ABSTRACT

Objective: to describe the implications of high levels of noise of alarms from electro-medical equipments for comfort and safety of the patients. Method: an integrative review of literature performed in BIREME from the question: What is the impact of the high level of noise in the comfort and safety of the patient? To extract the data, we used an instrument, including characterization of the article and results. The analysis of its content was from multi-referentiality. Results: the high level of noise is one of the most common problems that affect the physiology, the sleep-wake cycle, beyond to be a potential influence to the safety of these patients. Conclusion: alarms, theoretically, are a great idea because patients are benefited from the fact the team be alerted to sudden changes and vital parameters. The results showed that most of the alarms occurring in the ICU is false alarm or have limited their usefulness. Descriptors: Clinical Alarms; Noise; Comfort; Safety; Intensive Care.

RESUMO

Objetivo: descrever as implicações dos elevados níveis de ruidos dos alarmes de equipamentos eletromédicos para o conforto e segurança do paciente. Método: revisão integrativa de literatura, realizada na BIREME a partir da questão: Qual o impacto do elevado nível de ruídos no conforto e na segurança do paciente?. Para extração dos os dados utilizou-se um instrumento incluindo caracterização do artigo e resultados. A análise de seu a partir da multirreferencialidade. Resultados: o elevado nível de ruídos é um dos problemas mais frequentes que acometem a fisiologia, o ciclo sono-vigília, além de potente influência à segurança desses doentes. Conclusão: os alarmes, teoricamente, são uma ótima ideia, pois os doentes se beneficiam do fato da equipe ser alertada para mudanças repentinas e parâmetros vitais. Os resultados demonstraram que a maioria dos alarmes que ocorrem na UTI é falso alarme ou tem sua utilidade limitada. Descriptores: Alarmes Clínicos; Ruidos; Conforto; Segurança; Terapia Intensiva.

RESUMEN

Objetivo: describir las consecuencias de los niveles de ruido de las alarmas de los equipos eléctricos para la seguridad de los pacientes. Método: revisión integradora de la literatura celebrado en BIREME de la pregunta: ¿Cuál es el impacto del nivel de ruido en la seguridad del paciente? Para extraer los datos se utilizó un instrumento, incluyendo la caracterización del artículo y los resultados. El análisis de su multi-referencialidad. Resultados: el alto nivel de ruido es uno de los problemas más comunes que afectan a la fisiología, el ciclo sueño-vigilia, y la influencia potencial a la seguridad de los pacientes. Conclusión: las alarmas, en teoría, son una gran idea ya que los pacientes se benefician de tener el equipo se alertó a los cambios repentinos y parámetros vitales. Los resultados mostraron que la mayoría de las alarmas que ocurren en la ICU es falsa alarma o han limitado su utilidad. Descriptores: Alarmas Clínicas; Ruido; Cuidados Paliativos; Seguridad; Cuidados Intensivos.

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INTRODUCTION

The use of hard technologies in assisting provided in intensive care units is a constant target by researchers that investigate them, both in terms of their appointment, efficiency, resolution and like possible iatrogenic factors. In this sense, the noise emitted by such equipment also become objects of research for the scientific community, not only in nursing area, but to health area in general.

Noise pollution is now treated as an atmospheric contamination through energy (mechanical or acoustic), and it is defined as any change in physical properties in the environment caused by pure or combination of sounds, acceptable or not, that can be directly or indirectly harmful to health, safety and welfare.

Noise pollution has repercussions throughout the body and not just in the hearing system. The loud and permanent noise can cause various disorders, altering significantly the mood and the ability to concentrate in daily actions, furthermore led the individual to a degree of conditioning, which can be dangerous to its health. Noises also compromise the quality of sleep and cause interference in the metabolism of the whole organism with risk for cardiovascular disorders.

