Clinical Microbiology: Open Access

Mahaluça et al., Clin Microbiol 2018, 7:5
DOI: 10.4172/2327-5073.1000319

Research Article Open Access

The Etiology of Hospital Infections in the Intensive Care Unit of a Reference Hospital in Southern Mozambique

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Received date: Oct 07, 2018; **Accepted date:** Oct 22, 2018; **Published date:** Oct 31, 2018

Abstract

Background: The knowledge of the etiological agents of hospital infections and their antimicrobial susceptibility profiles is fundamental to direct the specific therapy, inform treatment guidelines, and the implementation of measures of surveillance and control of these infections. The present study describes the profile of bacteria most frequently implicated in infections in patients admitted to the Intensive Care Unit (ICU) in Maputo Central Hospital (HCM).

Methods: This was a cross-sectional, epidemiological, quantitative approach, with a retrospective analysis of secondary data, performed at the ICUs in Maputo Central Hospital.

Results: Most of the bacteria identified in this study were Gram-negative with 79.3% (142) *versus* the 20.7% (37) Gram-positive. The most frequent bacterium was *Staphylococcus aureus* with 16.8% (30), followed by *Klebsiella pneumoniae* 13.4% (24), *Enterococcus spp.* 10.1% (18), *Klebsiella spp.* 9.5% (17), *Acinetobacter spp.* 8.9% (16), *Enterobacter spp.* 8.4% (15), *Pseudomonas aeruginosa* 7.8% (14), *Escherichia coli* 7.3% (13), *Acinetobacter baumanni* 4.5% (8) and *Pseudomonas spp.* 3.9% (7). Most etiologic agents were isolated in blood (49.2%), pus (20.7%) and urine samples (19.0%).

Conclusions: The epidemiological surveillance, standard precautions, isolation measures, adequate materials and equipment, hygiene of the environment, training of the multi-professional team, and implementation of control measures are important and determinant factors that may interfere in the results with a reduction in the prevalence rates of hospital infection.

Keywords: Hospital infection; Intensive care; Bacteria; Sample type; Mozambique

Introduction

Health-care-related infections represent a major problem for patient safety and quality of life, and their impact may result in death, prolonged hospitalization, long-term disability, a large financial burden on health facilities, and high costs for patients and their relatives [1].

Intensive Care Unit (ICU) patients, although comprising a small subset of hospitalized patients, representing only 5% to 10% of the sum, present an average risk of infection 5 to 10 times higher than other patients and mortality rates range from 10 to 80%, according to the profile of the hospitalized patient [2].

The main causes of infections are the clinical conditions of the patient, underlying diseases, high numbers of invasive procedures, failures in infection control measures, and prevention of noninvasive infections (urinary, pneumonias and surgical wounds) as well as invasive methods of mechanical ventilation and intravascular catheters.

Critically ill patients are more vulnerable because they are in a susceptible environment and have low immunity. These factors may contribute to high infection rates and high hospital mortality in ICUs. The most prevalent infections are of the respiratory tract, urinary tract, bloodstream, surgical site and pneumonia associated with mechanical ventilation [3]. The etiological agents most commonly found in hospital infections are *Klebsiella pneumoniae*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Acinetobacter spp.*, *Escherichia coli*, *Enterobacter spp.* and *Candida spp.* [4]. Consequently, nosocomial infections influence longer hospitalization time, higher hospital costs and increased hospital deaths [5].

More than 70% of critically ill patients hospitalized in the ICUs receive some antimicrobial treatment during their stay. In addition, infections play an important role in morbidity and mortality within the units, and the prevalence of pathogen infections whose treatment is increasingly complex has steadily increased over the past few years [6,7].

The knowledge of the etiological agents of hospital infections and their antimicrobial susceptibility profiles is fundamental to direct the specific therapy, inform treatment guidelines, as well as the

implementation of measures of surveillance and control of these infections.

Considering these factor, the present study describes the profile of bacteria most frequent implicated in infections in patients admitted to the ICUs in Maputo Central Hospital (HCM).

Materials and Methods

This was a retrospective, descriptive cross-sectional, epidemiological, quantitative study of data obtained from the HCM Microbiology Laboratory. The study was carried out in the Pediatrics ICU, Medicine ICU and Surgical ICU at HCM from January to December 2017, with the data from latter consolidated. HCM is a quaternary public and teaching hospital with about 1463 beds, provides 4 Intensive Care Services: the Emergency ICU with 16 beds, the Medicine ICU with 6 beds, the Pediatrics ICU with 16 beds and the Surgical ICU with 12 beds. During the study period, 1913 patients of all ages and both sexes were admitted to HCM ICUs, including 1129 in the Pediatrics ICU, 355 in the Medicine ICU and 429 in the Surgical ICU.

