BRIEF REPORT

NOSOCOMIAL INFECTIONS IN EMERGENCY OBSERVATION UNITS AND THEIR ASSOCIATION WITH OVERCROWDING AND VENTILATION

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ABSTRACT

The aim of this study was to measure the frequency of nosocomial infections in the internal medicine observation units of the emergency services in two level III hospitals in Lima. A 5-day prevalence study was carried out on patients admitted after a 72 hours observation period, in whom community-based infections were ruled out. Data was obtained from clinical records. Additionally, overcrowding and ventilation in the hospitalization rooms were evaluated. The frequency of nosocomial infections in the emergency services was found to be 8.1%, four times what was reported as period prevalence in Peru. The associated risk factors were prolonged length of stay and lack of proper ventilation in the hospital environment. Inadequate ventilation triples the risk of nosocomial infections.

Keywords: Cross Infection; Healthcare-Associated Pneumonia; Hand Disinfection; Medical Waste Disposal; Ventilation; Peru (Source: MeSH NLM).

INTRODUCTION

Nosocomial infections (NIs) are defined as infections that are contracted 48 hours after hospitalization and were not present or incubating prior to the patient being admitted to the hospital [1]. The prevalence of NIs in developed countries varies between 5.1% and 11.6%, while in low- and middle-income countries it fluctuates between 5.7% and 19.1% [2,3]. In 1999, a study of the prevalence of NIs in 62 hospitals was conducted for the first time in Peru and found prevalence rates between 0 and 3.5%, depending on the complexity level of the hospital. Subsequently, several studies on the prevalence of NIs have been conducted in hospitalization areas from various public hospitals in Lima and in some regions, and the results vary between 0% and 15%, depending on the complexity level [4].

NIs increase the average length of hospital stay by nine days and the average intensive care unit stay by seven days [5]; they also increase morbidity, mortality, and the economic burden on health services [4,6,7].

NIs are particularly prevalent in overcrowded places [8], such as the observation units of the emergency services. Some of these units do not meet the minimum requirements: attention periods of 12 hours, areas differentiated by sex, maximum capacity of six beds per room and a minimum area of nine square meters [2,9,10].

The prevalence of NIs in Colombia has reportedly increased, related to larger hospitals and greater number of beds [11]. Overcrowding in the emergency room, as well as a long wait

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for diagnosis and treatment, increase the patient's length of hospital stay and their exposure to infectious agents. As a result, NIs raise costs and mortality [12,13].

The aim of this study was to estimate the period prevalence of NIs in two level III hospitals in Lima. Likewise, we described the characteristics of patients and the areas where they were hospitalized regarding overcrowding and ventilation.

THE STUDY

A cross-sectional descriptive study was carried out to estimate the period prevalence of NI during a 5-day period in the emergency services of the Hospital Nacional Cayetano Heredia (HNCH) and the Hospital Nacional Arzobispo Loayza (HNAL); both are level III-2 hospitals in Metropolitan Lima. We included patients who were hospitalized for more than 72 hours in the internal medicine observation unit of the emergency service, after having ruled out any community-acquired infection.

Overcrowding was evaluated according to the Peruvian Technical Standard for Hospital Architecture, which establishes a minimum distance between beds of 150 cm and a 9 m^2 area for each bed [14]. A ventilated area was defined as the existence of some system of air extraction, artificial or adequate natural ventilation (tall ceilings, wide windows) in the lower or upper part of the hospital area [15,16]; if none of these options were available, the area was considered "unventilated". The area dedicated to the medical observation unit in the HNCH emergency service is 397.02 m^2 and that of the HNAL is 321.32 m^2.

NI was defined as the presence of one of the following criteria: fever after 72 hours of admission, new pulmonary infiltrate (not present at the time of admission), abnormal urine test (in persons with normal urine test at the time of admission), infection associated with a device installed during hospitalization, and a laboratory test result suggestive of infection (not present at the time of admission).

