 dB	108.4 dB
Otorhinolaryngology	59.2 dB	106.6 dB
Pediatric	58.6 dB	99.6 dB
Plastic	58.8 dB	108.4 dB
Thoracic	62.5 dB	107.1 dB
Urology	58.7 dB	106.5 dB
Vascular	57.2 dB	100.4 dB

Table IV: Average noise and maximum noise with the presence of different sources.

SPECIALTIES	AVERAGE NOISE	AVERAGE MAXIMUM
Blanket	61 dB	107 dB
Drill	63 dB	108 dB
Scalpel	61 dB	107 dB
Scopy	61 dB	107 dB
Song	62 dB	106 dB
Talk	61 dB	107 dB
Vacuum cleaner	60 dB	106 dB

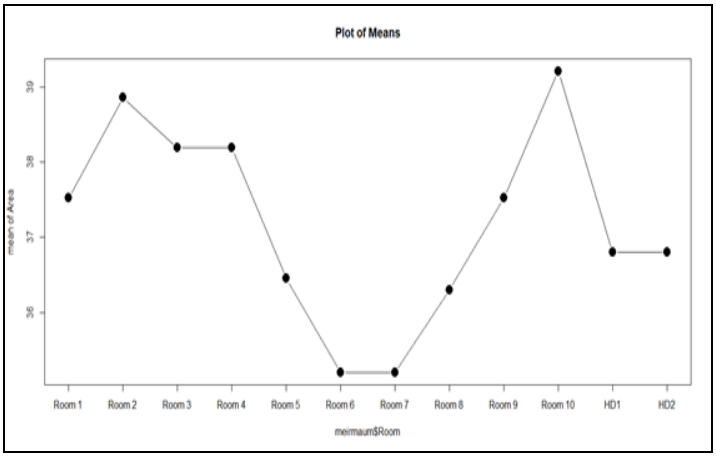

Figure 1: The operating rooms' footage.

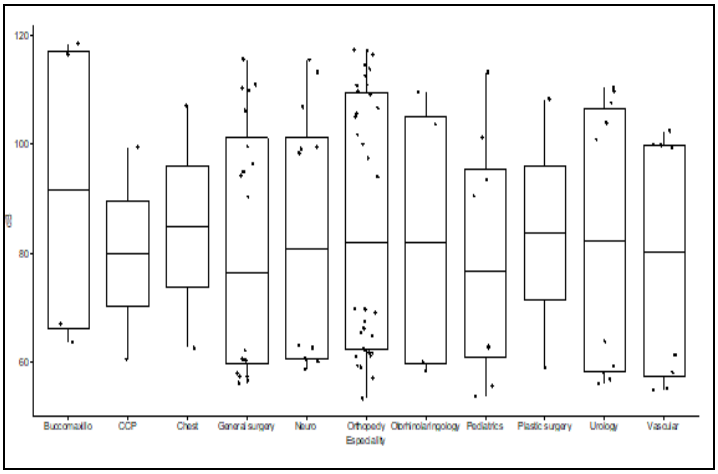

Figure 2: The type of surgery and the noise level.

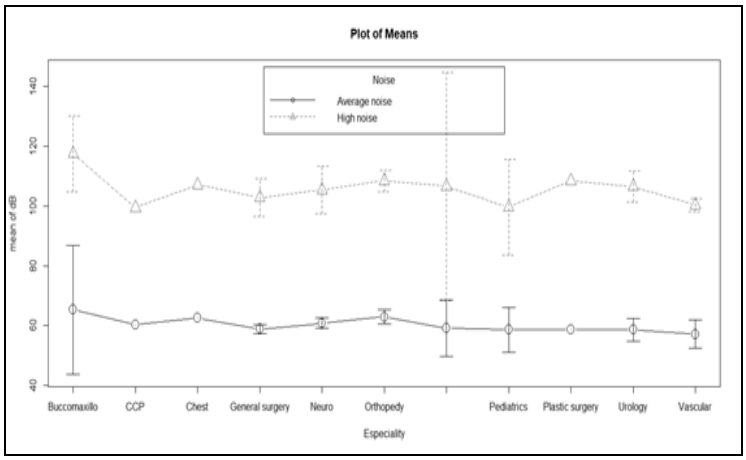

Figure 3: Average noise and the high noise between the different specialties.

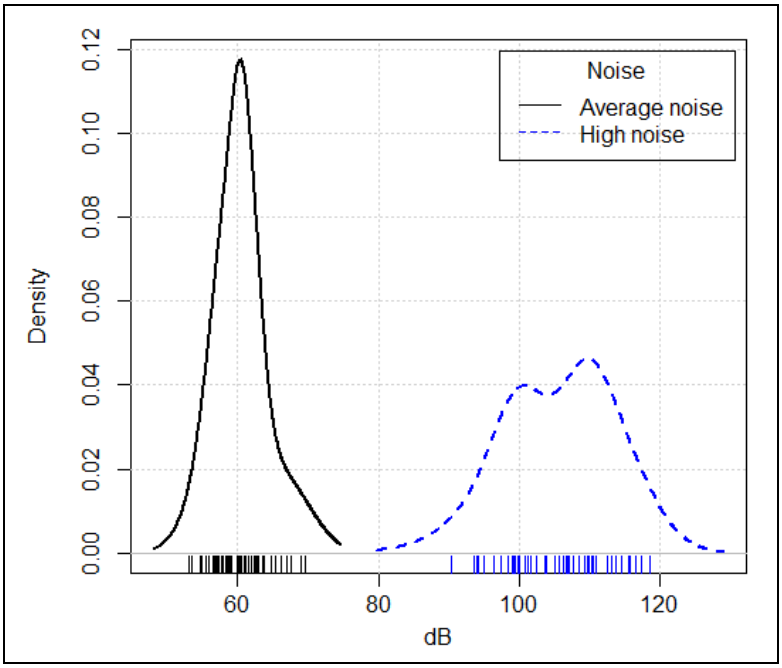

Figure 4: Mean noise levels and mean noise maximum levels.

