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PREVALENCE RATES OF INFECTION IN INTENSIVE CARE UNITS OF A TERTIARY TEACHING HOSPITAL

Carlos Toufen Junior, André Luiz Dresler Hovnanian, Suelene Aires Franca and Carlos Roberto Ribeiro Carvalho

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OBJECTIVE: To determine the prevalence rates of infections among intensive care unit patients, the predominant infecting organisms, and their resistance patterns. To identify the related factors for intensive care unit-acquired infection and mortality rates.

DESIGN: A 1-day point-prevalence study.

SETTING: A total of 19 intensive care units at the Hospital das Clínicas - University of São Paulo, School of Medicine (HC-FMUSP), a teaching and tertiary hospital, were eligible to participate in the study.

PATIENTS: All patients over 16 years old occupying an intensive care unit bed over a 24-hour period. The 19 intensive care unit s provided 126 patient case reports.

MAIN OUTCOME MEASURES*:* Rates of infection, antimicrobial use, microbiological isolates resistance patterns, potential related factors for intensive care unit-acquired infection, and death rates.

RESULTS: A total of 126 patients were studied. Eighty-seven patients (69%) received antimicrobials on the day of study, 72 (57%) for treatment, and 15 (12%) for prophylaxis. Community-acquired infection occurred in 15 patients (20.8%), non- intensive care unit nosocomial infection in 24 (33.3%), and intensive care unit-acquired infection in 22 patients (30.6%). Eleven patients (15.3%) had no defined type. The most frequently reported infections were respiratory (58.5%). The most frequently isolated bacteria were *Enterobacteriaceae* (33.8%), *Pseudomonas aeruginosa* (26.4%), and *Staphylococcus aureus* (16.9%; [100% resistant to methicillin]). Multivariate regression analysis revealed 3 risk factors for intensive care unit-acquired infection: age ≥ 60 years (p = 0.007), use of a nasogastric tube (p = 0.017), and postoperative status (p = 0.017). At the end of 4 weeks, overall mortality was 28.8%. Patients with infection had a mortality rate of 34.7%. There was no difference between mortality rates for infected and noninfected patients (p=0.088).

CONCLUSION: The rate of nosocomial infection is high in intensive care unit patients, especially for respiratory infections. The predominant bacteria were Enterobacteriaceae, *Pseudomonas aeruginosa,* and *Staphylococcus aureus* (resistant organisms). Factors such as nasogastric intubation, postoperative status, and age ³60 years were significantly associated with infection. This study documents the clinical impression that prevalence rates of intensive care unit-acquired infections are high and suggests that preventive measures are important for reducing the occurrence of infection in critically ill patients.

DESCRIPTORS: **Intensive care unit. Nosocomial infection. Prevalence rate.**

Intensive care units (ICUs) are of paramount importance in the control and treatment of the most variable and severe illnesses that affect the human body. They represent a powerful tool in modern medicine.

In the beginning, beds for intensive care were established to provide post-operative care for critical patients in 1920s. During the Second World War, they became more prevalent. The first ICUs were created in the 1950s to treat patients who needed special monitoring during the postoperative period of cardiac surgery. In 1971, the Society of Critical Care Medicine was founded, and during this decade, intensive care medicine reached the position of a medical specialty.

In spite of their invaluable and well-established role, ICUs bring some

From the Division of Respiratory Diseases, Heart Institute (INCOR), Hospital das Clínicas, Faculty of Medicine, University of São Paulo – São Paulo/SP, Brazil.
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degree of morbidity to patients, and nosocomial infection is clearly related to that.

Nosocomial infection is associated with a considerable increase in morbidity and mortality of patients at a hospital as well as to significant increases in costs[1]. Nosocomial infections occur in 5% to 17% of hospitalized patients[1]. In ICUs, where the frequent use of invasive procedures and multiple therapies expose patients to an increased risk, prevalence rates are even higher[1].

Data from the Study on the Efficacy of Nosocomial Infection Control (SENIC) show that one-third of nosocomial infections could be prevented through infection control and vigilance programs[2].

In view of the relevance and impact of such observations, it is crucial to know the prevalence rates and nature of nosocomial infections to achieve satisfactory results in controlling this important phenomenon.

The present study was undertaken to determine the prevalence rates of infection for ICU patients in our hospital, identify the most common infectious agents and their resistance patterns, and establish the prevalence rates of ICU-acquired infection and the possible associated factors.

