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The influence of the workplace indoor environmental quality on the incidence of psychological and physical symptoms in intensive care units

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ABSTRACT

The present study aimed to investigate the risk of symptomatological complaints resulting from exposure to indoor environmental quality variables in intensive care units (ICUs) and to determine the exposure risk caused by the interaction of these variables. Nine ICUs in the city of João Pessoa/Brazil, were selected, and for three consecutive days, temperature, noise, lighting and air quality measurements were collected. Simultaneously, 128 professionals were interviewed to assess their perceptions of, satisfaction with and health conditions associated with the environment. The risk of exposure to adverse environmental conditions was estimated using Bayesian networks and validated according to the predictive values and the area under the Receiver Operating-Characteristic curve. The results indicated that the ICUs were at the limits of the hygienic standards stipulated for the sector; employees working had a 42.2% probability of experiencing physical symptoms associated with environmental discomfort and a 45.3% probability of experiencing psychological symptoms associated with environmental discomfort, representing increases of 24.5% and 6.9%, respectively, above the basal probability. The variables with the highest impact on the health of professionals were temperature variables, which were estimated using the average rating predicted by ISO 7730/2005 and self-reported perceptual variables. The interaction between environmental attributes in a risk scenario indicated that the environmental temperature could affect other environmental variables that impact the health of professionals. Hence, the risk arising from an uncomfortable environment is not simply the sum of the individual risks for each attribute; rather, it is the result of synergy between the measurable and perceived variables.

1. Introduction

The ICU is a hospital environment designed for the control, maintenance and recovery of vital functions. Patients hospitalized in the ICU have significant and potentially lethal morphofunctional impairments that require highly specialized and intensive human, material and technological investments [5,64].

ICUs arose from the evolution of the complexity of human diseases and have undergone substantial technological, physical and organizational changes throughout the years. Current intensive care practices in the ICUs are very different from those that marked the origins of these units. The scientific progress of medicine, the aging of the population and the appearance of multi-resistant organisms has resulted in the need to group a larger number of professionals, develop patient monitoring and life support equipment that are more effective and precise, and create improved, highly specialized pharmaceuticals [35,51,55].

Thus, "intensive medicine is one of the fields showing remarkable progress, in terms of research as well as treatment" [70]. This statement reflects the social importance of this field; as an example, intensive medicine represents approximately 0.66% of the gross domestic product of the United States, generating over $81 billion dollars in expenses per year [24,48]. It is predicted that in the next 10 years, there will be greater investments in this sector, with the consequent implementation of changes in technology and work processes, including the application of computerized data management [35].

The objective of these health services is to provide conditions that are favorable to the patients' healing process [44].

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Nevertheless, both the performance of the work and the intended results can be affected by environmental comfort variables [25] such as lighting, noise, temperature and air quality. It is worth mentioning that environmental stimuli have different repercussions in the body and mind of an individual. Hence, in terms of environmental aspects, unhealthy workplaces can cause several diseases that affect workers' physical and/or mental health [57] and behavioral and social functioning [47].

The influence of occupational environmental variables on human beings includes aspects of quality of life and general health [7] and can even affect cognitive processes [61]. Considering that the work performed in the ICU requires attention, agility and concentration, unfavorable environmental conditions can harm employee health and wellness by inducing such symptoms as headache, irritability and fatigue; are attenuating factors for workplace accidents; and can slow patient recovery by introducing an increased number of number of medical errors [39]. Hence, to perform work tasks efficiently and safely, it is necessary to reach an equilibrium between the workplace environment and the psychophysiological requirements for comfort, which encompasses the perception of and satisfaction with the environment [16,63]. Additionally, it is possible to prevent the harms associated with exposure to physical environmental variables by applying risk stratification and proper environmental control.

