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# Financial impact of nosocomial infections in the intensive care units of a charitable hospital in Minas Gerais, Brazil

*Impacto financeiro das infecções nosocomiais em unidades de terapia intensiva em hospital filantrópico de Minas Gerais*

1. Santa Casa de Belo Horizonte - Belo Horizonte (MG), Brazil.

## ABSTRACT

**Objective:** Infections in intensive care units are often associated with a high morbidity and mortality in addition to high costs. An analysis of these aspects can assist in optimizing the allocation of relevant financial resources.

**Methods:** This retrospective study analyzed the hospital administration and quality in intensive care medical databases [Sistema de Gestão Hospitalar (SGH)] and RM Janus<sup>®</sup>. A cost analysis was performed by evaluating the medical products and materials used in direct medical care. The costs are reported in the Brazilian national currency (Real). The cost and length of stay analyses were performed for all the costs studied. The median was used to determine the costs involved. Costs were also adjusted by the patients' length of stay in the intensive care unit.

**Results:** In total, 974 individuals were analyzed, of which 51% were male, and the mean age was 57±18.24 years. There were 87 patients (8.9%) identified

who had nosocomial infections associated with the intensive care unit. The median cost per admission and the length of stay for all the patients sampled were R\$1.257,53 and 3 days, respectively. Compared to the patients without an infection, the patients with an infection had longer hospital stays (15 [11-25] *versus* 3 [2-6] days,  $p<0.01$ ), increased costs per patient in the intensive care unit (median R\$9.763,78 [5445.64 - 18,007.90] *versus* R\$1.093,94 [416.14 - 2755.90],  $p<0.01$ ) and increased costs per day of hospitalization in the intensive care unit (R\$618,00 [407.81 - 838.69] *versus* R\$359,00 [174.59 - 719.12],  $p<0.01$ ).

**Conclusion:** Nosocomial infections associated with the intensive care unit were determinants of increased costs and longer hospital stays. However, the study design did not allow us to evaluate specific aspects of cause and effect.

**Keywords:** Cross infection/economy; Sepsis/economy; Health care costs; Hospital costs

This study was conducted at the Santa Casa de Belo Horizonte - Belo Horizonte (MG), Brazil.

**Conflicts of interest:** None.

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## INTRODUCTION

Nosocomial infections occur in approximately 10% of patients hospitalized in intensive care units (ICUs)<sup>(1,2)</sup> and are indicative of poor outcomes in critically ill patients.<sup>(3,4)</sup> The clinical pictures of infections in ICUs are associated with increased morbidity and mortality in addition to high costs.<sup>(3,4)</sup> In Brazil, Toufen Junior et al.<sup>(5)</sup> studied the prevalence of infections in ICUs in a university hospital and found high rates of infection, predominately with drug-resistant bacteria. Special attention has been given to preventing and treating these infections and to the early detection of sepsis.<sup>(6-8)</sup>

There is ample evidence that the rates of nosocomial infections are higher

in Brazil than in other countries.<sup>(9-12)</sup> A subanalysis of the study Extended Prevalence of Infection in Intensive Care II (EPIC II), which only evaluated the patients from Brazil, found that approximately 62% of the 1235 patients included presented with clinical symptoms of infection. This prevalence is significantly higher than that observed with the same database for other locations, such as Europe and North America. The most frequent site of infection was the respiratory tract (71.2%), which was followed by urinary tract infections (16.6%), abdominal infections (13.4%) and bloodstream infections (10.1%). This study also found a high prevalence of Gram-negative bacteria compared to other regions (especially more developed regions), which is consistent with the findings from other studies.<sup>(9)</sup>

Antimicrobial drugs are usually expensive medications, and infected patients have many direct and indirect medical expenses.<sup>(11,13)</sup> There is an association between the development of bacterial resistance to antimicrobial agents and increased costs, extended hospital stays and higher morbidity and mortality.<sup>(14)</sup> Particularly for patients with sepsis, a Brazilian study reported higher treatment costs for sepsis in ICUs and increased costs for the treatment of non-survivors.<sup>(15)</sup> The pharmacoconomics of infections in ICUs have been used to better allocate the available financial resources.

Data on the economic impact of nosocomial infections in ICUs in our region are still scarce. An analysis of these economic aspects, especially in hospitals affiliated with the Unified Health System [Sistema Único de Saúde (SUS)], can help to optimize care and better allocate the financial resources. The aim of this study was to retrospectively evaluate the economic impact of ICU-acquired nosocomial infections.

## METHODS

This was a retrospective analysis of the hospital management database [Hospital Management System - Sistema de Gestão Hospitalar (SGH)] and management system database for infection control in hospitals (RM Janus) of patients hospitalized in the ICUs at Santa Casa de Belo Horizonte, including two clinical units, a surgical unit and a cardiovascular unit, for a total of 40 beds. This institution is classified as a charitable general hospital in which the primary population served consists of SUS patients (>95%). The variables analyzed in this study included age, gender, presence and type of nosocomial infection, length of stay in the ICU and expenses (total and per day). This study was approved by the local Committee for Ethics in Research (CER) in accordance with opinion 041/2010. A consent form for reviewing the patient medical records was waived by the CER.