PATIENTS AND METHODS

Setting. A total of 19 ICUs at a teaching and tertiary hospital were eligible to participate in the study. Pediatric intensive care and infant special care units were excluded from the study. The study period lasted 24 hours during June 15, 2000. Seventeen volunteers (medical doctors and students of medicine) participated in the experiment collecting data on a survey record form.

Patients. All patients over 16 years of age occupying a bed in a participating ICU over the study period took part in the study. For each patient, information was collected concerning demographics (age and gender), operative and clinical status on admission to the ICU, and diagnostic and therapeutic interventions performed on the study day. The Simplified Acute Physiologic Score II (SAPS II)[3] was calculated from data collected in the first 24 hours of ICU admission.

Types of infection. The presence or absence of infection by type was documented according to the standard definitions of the Centers for Disease Control and Prevention (CDC):

- *Community-acquired* – an infection occurring in the community and manifested on admission to hospital;
- *Hospital-acquired* – an infection manifested on admission to the ICU and deemed to be related to the present hospital admission;
- *ICU-acquired* – an infection having originated in the ICU and active or under treatment on the day of study but not clinically manifested at the time of admission to the ICU.

Antimicrobials prescribed on June 15, whether for treatment or prophylaxis, were documented. Microbiological data were recorded whenever available, including the results of bacteriologic sampling undertaken on or before the day of study.

Recorded risk factors for ICU-acquired infection included the presence or absence of intravascular and urinary catheters, nasogastric intubation, mechanical ventilation, and agents for stress ulcer prophylaxis.

Patient outcome was recorded by researching patient data 4 weeks after the study day.

Following the completion of the study, all record forms were collected centrally. Data entry was followed by a series of computer validation tests to detect omissions or inconsistent entries. Any errors identified at this stage were corrected whenever possible or the data were recorded as "missing".

Variables. Some potential risk factors for ICU-acquired infection were analyzed. These included: age equal to or greater than 60 years; kind of admission (medical or surgical); time period of ICU stay; and use of a central venous catheter, nasogastric tube, urinary catheter, and/or gastric protectors.

Definition of infection. A patient was given a diagnosis of infection when there was a medical diagnosis of an infectious focus that required the use of antimicrobial treatment.

Cultures. The cultures employed were: cultures of blood (more than 2 positive pairs of culture for the same pathogen), urine (more than 10,000 CFU when collected from urinary catheter and 100,000 CFU when not), broncho-alveolar lavage (more than 10,000 CFU for a single pathogen), and surgical wounds.

Statistical analysis. The point prevalence of community-acquired, hospital-acquired, and ICU-acquired infections was estimated. Data from the overall population were used for analysis of infection. The risk factors for ICU-acquired infection were estimated at first with a simple unadjusted analysis. Aiming at adjusting the variables and controlling the effect of potentially confounding variables, a multivariate model construction by logistic regression analysis was performed. Epi Info, version 6.04, and SPSS, version 6.0.1, were used.

RESULTS

ICU Profiles. Among the 19 ICUs, with 170 beds, 1 did not participate in the study because there were no patients on the day of study. In the remaining 18, there were 126 patients.

Patients' Demographics and Interventions. Among the 126 patients

studied, 70 were male (56%); the average age was 56.6 ± 18.1 (SD) years. Female patients accounted for 44% of all patients; the average age was 59.2 ± 17.2 (SD) years.

A total of 52 patients had undergone surgery 24 hours before admission, of whom 38 (73%) had elective and 14 (27%) had emergency surgery.

On the day of the study, 52 patients (41.3%) were being mechanically ventilated, 86 (68.2%) had a central venous catheter, 10 (7.9%) had a Swan-Ganz catheter, 88 (69.8%) had a urinary catheter, and 66 (52.3%) had a nasogastric tube (Figure 1).

Antimicrobial Use. A total of 87 patients (69%) received antimicrobials on the day of the study, 72 (82.8%) for treatment and 15 (17.2%) for prophylaxis. The most frequently used antimicrobials were cephalosporins (48.6%), followed by vancomycin (45.8%) and carbapenems (25%).