For the statistical analysis, we used the STATA software version 13.0. An exploratory analysis of the association between categorical variables was carried out. The chi-square test was used to compare proportions between groups. For continuous variables, we used the Student's t test for normal distribution, otherwise the Mann-Whitney U test was used.

Prior to data collection, the HNCH and HNAL Ethics Committees reviewed and approved the study. All patients signed the informed consent form to be included in the study.

KEY MESSAGES

Motivation for the study: Areas not designed for medical care, such as corridors, are being used for the observation of seriously ill patients in emergency services in Peru. Poor infrastructure conditions make patient care precarious.

Main findings: The frequency of nosocomial infections in patients admitted to the observation units of emergency services was 8.1%. Poor ventilation triples the frequency of nosocomial infections.

Implications: Inadequate infrastructure of emergency services is harmful to patients and significantly increases the frequency of nosocomial infections.

FINDINGS

In a five-day period, 241 hospitalizations were registered. Thirty patients preferred not to participate in the study, so the sample was made up of 211 patients (Table 1).

Emergency Room Ventilation

We found that 100% of the rooms of the HNAL emergency service met the criteria for adequate ventilation. In the HNCH, 32.1% of patients were located in ventilated areas ($p < 0.001$).

Overcrowding of emergency areas

From 109 beds in the HNCH, we obtained a median distance between beds of 58 cm (IQR: 38-88); the shortest distance was 8 cm and the longest was 130 cm. From 102 beds in the HNAL, we obtained a median distance between beds of 66 cm (IQR: 30-83), the shortest distance was 15 cm and the longest was 157 cm. In the HNCH the average area for each bed was 5.7 m^2, while in the HNAL the average was 6.9 m^2. Neither institution met the recommendations of the national technical standard. There was no statistical difference ($p = 0.064$).

Nosocomial infections

We found 17 cases of NIs, 12 (70.6%) in the HNCH and 5 (29.4%) in the HNAL. The overall prevalence was 8.1%, which corresponds to 11.1% in the HNCH and 4.9% in the HNAL. Of these cases, 9 (52.9%) were male and 11 (64.7%) were adults over 65 years. As for the type of the NI, 15

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Table 1. Descriptive characteristics of 211 patients hospitalized in the emergency services of the Hospital Cayetano Heredia and the Hospital Nacional Arzobispo Loayza, according to the presence of nosocomial infection.

Characteristic	Patients without nosocomial infection (n = 194)	Patients with nosocomial infection (n = 17)	p value [a]
Sex			0.925
Female	89 (45.9)	8 (47.1)	
Male	105 (54.1)	9 (52.9)	
Age, median (IQR)	62 (46-75)	74 (63-84)	0.273 [b]
Age group (years)			0.120
18-65	106 (54.9)	6 (35.3)	
>65	87 (47.1)	11 (64.7)	
Hospital			0.083
HNCH	97 (50.0)	12 (70.6)	
HNAL	97 (50.0)	5 (29.4)	

IQR: Interquartile Range; HNCH: Hospital Nacional Cayetano Heredia; HNAL: Hospital Nacional Arzobispo Loayza
[a] Chi-square test; [b] Mann Whitney U-test

(88.2%) had hospital-acquired pneumonia and 2 (11.8%) had urinary infection.

Of the 12 patients with NIs in the HNCH, 8 (66.7%) were in non-ventilated areas and 4 (33.3%) in ventilated areas ($p < 0.01$). We observed that the length of hospital stay was longer in patients with NI. Patients from the HNCH had a median length of hospital stay of 7 days (IQR: 6-12), and those from HNAL had a median of 5 days (IQR: 3-6), this difference being significant ($p < 0.001$).

No association was found between overcrowding and NIs, the median distance between beds was 71 cm (IQR: 65-90) and it was not different between institutions ($p = 0.227$).

DISCUSSION

The prevalence of NIs in the emergency medical observation areas of both hospitals was 8.1%, and the variables that had significant association were ventilation of the hospital area and length of hospitalization.