In Intensive Care Units (ICU), the noise level caused by the operation and trigger of alarms from electro-medical equipments such as infusion pumps, multi-parametric monitors, mechanical ventilators, pulse oximeters, among others, need to be considered by health professionals as something that may be uncomfortable for the patients, making them vulnerable to the effects of noise pollution in these units and predispose to phenomenon fatigue of alarms, which has been one more concern, nowadays.

Although the idea of comfort has been addressed in nursing literature as part of physical care, with emphasis on actions aimed at promote hygiene, position of the patient in bed, maintenance of bodily integrity, sleep and rest, Nightingale said that comfort is an important aspect to the care - taking into account the quality of nursing care - a practice regarded by her as the principal responsibility of the nurse regarding the process of restoring health, whose environmental characteristics may be determinant in this process.

Unfortunately, the physical comfort is not valued in the hospital environment, especially in intensive care. In her Notes on Nursing, Florence Nightingale emphasized the importance of making the environment comfortable as desirable goal in /of nursing care. So, thinking about comfort in the intensive care unit pass through, necessarily, by the issue of noise in these units.

In intensive care units, as much as Florence Nightingale has called attention to the importance of the environment, the bases that have grounded the nursing actions in these units, mostly, bring with them a significant biological knowledge aimed at the identification and recognition signs and symptoms of the disease, these aspects usually considered easy to measure from the use of multi-parametric monitoring systems, which allows the constant measurement and in real-time of physiological variables understood as vital signs.

What we have observed in the daily of nursing care in these units is that the aspects of basic human needs, which involve physical comforts, psychological, emotional, social and spiritual, have not been understood from environmental factors which can restore the health, or be preventives of disease. It is worth mentioning that this biological knowledge is relevant and necessary, not only in intensive care, but whatever the unit. However, it can not be considered unique, but should be linked to other knowledge and actions that emphasize the care and comfort for the promotion of healing in these units.

For Nightingale, the issue of environment is central to the process of restoring the health, however, for safety of patient; it is also a watershed between the practice of nursing and medicine. She expressed the firm conviction in that respect, and described the specific role of the nurse to propose that the patient should be placed in the best conditions for nature to act on it, exposing the idea that nursing is based on knowledge on people and the environment, which serves as the basis for the distinction between nursing knowledge and those knowledge used by doctors in their practice.

During the Crimean War, Nightingale put into practice her concern for the environment in patient care, even in face of uncountable adversities (it was a front of battle, not a hospital). She exposed the environmental problems of local, such as lack of sanitation and the presence of filth (contaminated water, dirty sheets and contaminated blankets and latrines with excessive influx) as the main responsible for the high casualty rate and...
death. One of her first attitudes was to drastically change the environment in which lay the wounded, which was totally unhealthy.

When reading Notes on Nursing, it is easy to identify the importance that the author attributes to the physical environment. Her concern with aspects of the environment included not only the hospital scenarios, but those used in the treatment of sick people. Nightingale believed that a healthy environment was necessary to nursing cares and their specific conditions of adequacy.

In her book Notes on Nursing, she said that nursing should mean a proper use of pure air, lighting, heating, cleaning, silence and adequate selection of diet, not only in the way of preparing it, as well as how it is served.

Silence is remembered by Nightingale in her recommendations in order to obtain a suitable environment for care. Here are the recommendations: air movement should not only be adequate, but nice. The lighting could not bother the patient, the noises needed to be smoothed (sounds and rustles) and the cleaning should be adequate in the place where the patient would stay in hospital. Moreover, the clothes had to be clean and smelling well, and the furniture looks good, disinfected after the discharge of the patient to have appropriate conditions to receive the next patient. All this, in the contingency of the hospital routine, when well executed and provided, can contribute to the promotion of comfort to the patient hospitalized.

The Nightingale’s theory on the five essential foundations of environmental health (pure air, pure water, efficient drainage, cleaning and lightning) is as essential today as it was 150 years ago, including, however, the silence.