The patients were hospitalized between March and October of 2010. The cost analysis was performed by evaluating the medications (antibiotics, sedatives, vasoactive medications and other routine medications used in intensive care) and supplies (catheters, bandages, probes, etc.) used in direct medical care during the patients' stay in the ICU. Indirect costs in the ICU and any information outside of intensive care were not taken into account. The costs are reported in the Brazilian national currency (Real). A cost analysis and length-of-stay analysis were performed for all the patients sampled. The costs were adjusted based on the length of the stay in the ICU. The diagnostic criteria for nosocomial infections were defined by the institution's Hospital Infection Control Committee, based on the CDC-NHSN (Centers for Disease Control and Prevention - National Healthcare Safety Network) guidelines. All cases that were considered positive were validated by the ICU medical team and the hospital infection control committee (HICC).

## Statistical analysis

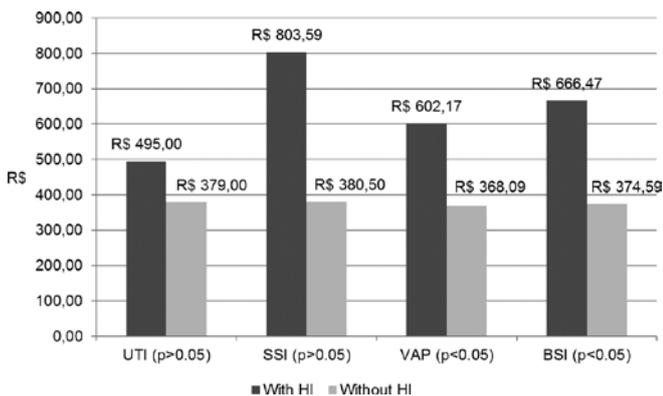
Quantitative variables were expressed as the mean  $\pm$  standard deviation (SD) or median and interquartile range [25-75 percentiles] based on the sample distribution. The variables were compared using Student's *t*-test or Mann-Whitney test based on the normality of the distribution. The distribution of the patients sampled was calculated using the Kolmogorov-Smirnov test. Categorical variables are expressed as numbers/totals and percentages, and the comparison tests were performed using the  $\chi^2$  or Fisher's exact tests. The *p*-values <0.05 were considered significant.

## RESULTS

### Sample description

In total, 1,096 patients who were admitted to ICUs (medical, surgical and cardiovascular) were included, and 122 patients were excluded due to a lack of information, resulting in a total of 974 individuals included in the analysis. Of these, 500 patients (51%) were male. The mean age was  $57 \pm 18.24$  years. Overall, 87 patients (8.9%) presented with ICU-associated nosocomial infections. There were no differences in the age of the patients with an infection and those without an infection ( $56.4 \pm 19$  years *versus*  $57.7 \pm 18$  years, respectively, *p*=0.53). There were also no differences in the gender of the patients between these two groups (males 55.2% *versus* 50.8%, respectively, *p*=0.44). Overall, 44 (4.5%) of the patients presented with ventilator-associated pneumonia, 24 (2.5%) had bloodstream infections, 16 (1.6%) displayed urinary tract infections, 7 (0.7%) presented with surgical site infections, and 14 (1.4%) showed other types of infections.

The median costs per hospitalization, median costs per day and per length of stay in the ICU for all the patients were R\$1.257,00 [462.97-3924.47], R\$381,00 [185.22-753.20] and 3 [2-7] days, respectively. The median cost per day (Figure 1) was R\$495,00 [353.68-605.47] for the patients who presented with urinary tract infections, R\$803,59 [456.29-943.02] for surgical site infections, R\$666,47 [420.30-821.53] for catheter-associated bloodstream infections and R\$602,17 [409.52-953.94] for ventilator-associated pneumonia. Surgical site infections were associated with higher costs per day (R\$803,59) [456.29-943.02].



**Figure 1** – Expense analysis per day based on the type of infection. HI - hospital-acquired infection; UTI - urinary tract infection; SSI - surgical site infection; VAP - ventilator-associated pneumonia; BSI - bloodstream infection.

### Comparative analysis

Infected patients had longer stays than uninfected patients (15 [11-25] *versus* 3 [2-6] days, respectively,  $p < 0.01$ ), increased costs per patient (R\$9.763,78 [5445.64-18,007.90]) *versus* R\$1.093,94 [416.14-2755.90], respectively,  $p < 0.01$ ) and increased costs per day for ICU hospitalization (R\$618,00 [407.81-838.69] *versus* R\$359,00 [174.59-719.12], respectively,  $p < 0.01$ ).

Ventilator-associated pneumonia and bloodstream infections were associated with higher costs per day. For this comparison, multivariate analyses were not performed.