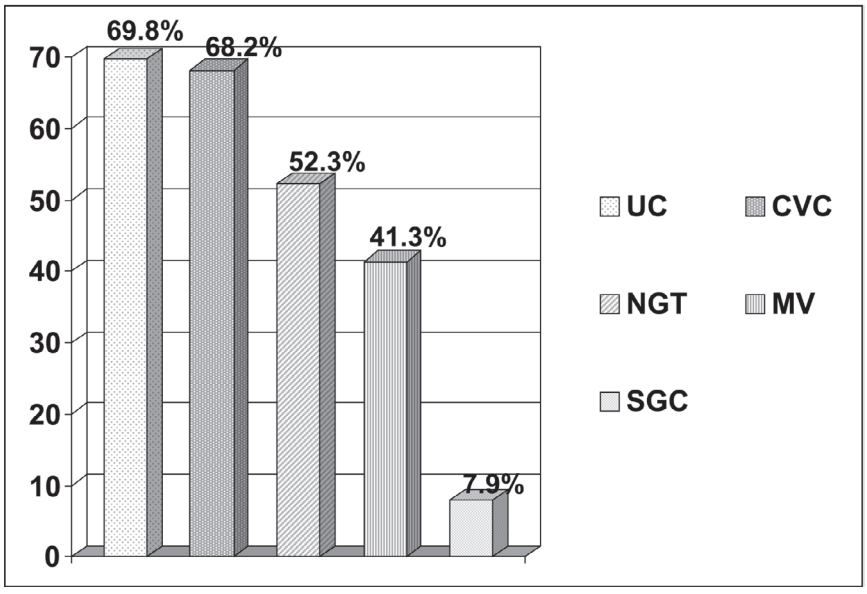
Prevalence of infection. Among the 72 patients who received therapeutic antibiotics, 15 (20.8%) had community-acquired infection, 24 (33.3%) had acquired an infection at another hospital service before being transferred to the ICU, 22 (30.6%) had ICU-acquired infection, and 11 (15.3%) had no defined type (Figure 2).

Regarding the site of infection, 41 (56.9%) were pulmonary, 5 (7.0%) were clinical sepsis, and 4 (5.6%) had an infection site in the urinary tract (Figure 3).

Overall, 37 (51.4%) of the clinically identified infections were supported by positive cultures. Fourteen patients had a mismatch between the antimicrobial used and the antibiogram, representing 19.4% of the 72 patients that were considered to be clinically infected. This inadequate antimicrobial treatment of infection was observed more frequently among patients with ICU-acquired infection (22.7%), followed by patients with community-acquired infection (20.0%), and acquired infection at another hospital service before being transferred to ICU (16.6%).

The most frequently reported isolates were as follows: Enterobacteriaceae (33.8%), *Pseudomonas aeruginosa* (26.4%), *Staphylococcus aureus* (16.9%), Streptococci (7.5%), coagulase-negative staphylococci (5.6%), and *Candida* species (7.5%).

Patterns of Antimicrobial Resistance. Among the 9 *S. aureus* isolates, all were methicillin-resistant strains (MRSAs), and all were sensitive to



UC- Urinary Catheter; **CVC**- Central Venous Catheter; **NGT**- Nasogastric Tube; **MV**- Mechanical Ventilation; **SGC**- Swan-Ganz Catheter.

Figure 1 - Invasive procedures of 126 patients studied on June 15, 2000.

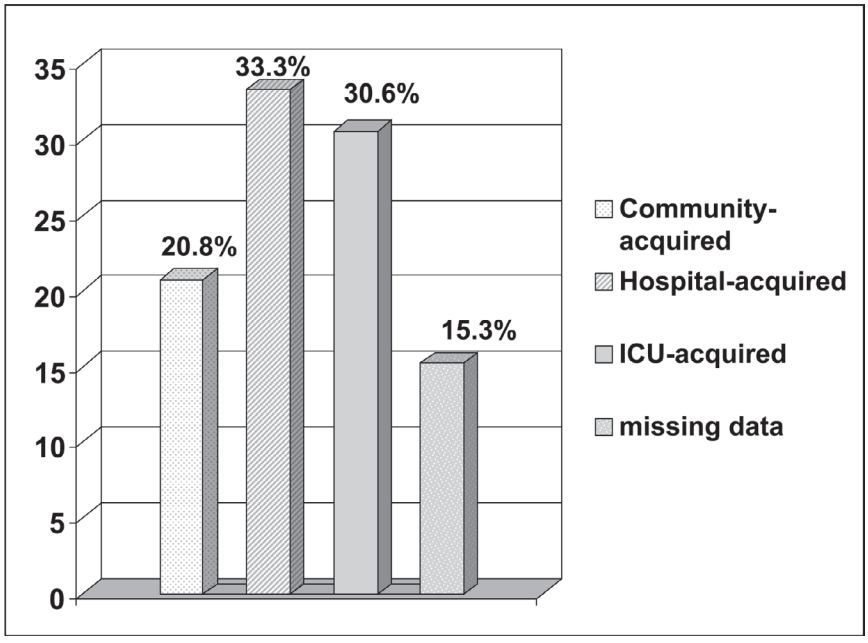


Figure 2 - Prevalence rates of infection by type of 72 patients who received therapeutic antibiotics on June 15, 2000.