Data on the profile of etiological agents was extracted from the WHONET electronic database of the HCM Microbiology Laboratory, which was set up at the end of October 2009 in order to monitor antimicrobial resistance in bacteria isolated from routine clinical samples. The database contains information on the specimens taken, patient details, growth or non-growth of infectious agents, the bacteria isolated, antibiotic sensitivity, as well as data from the patient justifying examination [8].

A descriptive statistical analysis was performed using graphs and frequency tables to understand the behavior of the variables under study. Data analysis was done with the Statistical Package for Social Sciences (SPSS) version 20 and BioEst version 5.2. The Z-test or Standardized Score was used for the comparison of proportions and the P-value of less than 0.05 was considered significant.

Before conducting data analysis, a request for authorization of the research was submitted to the HCM Scientific and Pedagogical Department under reference number 321/024/DCIEFHCM/18. After authorization of the research request, the project was submitted to the ISCISA Institutional Health Bioethics Committee and approved under reference number TFCMCSFM05/18.

The study complied with the 2013 Helsinki Declaration on health research standards.

Results

Of the 524 specimens taken, 179 were positive for bacteriological growth, of which 127 (70.9%) were from the Pediatrics ICU, 51 (29.1%) from the Adults ICU. Of the positive samples, 88 (49.2%) were of blood, 37 (20.7%) pus, 34 (19.0%) urine, 7 (4.5%) catheter tip, 4 (2.8%) sputum, 32 (1.1%) pharyngeal exudate and faeces respectively. There was no positive bacteriological examination for urethral and vaginal secretions (Table 1).

According to Table 2, most of the microorganisms identified in this study were Gram-negative with 79.3% (142) against the 20.7% (37) Gram-positive. The most frequent bacterium was *Staphylococcus Aureus* with 16.8% (30), followed by *Klebsiella pneumoniae* with 13.4% (24), *Enterococcus spp.* 10.1% (18), *Klebsiella spp.* 9.5% (17), *Acinetobacter spp.* 8.9% (16), *Enterobacter spp.* 8.4% (15), *Pseudomonas aeruginosa* 7.8% (14), *Escherichia coli* 7.3% (13), *Acinetobacter baumanni* 4.5% (8) and *Pseudomonas spp.* 3.9% (7).

Sample Type	Type of ICU					
	Pediatrics		Adults		Sum	
	n	%	n	%	n	%
Blood	68	77.3	20	22.7	88	49.2
Urine	16	47.1	18	52.9	34	19
CSF	3	100	0	0	3	1.7
Pus	34	91.9	3	8.1	37	20.7
Catheter tip	4	50	4	50	8	4.5
Faeces	2	100	0	0	2	1.1
Expectoration	0	0	5	100	5	2.8
Pharyngeal Exudate	0	0	2	100	2	1.1
Sum	127	70.9	52	29.1	179	100

Table 1: Positive culture distribution in samples of pediatric and adult ICU patients from HCM in the year 2017.

Microorganisms	Type of ICU					
	Pediatrics		Adults		Sum	
	n	%	n	%	n	%
A.baumanni	6	4.7	2	3.8	8	4.5
Acinetobacter spp.	14	11	2	3.8	16	8.9
Citrobacter spp.	6	4.7	0	0	6	3.4
E.coli	7	5.5	6	11.5	13	7.3
Enterobacter spp.	10	7.9	5	9.6	15	8.4
Enterococcus spp.	7	5.5	11	21.2	18	10.1
K.pneumoniae	20	15.7	4	7.7	24	13.4
Klebsiella spp.	5	3.9	12	23.1	17	9.5
P.aeruginosa	13	10.2	1	1.9	14	7.8
Pseudomonas spp.	5	3.9	2	3.8	7	3.9
S.aureus	24	18.9	6	11.5	30	16.8
Staphylococcus spp.	4	3.1	0	0	4	2.2
Stenotrophomona spp.	3	2.4	1	1.9	4	2.2
Streptococcus spp.	3	2.4	0	0	3	1.7
Sum	127	70.9	52	29.1	179	100

Table 2: Frequency of etiological agents associated with infections in pediatric and adult ICUs patients at HCM in 2017.

In the Pediatrics ICU, the most prevalent microorganism (>10%) was *Staphylococcus Aureus* with 18.9%, *Klebsiella pneumoniae* (15.7%) and *Acinetobacter spp.* (11%). The species of *Stenotrophomona spp.* and *Streptococcus spp.* were the least predominant with only 2.4% each.