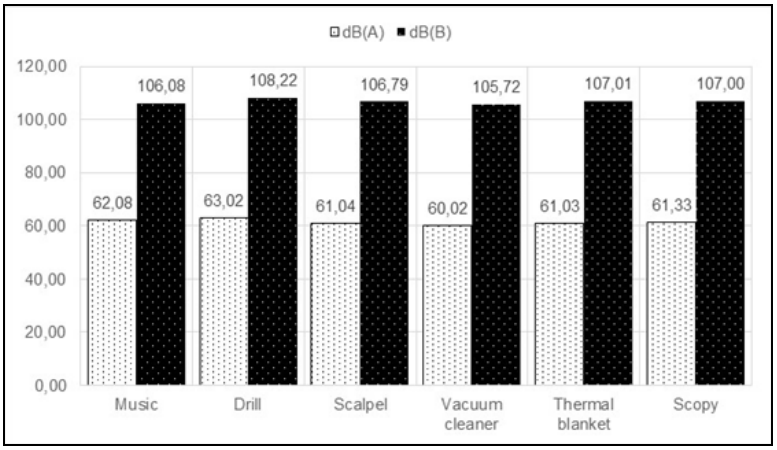

Figure 5: Average or maximum noise level with the use of different equipment.

DISCUSSION

The World Health Organization (WHO) recommends that background noise in a patient's hospital room should be **no greater than 35 dB (A) during the day, 30 dB (A) at night**, with peaks no higher than 40 dB (A).[8] This study revealed average noise levels exceeding the recommendation by more than 100% and maximum levels by almost 400%. There are two concerns raised by excessive sound: the potential for hearing loss and the interruption of clear verbal communication. However, it may also be relevant to take into account the fact that the recommendations may not be realistic in the current scenario.

A limitation of the present study was the lack of information regarding the instantaneous correlation of changes in the noise level with the use of different equipment, as soon as they were used. There was also interpolation of different equipment, making it impossible to individually analyze the influence of each one in the surgical environment.

Building a new operating room is a complex process that involves balancing needs of facility staff with construction costs, while also looking forward to future healthcare trends.[9] To make planning and construction go smoothly, it helps to consider every possible variable at the outset of the growth process. In its 2014 Operating Room Requirements Guidelines, the Facility Guidelines Institute recommends that the minimum inpatient operating room size be no less than 400 square feet (37.16 m^2). Operating spaces designed for specialized procedures generally require more staff, and are recommended to be at least 600 square feet (55.74 m^2).[9] All rooms evaluated were around 400 ft^2 (37.16 m^2) and should not correlate with noise.

In a review carried out in 2010, the primary noise sources identified were: opening and preparing for

operation, moving trolleys and equipment, soors opening and slamming, moving and dropping metal tools, suction, anesthetic monitors, alarms from anesthetic and operating instruments and monitors, and conversation among staff and on the intercom.[2] In our study, conversation, music, the use of drill, scalpel, aspirator, blanket and scopy were evaluated during the surgical procedure, with a mean noise of 61.2 dB and a mean maximum noise of 106.8 dB. No difference was found between the noise of conversation and music. Likewise, no differences were found between the different materials used in terms of noise.

In two studiest, the highest noise levels were found in ORs where orthopedic surgery was performed.[10,11] In the present study, both the highest mean and maximum noise values were found in buccomaxillo surgeries, 65 and 117 dB, respectively, with orthopedics being in second place with 62 and 108 dB. The least noisy specialty was vascular surgery, with an average of 57 dB and a peak of 100 dB.

Even though music significantly increases decibel levels in the OR, perception and attitude toward playing music during surgery is favorably regarded by most OR staff, irrespective of specialty. The most appropriate music in the operating room seems to be the **classical type**. What role does music play in OR with the patient under general anesthesia? In a 2015 review, it shows that music contributes to the general stress of the environment, interferes with communication, impedes the ability to carry out tasks safely and represents a threat to the health and safety of patients and staff.[12] If music is played on the OR, this must be done judiciously and with the consent and assurance of all interested parties.

In order to study the presence of music in OR, a questionnaire with 18 questions was carried out and distributed to the doctors and nurses.[7] One hundred and seventy-one returned the completed questionnaire, 63% of the participants listen to music, and 58% prefer classical music. According to this study, music has a positive effect on the staff working in the operating rooms. As Brazil is a continental country, there are different types of music and the taste of each one in its region. However, there is still no study of the type of music in ORs in Brazil.

Noise levels in the hospital environment are excessively high, especially in the ambient ICU. In a study with the objective of determining noise with sound peaks ≥80 dB, it showed that they are liable to behavior modification it is possible to significantly reduce noise levels in an ICU setting through a behavior modification program.[13]

A recent survey of nine Greek public hospitals with more than 400 beds showed that: the hospital building, machinery, tools, and people in the operating room were the main noise factors.[14] The authors propose that to eliminate excess noise in the operating room, a multidisciplinary approach may be necessary, aiming to improve noise levels, the implementation of effective standards and the attention produced by the teams inside the room, are considered fundamental changes and necessary.

CONCLUSION

It has already been demonstrated that the tools, machines, equipment, and surgical material used, along with employee activities, have been confirmed as causes of increased noise levels in the OR. It can be seen from this study that mean noise intensity is related to the type and stage of surgery. It showed that the different categories of surgery examined in this study proved that buccomaxillary and orthopedic surgery have very different noises levels during the surgical time, and higher than the other surgeries studied.

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