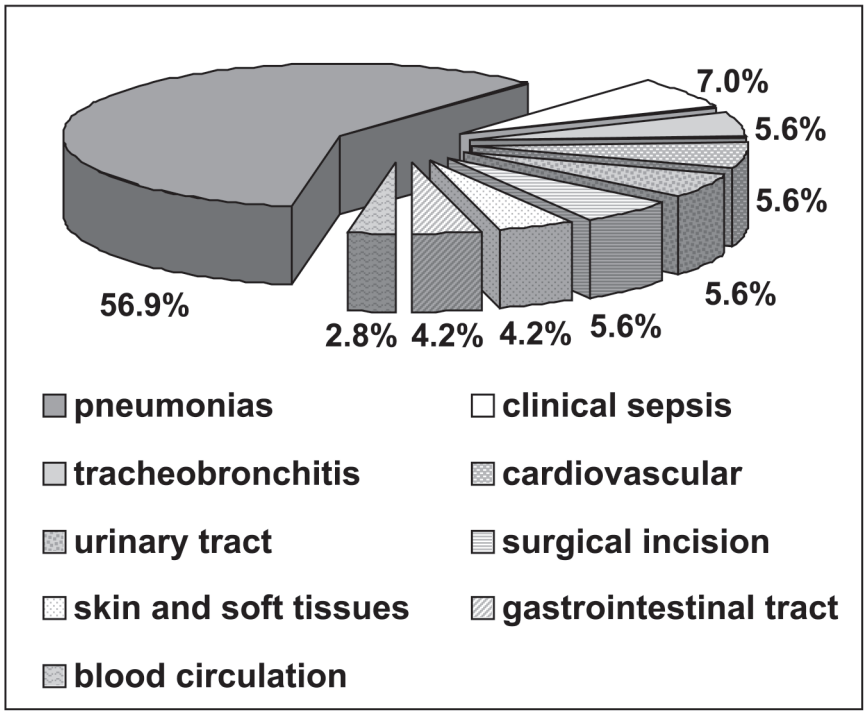


Figure 3 - Prevalence rates of infection by site of 72 patients who received therapeutic antibiotics on June 15, 2000.

vancomycin. Among the 14 cultures positive for *P. aeruginosa*, 12 were tested for gentamicin, with 50% resistance; 10 for imipenem, with 30% resistance; 11 for ceftazidime, with 50% resistance; 12 for ciprofloxacin, with 41.6% resistance; and 12 for amikacin, with 41.6% resistance.

Risk Factors for ICU-Acquired Infection. Univariate analysis was first employed to identify possible risk factors for acquiring infection inside the ICU environment. Only age equal to or greater than 60 years was identified as a risk factor. After stepwise logistic regression analysis to control for the effects of confounding variables, 3 factors were independent risk factors: use of a nasogastric tube ($p = 0.017$), postoperative status ($p = 0.017$,) and age equal to or greater than 60 years ($p = 0.007$) (Table 1).

Mortality. At the end of 4 weeks, overall mortality was 28.8%. Patients with infection had a mortality rate of 34.7%. Using a chi-square analysis, we found no difference between mortality rates for infected and noninfected patients ($p = 0.088$).

DISCUSSION

The present study, through a transversal (1-day point prevalence) analysis, reveals a profile of patient infections in the ICUs of a tertiary teaching hospital. It aims at characterizing patients with a focus on the prevalence rates of infection, sites and types of infection, the most prevalent microorganisms, and the antimicrobial resistance patterns, as well as at identifying the risk factors for ICU-acquired infection.

Medical staff that assisted the patients in the ICUs found 72 (57.1%) infected; thus, they prescribed antimicrobials with therapeutic intention. Similar results were obtained in a Mexican study (58.2%)[5]. The EPIC, a European study, showed lower rates of infection (44.8%)[1]. The great majority of patients (73.8%) received antimicrobials. This finding shows that because of the difficulty in establishing the specific diagnosis and because of the severity of infection, antimicrobials are empirically introduced most of the time. Among this population, 15 (20.8%) had community-acquired infection, 24 (33.3%) had infections that were hospital-acquired outside the ICU, and 22 (30.6%) developed infection inside the ICU. The remainder 11 infected patients (15.3%) were not classified. Higher prevalence rates for ICU-acquired infections are reported in the literature[1,5].