The NIs prevalence found in this study is almost four times the point prevalence reported by the Ministerio de Salud in 2016 [16] (2.8% in all health facilities and 6.2% in level III-2 facilities). If we analyze each institution separately, we find that the prevalence of NIs in the HNCH (11.1%) is almost four times the national average and twice the prevalence reported for level III-2 health facilities; while the HNAL has a prevalence lower than other institutions with the same complexity level (4.9%). These results require an in-depth analysis to verify and understand the underlying causes, however, this comparison is useful to contextualize the magnitude of the problem.

An interesting finding that may have influenced the development of NIs in our series was ventilation in hospital environments, we found a significant difference between the two hospitals. According to Beggs *et al*, environments with greater ventilation had less risk of spreading NIs [15], this has been described for bacteria, viruses, microbacteria and fungi. The difference in ventilation could be related to the lower frequency of NIs in HNAL compared to HNCH [16,17].

It is important to keep windows open as a measure to maximize ventilation in order to reduce the spread of airborne infections even more efficiently than mechanical ventilation systems, exhaust fans or negative pressure systems. The importance of natural ventilation was demonstrated in an experimental study using a carbon dioxide tracer in 368 experiments in different areas of Lima hospitals, and concluded that the natural ventilation system allows 28 air changes per hour [18]. Additionally, the same study showed that "old fashioned" infrastructure, with tall ceilings and large windows, provides better protection.

Another important factor for presenting a NI is the length of hospital stay. In our study, patients without a NI had a median stay of six days compared to patients with a NI who had a median of 14 days. This finding is similar to what has been reported by Stranieri *et al*, who found a median length of hospital stay of seven days and concluded that if a patient is hospitalized for more than this period of time, is more likely to acquire a NI [5]. Benavides *et al.* carried out a study in a third level hospital and defined prolonged stay as one that exceeds nine days of hospitalization [19]. By analyzing the situation in each hospital, we found that patients in the HNCH had a longer average stay compared to those in the HNAL (7 days vs. 5 days).

Regarding distance between beds, none of the hospitals met the recommendations established in Peru's technical standard [15]. The international technical standard is variable; for example, in the Netherlands a minimum distance of 150 cm is recommended, and in Turkey, 100 cm. However, when comparing the frequency of NIs in both countries, we found 7.2% for the Netherlands and 13.4% for Turkey, so it can be inferred that the minimum distance to be considered between beds should be 150 cm [20].

The normal use of transit areas as hospitalization environments is noteworthy. In some areas, the maximum distance between beds was 68 cm and the minimum was 9 cm. According to the standard, each bed occupied by a patient should have an area of 9 m^2 around it [8,15].

These findings show inadequate infrastructure and suggest that it can produce severe complications such as NIs, apart from the discomfort and impairment of individual rights that hospitalization in such conditions produces. This is a line of research that should be worked on until solutions are found to improve infrastructure and achieve the recommended standards of ventilation and space in Peruvian hospitals.

There are some limitations to our study, like its cross-sectional nature and the time frame in which the sample was taken. We measured prevalence in a period of only five days, so the findings could be related to factors or circumstances not measured such as seasonality. Because of the sample size, the statistical power may be insufficient to detect significant findings. The lack of some objective measurements, such as airflow or particles to define ventilation, may lead to non-differential selection bias and underestimation of results. However, despite these limitations, we did not find any other study conducted in Lima hospitals that evaluates overcrowding and ventilation in emergency hospitalization services and their association with NIs. Another limitation associated with an increase in NIs could be that the area of patient admission we found in the hospitals was not adequate. It was not possible to comply with hand hygiene, oral hygiene, and health personnel asepsis in these areas. Finally, we did not have bacteriological results associated with the infections found.

In conclusion, the frequency of NIs found in the emergency services of both hospitals was 8.1%, which is four times the reported prevalence in Peru. The factors associated with the presence of a NI were ventilation and length of hospital stay, factors on which urgent improvements should be made. The lack of ventilation triples the occurrence of nosocomial infections.

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