### DISCUSSION

This study shows that the rate of nosocomial infections in the ICU is similar to those in previously reported international studies.<sup>(1,2)</sup> Ventilator-associated pneumonia was the most frequent infection, as is commonly described.<sup>(9)</sup> Patients with an infection (especially surgical site infections and catheter-associated bloodstream infections) had higher ICU costs. In addition to the cost of antimicrobials, many of the other life support resources that were used for these patients may be

responsible for the increased costs.<sup>(8,13)</sup> National databases on the costs of the supplies and medicine used in this group of patients are scarce. These data were not compared to data from international studies due to the heterogeneity of the populations studied, the methodologies used and the economic peculiarities of each country.

From this study, the great economic impact of ICU-acquired infections in SUS hospitals can be observed. Due to economic difficulties faced by public and charitable hospital units, this topic is currently important and has been discussed from both administrative and pharmacoeconomic points of view. Medication costs (including antimicrobials) are gradually increasing each year.<sup>(16)</sup>

Special attention has been given to multidrug-resistant bacterial infections by public institutions such as the National Health Surveillance Agency (Agência Nacional de Vigilância Sanitária - ANVISA). The costs attributable to bacterial drug resistance are complex, multidimensional and difficult to estimate. Studies conducted between 2001 and 2011 that have addressed these issues have demonstrated the impact of the drug-resistant microorganisms on the statistically significant increase in the overall hospital costs<sup>(17-20)</sup> and the costs of antibiotics, especially in cases related to bacterial resistance.<sup>(17,19,20)</sup>

In addition to the direct spending on assistance, the increases in the length of stay in the ICU can have a similar impact on public health as a result of limiting access to intensive care.

From a public health viewpoint, another consideration regarding multidrug-resistant infections is the significant health risk they pose to other hospital patients. Prevention and control measures for multidrug-resistant infections involve qualification measures for hospital care, health surveillance and other measures that are related to the hospital's operations, which are normally adopted by the state, the municipality and each individual hospital. The control of nosocomial infections is difficult and involves significant collective efforts and persistent, sustained and often poorly recognized work in multi-professional teams. Lowering the rates of infection may help decrease the economic problems faced by public and charitable hospitals in Brazil, reduce the length of stay of patients, increase the bed turnover rate and increase the availability of vacancies in ICUs.

This study may be useful in raising the awareness of health professionals, especially administrators, in creating preventative institutional policies for healthcare-associated infections. These results may also help inform public policies by redefining the priorities for educational programs and research related to this area.

This work has significant limitations including that it

is a retrospective analysis of a patient database that did not evaluate important variables, such as comorbidities and organ dysfunction, multidrug-resistant bacterial infections, sepsis and septic shock. Furthermore, the cost analysis was performed by computing only the costs incurred for the supplies and medications used during hospitalizations in the ICU. The indirect costs were not included in the study because of methodological difficulties.

## CONCLUSION

This descriptive study showed that nosocomial infections associated with the ICU were major determinants of increased expenses and prolonged stays in the ICU.

## RESUMO

**Objetivo:** As infecções nas unidades de terapia intensiva estão associadas a elevada morbidade e mortalidade, além de alto custo. A análise desses aspectos pode contribuir para a otimização de recursos financeiros relacionados.

**Métodos:** Estudo retrospectivo, realizado por meio de análise de banco de dados de gestão hospitalar e qualidade em medicina intensiva (Sistema de Gestão Hospitalar - SGH) e RM

Janus<sup>®</sup>. A análise dos gastos foi realizada por meio de avaliação dos medicamentos e materiais utilizados na assistência médica direta. Os valores obtidos foram em moeda nacional (Real). Foi realizada análise de gastos e permanência para toda amostra estudada. Utilizou-se a mediana para determinação dos gastos envolvidos. Os gastos foram ajustados pela permanência na unidade de terapia intensiva.

**Resultados:** A análise de 974 indivíduos mostrou que 51% eram do gênero masculino, e a idade média foi de 57±18,24 anos. A infecção nosocomial relacionada à unidade de terapia intensiva foi encontrada em 87 pacientes (8,9%). A mediana dos gastos por internação e permanência de toda amostra foi de R\$ 1.257,53 e 3 dias, respectivamente. A comparação entre pacientes com infecção e sem infecção, por meio de medianas, mostrou maior permanência (15 [11-25] versus 3 [2-6] dias; p< 0,01), maior gasto por paciente em unidade de terapia intensiva (mediana R\$9.763,78 [5.445,64-18.007,9] versus R\$1.093,94 [416,14-2.755,90]; p<0,01) e maior gasto por dia de internação em unidade de terapia intensiva (R\$618,00[407,81-838,69] versus R\$359,00[174,59-719,12]; p<0,01).

**Conclusão:** As infecções nosocomiais relacionadas à unidade de terapia intensiva foram determinantes de maior gasto e permanência, embora o modelo do estudo não permita a avaliação aspectos de causa efeito.

**Descritores:** Infecção hospitalar/economia; Sepsis/economia; Custos de cuidados de saúde; Custos hospitalares

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