Overall, 37 (51.4%) of the clinically identified infections were supported by positive cultures. These isolates might not necessarily have represented the cause of the infection. They might have only reflected possible contamination of the sample or the process of colonization. Nevertheless, regarding the isolates reported, the predominance of gram-positive cocci, particularly *S. aureus*, and gram-nega-

Table 1 - Risk factors for Intensive Care Unit-acquired infection after logistic regression analysis.

Variable	*p* value
Medical admission	0.78
Surgical admission†	0.017
Time period of Intensive Care Unit stay	0.79
Use of Central Venous Catheter	0.58
Use of Nasogastric Tube†	0.017
Use of Urinary Catheter	0.76
Use of gastric protectors	0.72
Age ≥ 60 years†	0.007
SAPS II	0.87

† Independent risk factors.

tive organisms, especially *P. aeruginosa,* are in accordance with findings of recent studies[1,5]. Fourteen (11.1%) of the patients received inadequate treatment on the day of the study. This represents 19.4% of the 72 patients that were considered to be clinically infected. This finding could be explained by 2 possibilities: mistaken diagnosis by the medical team or failure of the diagnostic method if the medical diagnosis was correct.

Inadequate antimicrobial treatment of infection was observed more frequently among patients with ICU-acquired infection (22.7%), followed by patients with community-acquired infection (20.0%), and acquired infection at another hospital service before transfer to the ICU (16.6%).

It is interesting that 56.9% of patients were being treated for pneumonia, a number considerably higher than for other infections. This finding reveals the concern of medical teams with pneumonia, maybe because of its high morbidity and mortality rates and its known high prevalence rates. Additionally, it is quite difficult to distinguish nosocomial pneumonia from bacterial tracheobronchial colonization using only clinical findings, especially in intubated patients[6]. Definitive diagnosis that pneumonia is the result of a specific pathogen can be obtained only if cultures of blood, pleural fluid, or spinal fluid are positive in the presence of a lung infiltrate and a compatible clinical picture[7]. Bacteremia is uncommon in most pneumonias, usually occurring in only 8% to 15% of nosocomial pneumonias[8,9].

Regarding bacterial agents, the most prevalent were a member of the family of Enterobacteriaceae, *Pseudomonas aeruginosa,* and *Staphyloccocus aureus*, which were respectively 33.8%, 26.4%, and 16.9% of the isolated agents. Concerning resistance patterns for *S. aureus*, 100% were resistant to methicillin and 100% had sensitivity to vancomycin. Among cultures of *P. aeruginosa*, none revealed sensitivity higher than 70% to any antimicrobial tested. These data confirm that in the intensive care medical environment, the most pathogenic agents, those that are in general the most resistant, are the most frequently found[1,5]. Regarding use of antimicrobials, the most frequently used were cephalosporins (35 patients, 48.6%), vancomycin (33, 45.8%), imipenem (18, 25%), clindamycin (8, 11.1%), and aminoglycosides (6, 8.3%). Normally, empirical treatment schemes are based on knowledge of local microbiota and utilization of a wide range of antimicrobials associated or not with others of more specific action, such as vancomycin for *S. aureus* or clindamycin for anaerobic bacteria.

Three factors were significantly related to ICU-acquired infection: use of a nasogastric tube, postoperative status, and age equal to or greater than 60 years.

The finding of a relationship between nasogastric intubation and infection is in accordance with the literature[7,10]. According to the literature, pneumonia was the most frequently observed infection in ICUs, and nasogastric intubation represents one of the main risk factors. Aspiration of oropharyngeal contents, which is rich in bacteria, is facilitated by the presence of a nasogastric tube, particularly if food is administered in bolus or when the patient is in a supine position. Use of drugs that increase gastric pH, thus facilitating growth of gram-negative bacteria, raises the risk of pulmonary infections. Our data show that these drugs were used frequently (107 patients – 85.6% – were given gastric protectors, while only 6 patients with a nasogastric tube were not), in accordance with the relationship pointed out in the literature[7].

Postoperative patients also had a higher number of infections. This type of patient has a higher propensity for developing infectious complications, since surgical incision represents a gateway for infection. Additionally, postoperative patients are intubated for surgery and have a transitory decrease in immune responses due to surgical damage.