Microorganisms	Type of ICU							
	Pediatrics		Adults		Sum		Z Test	
	n	%	n	%	n	%	Z	P-value
A.baumanni	3	4.4	2	10	5	5.7	0.949	0.3426
Acinetobacter spp.	7	10.3	0	0	7	8		
Citrobacter spp.	4	5.9	0	0	4	4.5		
E.coli	5	7.4	1	5	6	6.8	0.367	0.7136
Enterobacter spp.	7	10.3	1	5	8	9.1	0.724	0.4691
Enterococcus spp.	3	4.4	4	20	7	8	2.2647	0.0235
K.pneumoniae	14	20.6	1	5	15	17	1.6297	0.1032
Klebsiella spp.	4	5.9	4	20	8	9.1	1.9306	0.0535
P.aeruginosa	4	5.9	0	0	4	4.5		
Pseudomonas spp.	2	2.9	0	0	2	2.3		
S.aureus	11	16.2	6	30	17	19.3	1.3765	0.1687
Staphylococcus spp.	1	1.5	0	0	1	1.1		
Stenotrophomona spp.	2	2.9	1	5	3	3.4	0.3278	0.6556
Streptococcus spp.	1	1.5	0	0	1	1.1		
Sum	68	77.3	20	22.7	88	100		

Table 3: Microorganisms isolated from blood cultures in pediatric patients and adults from HCM ICUs in 2017.

In the Adults ICU, the microorganisms *Klebsiella spp.* (23.1%), *Enterococcus spp.* (21.2%), *Escherichia coli* and *Staphylococcus aureus* (11.5%) were prevalent in more than 10%. With lower prevalence *Pseudomonas aeruginosa* and *Stenotrophomona spp.* with 1.9% each were observed.

Table 3 shows that of the 88 blood cultures performed, 19 (21.6%) are gram-positive and 69 (78.4%) gram-negative cocci. Of the gram-positive bacteria the most prevalent was *Staphylococcus aureus,* while for gram-negative *Klebsiella pneumoniae* prevailed. There was a significant difference between the proportions of *Enterococcus species* of pediatric and adult patients (p=0.0235).

In urocultures, *Enterococcus spp.* and *Escherichia coli* were the most isolated with 29.4% and 14.7% respectively (Table 4).

According to Table 5, in isolated samples of pus, the most prevalent bacterium was *Pseudomonas aeruginosa* with 24.3%. In adults only *Enterobacter* and *Enterococcus species* were identified. There was a significant difference between the proportion of *Enterobacter spp.* in adult and pediatric patients (p=0.0001). In isolates from the catheter tip, 3 samples of *Staphylococcus aureus*, 2 of *Klebsiella spp.*, and 1 of *Acinetobacter spp.*, *Klebsiella pneumoniae* and *Pseudomonas spp.* were recorded. In the isolated samples of sputum, the most prevalent bacterium was *Klebsiella spp.* (2), *Pseudomonas spp.*, *Klebsiella pneumoniae* and *Enterobacter spp.* with only 1 sample.

Microorganisms	Type of ICU							
	Pediatrics		Adults		Sum		Z Teste	
	n	%	n	%	N	%	Z	P-value
A.baumanni	1	6.3	0	0	1	2.9		
Acinetobacter spp.	0	0	1	6.3	1	2.9		
Citrobacter spp.	1	6.3	0	0	1	2.9		
E.coli	1	6.3	4	25	5	14.7	1.3126	0.1893
Enterobacter spp.	2	12.5	1	6.3	3	8.8	0.7126	0.4761
Enterococcus spp.	4	25	6	37.5	10	29.4	0.5323	0.5945
K.pneumoniae	2	12.5	1	6.3	3	8.8	0.7126	0.4761
Klebsiella spp.	0	0	4	25	4	11.8		
P.aeruginosa	0	0	1	6.3	1	2.9		
S.aureus	3	18.8	0	0	3	8.8		
Staphylococcus spp.	2	12.5	0	0	2	5.9		
Sum	16	47.1	18	52.9	34	100		

Table 4: Microorganisms isolated in urine samples in pediatric patients and adults from the HCM ICUs in the year 2017.