(...) The unnecessary noise and the need for quietness was also a concept that required assessment and intervention by the nurse ... The noise originated by physical activities on the environment (room) should be avoided by the nurse, because it can harm the patient (...) The nurse had control of the environment, both physically, and administratively (...) The nurse had to control the environment to protect the patient from the physical and psychological harm; for example, the nurse hinder the patient to receive disturbing news, to receive visits that could adversely affect the recovery and experiencing sudden interruptions of sleep.

Supporting us on the above mentioned authoress, we believe that nowadays, the advent and incorporation of new technologies such as electro-medical equipments and the continuing increase of the severity of our patients are factors that require the vast therapeutic apparatus currently available, nevertheless, the control of noise must be seen as an emerging foundation, essential to environmental health and, consequently, be more valued in intensive care, when current research reaffirm increasingly the Nightingale’s concerns in relation to impairment of the restoration of health of patients in environments with high levels of noise.

Regarding the problems inherent to fatigue of alarms, which has to do with the decreased sensitivity of health professionals for the alarms, it is observed that with the development of new technologies has been increased considerably the number of audible and visual alarms in ICUs, in order to alert professionals about patients’ conditions and failures in equipments, ensuring the safety of patient and quality of care.

There are about twenty-five years ago, practically, there were not equipments with alarm system. Nowadays, most of health establishments have some type of alarm; however there is not a standardize from manufacturers on the sounds produced by alarms, leaving it to professionals to distinguish and react based on their perception of the importance of the event or not.

Ironically, the alarms were designed to provide safety to patients, but they increase the noise in the ICUs, causing fatigue of alarms and bring a false sense of security.

Thus, not only concerned with the promotion of comfort, but also with the safety of patient and the impact of high levels of noise provided, among other things, by excessive number of alarms, we defined as guiding question in this research: What is the impact of high level of noise in the comfort and safety of the patient?

Whereas most have been concerned at this point is how the alarms of the electro-medical equipments can be extrapolating the levels considered acceptable for intensive care units and the impact on sleep quality and safety of the patient in these units.

In this sense, this study is justified by the need to understand the implications of high levels of noise emitted by alarms from different electro-medical equipments used in intensive care units, so that we can think of strategies to raise awareness and alert to the professionals health and the own specialized
industry, with regard to the rational use of resources present in these devices, focused, a priori, for safety of the patient, but thinking, too, in its comfort.

Studies show that although the verification of the level of noise inside the intensive care can be a concern for professionals involved in improving the quality of care in these units, little is known about the sound profile of the electro-medical equipments, for which reason further studies need to be made for this purpose.

This study is relevant, because we know that high levels of noise affect not only patients but also health professionals who work in these environments surrounded by noisy equipments, making them vulnerable to damages to the health and, consequently, contributing to the compromising of safety of the patients assisted in intensive care units, including at the possibility fatigue of alarm.

In order that it was possible to better determine the objectives to be achieved in this study, we delimited the following:

- Identify in the literature the levels of noise considered acceptable in intensive care units.
- Describe the implications of high levels of noise within these units.
- Analyze the possible relations of the phenomenon fatigue of alarms with high levels of noise.
- Discuss about alternatives and strategies that can be used by nurses to promote comfort and ensure the safety of the patient in environments with high levels of noise.

**METHODODOLOGY**

This is a descriptive study with integrative review of literature and data collection in electronic media. The general purpose of an integrative review of literature is to gather knowledge about a topic, describing the state of the current art and, in that direction, assisting in the foundations of a significant study for nursing.8

The analysis of articles was conducted in the following databases accessed from the BIREME: Latin American and Caribbean Health Sciences (LILACS) and Medical Literature Analysis and Retrieval System Online (Medline). We used in the search the combination of descriptors: clinical alarms, noise, comfort, safety and intensive care.

Inclusion criteria were: articles published in full version, in Portuguese or English, related to the theme - alarms and noise in intensive care - that have been indexed in the last ten years and that were available in its full version. We selected 16 articles that met the inclusion criteria.