Patients of an age equal to or greater than 60 years have higher rates of ICU-acquired infections, a finding that reveals the fragility of the elderly to infections and invasive procedures.

Our data reveal frequent use of antimicrobials in our intensive care medicine environment, even without laboratory support for it. This finding has potential implications, in that treatment with antimicrobials raises the cost of treatment considerably and contributes to the selection of multiresistant species. The excessive use of gastric protectors was unexpected, since there is no evidence that their use would bring any benefit in terms of reduction of digestive complications. Simple practices could be immediately performed at ICUs to reduce rates of pulmonary infections, such as keeping the head of the bed elevated and taking care with diet administration.

It should be noted that a prevalence study like this one has some limitations. One limitation concerns the difficulty in establishing relationships of causality between factors; one cannot predict which factor comes first. The other is that 1-day point studies tend to overestimate long-duration infections and underestimate the short-duration ones.

Nevertheless, this type of transversal analysis has fundamental importance for the knowledge about the ICU population. It provides an impetus for new strategies and interventions concerning critical patients in terms of scientific research and clinical practice.

RESUMO

TOUFEN Jr. C e col. - Prevalência de infecção em unidades de terapia intensiva de um hospital escola terciário. **Rev. Hosp. Clín. Fac. Med. S. Paulo 58** (5):254-259, 2003.

OBJETIVO: Determinar a prevalência de infecções em pacientes de Terapia Intensiva, os agentes infecciosos mais comuns e seus padrões de resistência. Identificar os fatores relacionados a infecção adquirida na Unidade de Terapia Intensiva e as taxas de mortalidade.

DESENHO: Estudo de prevalência de um dia.

LOCAL: Um total de 19 Unidades de Terapia Intensiva do Hospital das Clínicas da FMUSP (HC-FMUSP) participaram do estudo.

PACIENTES: Todos os pacientes com idade superior a 16 anos internados em leitos de terapia intensiva por mais de 24 horas foram incluídos. As 19 Unidades de Terapia Intensiva forneceram 126 casos.

VARIÁVEIS: Taxas de infecção, uso de antibióticos, padrões de resistência microbiológica, fatores relacionados à infecção adquirida na Unidade de Terapia Intensiva, taxas de mortalidade.

RESULTADOS*:* Um total de 126 pacientes foi estudado. Oitenta e sete (69%) receberam antibióticos no dia do estudo, sendo 72 (57%) para tratamento e 15 (12%) para profilaxia. Baseado no tipo, observou-se que a infecção adquirida na comunidade ocorreu em 15 pacientes (20,8%), infecção hospitalar fora da Unidade de Terapia Intensiva em 24 (33,3%), e infecção adquirida na Unidade de Terapia Intensiva em 22 pacientes (30,6%). Para 11 pacientes (15,3%) não se definiu o tipo de infecção. Quanto ao sítio de infecção, as respiratórias foram as infecções mais comuns (58,5%). Os agentes mais freqüentemente isolados foram: *Enterobacteriaceae* (33,8%), *Pseudomonas aeruginosa* (26,4%) e *Staphylococcus aureus* (16,9%; 100% meticilina-resistentes). Análise multivariada identificou 3 fatores associados à infecção adquirida na Unidade de Terapia Intensiva: idade maior ou igual a 60 anos (p=0,007), uso de sonda nasogástrica (p=0,017) e pós-operatório (p=0,017). Ao final de quatro semanas, a taxa de mortalidade foi de 28,8%. Entre os infectados, a mortalidade foi de 34,7%. Não houve diferença entre as taxas de mortalidade para pacientes infectados e não-infectados (p=0,088).

CONCLUSÃO: A taxa de infecção é alta entre os pacientes de terapia intensiva, especialmente as infecções respiratórias. As bactérias predominantes foram: *Enterobacteriaceae*. *Pseudomonas aeruginosa* e *Staphylococcus aureus* (agentes resistentes). Fatores como uso de sonda nasogástrica, pós-operatório e idade maior ou igual a 60 anos mostraram associação com infecção. Este estudo documenta a impressão clínica de que a prevalência de infecção adquirida na Unidade de Terapia Intensiva é alta e sugere que medidas preventivas são importantes para reduzir a ocorrência de infecção em pacientes críticos.

DESCRITORES: **Unidade de terapia intensiva. Infecção nosocomial. Taxa de prevalência.**

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