Microorganisms	Type of ICU							
	Pediatrics		Adults		Sum		Z Teste	
	n	%	n	%	N	%	Z	P-value
A.baumanni	1	2.9	0	0	1	2.7		
Acinetobacter spp.	6	17.6	0	0	6	16.2		
Citrobacter spp.	1	2.9	0	0	1	2.7		
E.coli	1	2.9	0	0	1	2.7		
Enterobacter spp.	1	2.9	2	66.7	3	8.1	3.8763	0.0001
Enterococcus spp.	0	0	1	33.3	1	2.7		
K.pneumoniae	3	8.8	0	0	3	8.1		
Klebsiella spp.	1	2.9	0	0	1	2.7		

P.aeruginosa	9	26.5	0	0	9	24.3		
Pseudomonas spp.	3	8.8	0	0	3	8.1		
S.aureus	6	17.6	0	0	6	16.2		
Staphylococcus spp.	1	2.9	0	0	1	2.7		
Stenotrophomona spp.	1	2.9	0	0	1	2.7		
Sum	34	91.9	3	8.1	37	100		

Table 5: Microorganisms isolated in the samples of pus in pediatric patients and adults in HCM ICUs in the year 2017.

In CSF isolates, 2 strains of *Streptococcus spp.* and 1 of *Staphylococcus aureus* were recorded. In samples of pharyngeal exudate, 1 *Escherichia Coli* and 1 *Klebsiella pneumoniae* were identified. In the faeces samples only 1 *Acinetobacter baumanni* and 1 *Acinetobacter spp.* were recorded.

Discussion

Most of the bacteria identified in this study are of the Gram-negative genus with 79.3% (142) against the Gram-positive 20.7% (37) and fungal infections were not identified. A study on the prevalence and clinical outcomes of infections in Brazilian ICUs in 2012 found that gram-negative bacteria were more prevalent with a percentage of 72%, corroborating with findings in this study [9]. This data shows that gram-negative bacteria are the most common cause of infections in ICUs in our hospital.

The most frequent bacterium was *Staphylococcus aureus* with 16.8% (30), followed by *Klebsiella pneumoniae* with 13.4% (24), *Enterococcus spp.* with 10.1% (18), *Klebsiella spp.* with 9.5% (17), *Acinetobacter spp.* with 8.9% (16), *Enterobacter spp.* with 8.4% (15), *Pseudomonas aeruginosa* 7.8% (14), *Escherichia coli* 7.3% (13), *Acinectobater baumanni* 4.5% (8) and *Pseudomonas spp.* 3.9% (7). A retrospective study conducted in Gabon on "Profile analysis of antimicrobial resistance" identified Staphylococcus aureus as the most common bacterium with 23.1%, followed by *Klebsiella pneumoniae* with 22.3% [10]. Barros et al. [11], in a similar study identified *Pseudomonas aeruginosa* as the most isolated bacteria followed by *Staphylococcus Aureus*. Another study conducted in sub-Saharan Africa and in low-income Asian countries on "antimicrobial susceptibility of bacterial isolates from community-acquired infections" identified the highest prevalence in *Staphylococcus species* [12].

About one-third of the population has *Staphylococcus aureus* as part of the transient flora of the skin constituting an important source of infection for the individual or for others and, is considered the main etiological agent of nosocomial and community infections [13].

In the present study, *Staphylococcus aureus* was more frequent in blood samples with a percentage of 57%. Meneses et al. [14], in a study performed in the ICU of a General Hospital in Fortaleza identified Staphylococcus aureus as the most prevalent in blood cultures.

Pseudomonas aeruginosa was more prevalent in the Pediatrics ICU, mostly isolated in pus samples. Infections caused by this species of Pseudomonas usually are of hospital origin and in Brazil during the last four decades the incidence by *Pseudomonas aeruginosa* was responsible for 10% of all nosocomial infections [15]. According to Christopher et al. [16], the causes are associated with pneumonia due to chronic lung disease, mechanical ventilation longer than eight days, tracheotomy and previous use of antibiotics.

Escherichia coli was more frequent in patients from the Pediatrics ICU, mostly isolated in urine samples. This microorganism is described as the main cause of urinary tract infection and is the most common hospital infection in children, mainly females, due to the shorter length of the ureter compared to boys [17]. Rappelli et al. [18] E Mandomando et al. [19] identified 68.4% and 22.6% of strains of *Escherichia coli* in children under 7 years of age in faeces isolates.

Citrobacter spp. samples were identified in patients from the Pediatrics ICU, with a higher prevalence in blood samples. The results of these studies are differentiated by several studies related to *Citrobacter species*, where urine is described as the most isolated culture [20].

The species of *Stenotrophomona* were isolated in samples of urine, secretions and blood. In a similar study, species of *Stenotrophomona* were identified in blood isolates, catheter tips and pus [21].

Conclusions

The epidemiological surveillance, standard precautions, isolation measures, adequate materials and equipment, hygiene of the environment, training of the multi-professional team, implementation of control measures are important and determinant factors that may interfere in the results with a reduction in the prevalence rates of hospital infection.

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