To extract the data from articles, we used a research instrument, including: identification of the article and results. The use of such instrument has like objective to ensure that all data is extracted, to minimize errors in the transcription, ensure accuracy in checking the information and serve as a record.8

The process of analysis was based on the multi-referentiality.

Then, we went to the stage of discussing the results, comparing publications with each other and with theoretical knowledge. This step allows the integrative review to identify possible gaps in knowledge and possibilities for performing future studies.8

**RESULTS AND DISCUSSION**

Noise is defined in physics as a random wave, inharmonious and fluctuating, whose measurement involves the analysis of intensity, frequency and temporal dimensions of the acoustic sound, which can be verified by equipment capable of registering the force per unit of area produced by sound waves.9

In physics, the measurement of the sound intensity is performed by a scale based on multiples of 10. On this scale, the threshold of hearing is 0 dB, the sound intensity at which no sound is noticeable. A sound 10 times more intense than 0 dB is recorded as 10 dB, a sound 100 times more intense is equivalent to 20 dB, and a sound 1,000 times more intense is equivalent to 30 dB. The noise level near the threshold of pain is equivalent to 130 dB (with intensity 10 trillion times larger than a sound at the threshold of hearing).

In order to record more accurately the sensitivity of the ear to the sound intensity in the frequency range of hearing, the researchers developed a unit of sound intensity "weighted" known as sound level A-weighted or dBA. On this scale, an increase of 10 dBA results in twice the pitch (loudness). In this study, the equipment used was calibrated to measure sound intensity in dBA.10

The noise generated in intensive care units has increased in recent decades by the major increase in the number of devices with acoustic alarms, which added to the background noise created by the actions and conversation of professional staff, may be
impaired to work and health of nursing team, but especially to the patient's health.

The Brazilian technical standard establishes for indoor environments of hospitals (apartments, hospital wards, nurseries and operating rooms) the sound level from 35 to 45 dBA, the first being considered the level of listening comfort and according to the acceptable limit. The same values are accepted by the United States Environmental Protection Agency.

Studies have shown that noise levels in intensive care units are above acceptable values. In a study that addressed the noise in neonatal intensive care units showed, during the measurements of sound pressure levels in the units studied, average values ranging from 58.9 to 64.1 dBA. The minimum value found was 51.9 dB and the maximum value of 82.4 dBA.

In this research, the authors investigated indistinctly level of noise within the units, relating them to the movement of people within it. Measurements lasted two hours per time period (morning, afternoon and evening); the number of people in the research environment was retold every 5 minutes.

Some studies performed in intensive care units in Australia found noise levels that exceeded the recommendations made by the World Health Organization (WHO) for hospitals. The level of equivalent average noise (L⁻eq) was 56.22 + / - 1.65 dBA and LA 90 was 46.8 + / - 2.46 dBA.

Other studies aimed to identify the impact of noise on sleep quality of patients hospitalized in intensive care units in Toronto, Canada. Objective and subjective measures of sleep quality indicated that the sleep of these patients in these units is extremely disturbed, and the noise was the main cause. The authors related excessive levels of noise in intensive care to the poor quality of sleep among the patients (sick).

Sleep disturbance can have adverse consequences for serious sick assisted in intensive care units, such as impairment of immune system and respiratory changes. Although many questions remain unanswered, including the impact of sleep disorders on clinical outcomes of patients hospitalized in ICU, there is growing interest in developing new strategies to improve sleep quality.

In a study intended to evaluate, from the perspective of 33 patients hospitalized in intensive care units, which environmental factors could more interfere on the sleep quality in these units, it was noted that noise was the environmental factor most bother for patients.

Studies in neonatal care units evidenced noise as a significant problem due to the damage it can cause the newborns (NB), given its physiological fragility and also by the requirement of living with them during their hospitalization.