Therefore, it is understood that the workplace represents an important quantitative indicator of risk exposure and how professionals are affected by the environmental aspects of comfort [5]. Nevertheless, the effects of exposure are frequently considered separately for each environmental variable; for instance, the effects of lighting on the satisfaction, performance, health and safety of the professional, as verified by Ref. [13]; the evaluation performed by Ref. [2] in relation to temperature-related comfort in hospitals in tropical climates [43]; investigation of the noise level in ICUs; and [20]; investigation of the concentration of suspended particulate matter in Greek hospitals. These studies are highly important; however, when analyzed in isolation, they do not reflect the risk arising from relationships among the variables, bearing in mind that the interaction between environmental attributes is synergic and the articulation of the environmental stimuli could promote broader risks than the simple sum of isolated effects.

Studies to evaluate the consequences of the set of environmental variables professional health were initiated by Ref. [11]; who evaluated environmental comfort in the ICU based on the noise, lighting and air temperature. However, this author did not include the air quality variable. Other authors, such as [27]; who identified professionals' health risks from noise levels, temperature, air humidity and lighting; and [68]; who evaluated the environmental attributes of the ICU and related them to the occupational risk; these authors performed studies focused on the identification of risk exposure from a qualitative categorization in levels (high, medium and low risk), but not from on risk in probabilistic terms.

This finding and the observation that environmental variables can predict the health status of exposed populations have been verified by Ref. [67]; who stated that the prevalence of echocardiographic abnormalities is associated with the long-term exposure to noise, which doubles the incidence of high blood pressure and increased heart rates; by Ref. [69]; who showed that improper lighting was associated with visual fatigue, headaches, sleep disorders and irritability that could be harmful to the health of humans; and by Ref. [65]; who verified the positive relationship between self-reported temperature perceptions and task execution and error rates. These studies have prompted new investigations to determine the probable risk to the health and welfare of ICU professionals that is associated with environmental comfort variables. In this sense, this paper presents a study of the risk associated with each variable individually and with all environmental comfort variables as a group, considering the professionals' perceptions of comfort, health and welfare in acclimatized intensive care units (ICUs).

2. Materials and methods

The methodological procedure began with a literature review, which provided the foundation for the instrumental aspects of data collection and the relevance of the proposed subject. This theoretical framework was structured according to the protocol in *Statement for Reporting Systematic Reviews* (PRISMA) [41].

2.1. Study field and sample

The study was conducted at adult ICUs in the public health system of the city of João Pessoa, State of Paraíba, Brazil (Table 1) between July 20 and August 29, 2015. The selection criterion was selected to maintain the homogeneity of the characteristics in the studied environment, that is, it was chosen so that they were as similar as possible, considering that adult ICUs differ from pediatric ICUs in terms of layout, organization and technological equipment and coverage, given that 68.4% of ICUs in Brazil provide adult care [1].

The analysis units showed heating, ventilation and air conditioning (HVAC), split and centralized types. Centralized HVAC were served by air handling units (AHU) for distribution in hospital specific areas such as ICU and surgical centers. In both cases, the air velocity varied between 0.3 and 0.5 m/s.

The sample included health care professionals (doctors, nurses, physiotherapists and nurse technicians), who formally agreed to participate in the study by signing the Free and Informed Consent Form and who had a minimum workload of six hours in the department.

The investigated professionals have purely assistential assignments, that is, they support the clinical treatment and therefore have similar working characteristics; they are in direct contact with the patient and are continuously in the ICU. The specific attribution of the doctor is the diagnosis and management of the assistance provided in ICU; the nurse's is the continuous and direct care of the patient and receiving and welcoming the patients' family; the physiotherapist's is the rehabilitation of a variety of organic systems; the nurse technician's is the provision of basic care in daily life, such as hygiene, nutrition and medication.

The study procedures were submitted to the Research Ethics Committee of the Center of Health Sciences of the Federal University of Paraíba (Universidade Federal da Paraíba), and were approved on July 1, 2015 under number 1.133.163.

2.2. Studied variables

Measurable data for comfort variables were considered. These variables included temperature, noise, lighting and air quality characteristics, which were classified as “predictor variables”; environmental perception parameters, which were classified as “mediating variables”; and symptomatic complaints related to exposure risk, which were classified as “result variables”. The variables were classified to meet the needs of the adopted statistical method and the structure of the designed model.

2.3. Data collection

Measurement logistics were planned in advance according to the architectural design of the studied ICUs and normative orientations. The measurements were performed near patients' beds and at the