The noise can damage the cochlea, causing hearing loss and alteration of physiological parameters. As a result, the NB may have fatigue, agitation, irritability, increased intracranial pressure, increased caloric intake and difficulty in weight gain.

Studying the level of noise emitted by the health staff in neonatal intensive care unit during the shift change, researchers obtained during this procedure values that ranged between 55.3 dBA and 72.2 dBA in the morning, between 57.4 and 70.9 dBA in the afternoon and between 55.2 and 70.5 dBA at night.

During medical visits, the authors recorded, in the mornings, variations between 56.0 dBA to 69.9 dBA. In the afternoon, it ranged from 56.2 and 75.7 dBA. They perceived at night only a medical visit and the values ranged between 58.3 and 67.6 dBA. In the shift changes of doctor’s duty, in the morning period, it ranged between 57.2 and 70.5 dBA. In the afternoon, they were between 60.7 and 67.8 dBA; at night, they ranged from 58.3 and 67.6 dBA.

Analyzing the observed Leq of 710 minutes, according to the classification of Sanchez, Sanchez and Gonzales (1996), the authors concluded that there was not acceptable noise (> 50dBA); the moderate noise (> 50 to 59dBA) was 12.68 % and excessive noise (> 59dBA) represented 87.65% (620) records.

As regards the assessment of the sound profile of electro-medical equipments available in intensive care units, few studies have been conducted until this present time. A study that sought to measure the noise emitted by equipment of neonatal NICU found that 100% of these devices have the intensity of noise above the level recommended by the ABNT standard - NBR 10152 which determine a level from 35 to 45 dBA.

The problem of excessive number of alarms has been recognized and studied in the last 20 years, particularly in ICUs. From this problem arose the concept of “fatigue of alarms”, a phenomenon often observed in the intensive care unit which is characterized, among other things, by delay in response time of
healthcare professionals to alarm signs. This can compromise the safety of the patient if the alarms are disabled, silenced or ignored.

Nursing often deals with false alarms (for example: alarm of tachycardia due to patient motion) and alarms that do not indicate relevant clinical situations, such as the alarm of “high pressure” of ventilator while the patient is coughing. The large number of alarms ends up generate large numbers of false positives, predisposing to the phenomenon of fatigue of alarms.

In 2002, the Joint Commissions on Accreditations of Healthcare Organizations (JCAHO), a nonprofit organization that oversees health services and consider it standard or not, published an urgent warning about alarms after 23 patients have died or become comatose due to malfunction of respirators. 65% of cases were related to alarms. According to this study, the professionals did not respond to alarms of equipment malfunctions, configured incorrectly the alarms or did not hear them play, because they were at low volume.

Several studies have sought to find ways to reduce the amount of false alarms, to ensure that situations that actually require interventions can be identified. The authors emphasize the need for improvement in alarm systems of current monitors and staff training. It is worth noting that there seems no need for more monitors, information and alarms, but more smart systems, able to correlate the several vital parameters. The complexity of managing alarms explains why, despite the large number of devices available, there are still adverse events related to them.

CONCLUSION

The state of the art about the noise in different hospital environments, as well as the consequences for sleep and comfort of patients, show that the noise emitted by alarms of the equipment available in intensive care units for adults has not yet been fully exploited as object of investigation, especially if we consider that the excessive number of alarms, as well as the high level of volume can contribute to fatigue of alarms, a problem that can, likewise, endanger the safety of the patient in intensive care.

Alarms, theoretically, are a great idea, because patients are benefited from the fact the team be alerted to sudden changes and vital parameters, such as ventricular fibrillation, early detected by the heart monitors. However, the researchers demonstrated that the majority (85%) of the alarms that occur in the ICU is false alarm or have limited use. This can lead to “fatigue of alarms” in which the health team ignores alarms - for low rate of true positives - constituting itself in a disturbing potent to the sleep of patients in this unit.

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