



CATHETER-ASSOCIATED URINARY TRACT INFECTION: ANTIMICROBIAL SENSITIVITY PROFILE*

INFECÇÃO DO TRATO URINÁRIO RELACIONADA AO CATETER: PERFIL DE SENSIBILIDADE ANTIMICROBIANA

INFECCIÓN DE TRACTO URINARIO RELACIONADA A CATETER: PERFIL DE SENSIBILIDAD ANTIMICROBIANA

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This descriptive quantitative study aimed to analyze the prevalence of microorganisms and the antimicrobial sensitivity profile from urine cultures of patients with catheter-associated urinary tract infection. We reviewed 394 medical records of adults hospitalized in the Intensive Care Units of the University Hospital of Londrina, Paraná, Brazil, from April to December 2011. The prevalence of catheter-associated urinary tract infection was of 34.0% (134) and 2.2% (3) of these patients developed sepsis. The most common microorganisms found in the urine cultures were *Candida* sp (44.4%), *Acinetobacter baumannii* (9.7%) and *Pseudomonas aeruginosa* (9.2%). This last one showed resistance of 86.7% to third-generation cephalosporins and the *Acinetobacter baumannii* showed resistance of 83.3% to carbapenems. *Klebsiella pneumoniae* had 87.5% of resistance to third and fourth generation cephalosporins and 75.0% to carbapenems. We concluded that bacterial resistance is frequent in catheter-associated urinary tract infection and that we should emphasize the control measures.

Descriptors: Urinary Tract Infections; Catheter-Related Infections; Intensive Care Units; Drug Resistance, Microbial.

Estudo descritivo, quantitativo, que objetivou analisar a prevalência de microrganismos e perfil de sensibilidade aos antimicrobianos em uroculturas de pacientes com infecção do trato urinário relacionada ao cateter. Foram revisados 394 prontuários de pacientes adultos internados nas Unidades de Terapia Intensiva do Hospital Universitário de Londrina-PR, Brasil, no período de abril a dezembro de 2011. A prevalência de infecção do trato urinário relacionada ao cateter foi de 34,0%(134) e 2,2%(3) desenvolveram sepse. Os microrganismos mais isolados nas uroculturas foram: *Candida* sp (44,4%), *Acinetobacter baumannii* (9,7%) e *Pseudomonas aeruginosa* (9,2%). Esta última apresentou 86,7% de resistência às cefalosporinas de terceira geração e o *Acinetobacter baumannii* 83,3% aos carbapenêmicos. A *Klebsiella pneumoniae* apresentou 87,5% de resistência às cefalosporinas de terceira e quarta geração e 75,0% aos carbapenêmicos. Conclui-se que a resistência bacteriana é frequente nas infecções do trato urinário relacionada ao cateter e medidas de controle devem ser ressaltadas.

Descritores: Infecções Urinárias; Infecções Relacionadas a Cateter; Unidades de Terapia Intensiva; Resistência Microbiana a Medicamentos.

Estudio descriptivo, cuantitativo, cuyo objetivo fue analizar la prevalencia de microorganismos y perfil de sensibilidad a antimicrobianos en uroculturas de pacientes con infección del tracto urinario relacionada al catéter. Se investigaron 394 registros médicos de pacientes adultos en Unidad de Cuidados Intensivos del Hospital Universitario de Londrina-Paraná, Brasil, de abril a diciembre de 2011. La prevalencia de infección de tracto urinario relacionada al catéter fue 34,0% (134) y 2,2% (3) desarrollaron sepsis. Los microorganismos más comunes aislados en los cultivos de orina fueron: *Candida* sp (44,4%), *Acinetobacter baumannii* (9,7%) y *Pseudomonas aeruginosa* (9,2%). La última representó 86,7% de resistencia a cefalosporinas de tercera generación y *Acinetobacter baumannii* 83,3% a los carbapenémicos. La *Klebsiella pneumoniae* presentó 87,5% de resistencia a cefalosporinas de tercera y cuarta generación y 75,0% a carbapenémicos. La resistencia bacteriana es frecuente en infecciones del tracto urinario relacionadas al catéter, y las medidas de control deben ser ressaltadas.

Descritores: Infecciones Urinarias; Infecciones Relacionadas con Catéteres; Unidades de Cuidados Intensivos; Farmacorresistencia Microbiana.

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INTRODUCTION

Among healthcare-associated infections (HAI), the urinary tract infection (UTI) stands out due to the increasing number of antimicrobial resistant strains of microorganisms, especially in patients admitted to intensive care units (ICU).

UTI consists of the invasion of microorganisms in any structure of the urinary tract and accounts for approximately 30.0% of nosocomial infections⁽¹⁾. The presence of urethral catheters contributes to the development of UTI, given the modifications of the inflammatory response, with suppression of the innate defense mechanisms of the urethral mucosa in addition to the microbial adherence to the catheter material⁽²⁾.

Catheter-associated urinary tract infection (CAUTI) is complicated because it involves more than one species of microorganism, which are able to develop antimicrobial resistance⁽³⁻⁴⁾. When this occurs, it compromises the conventional therapy, resulting in healthcare risk to the patient, including increased length of hospital stay and increased costs for the high-level antimicrobial treatment⁽⁵⁾.

Antimicrobial resistance represents an important public health problem, especially in hospital environments, and despite the vast knowledge of the scientific community on this issue, it continues to appear, particularly in ICUs⁽⁶⁻⁸⁾.

Antimicrobials are one of the most used drugs worldwide. However, their use often speeds up the selection of resistant microorganisms, which uses different mechanisms to evade antimicrobials. Among these mechanisms, we have the beta-lactamase production that degrades the beta-lactam ring; genetic mutations to produce new targets; modification of metabolic pathways to prevent the antimicrobial activity; modification of the cell walls to produce porins that prevent drug penetration; and developing the ability to pump antibiotics out of the cell by efflux mechanisms. The dissemination of resistance genes among bacteria can occur through the transfer of genetic material among the microorganisms⁽⁹⁾.

Patients hospitalized in ICUs are at high risk for CAUTI caused by resistant bacteria, since many present changes in their immune system, receive a lot of drugs, including antibiotics, and are often exposed to a wide range of invasive procedures, including bladder catheterization^(6,10). Factors related to this procedure may favor the onset of UTI: lack of professional training for the correct performance of the technique, inappropriate calibration of the catheter, failure to use aseptic technique when handling the circuit, improper use of collectors, among others.

A study conducted with 148 patients to evaluate predisposing factors of UTI in ICU patients with indwelling catheter, regarding its maintenance, concluded that most of the indicators reached almost all the observations (correct positioning of the collection bag, closed drainage system, clear urine flow, and urine volume below two-thirds of the collection bag). Nonetheless, the indicator related to the correct fixing of the probe was not identified in 93.0% of cases, which puts patients at risk of developing UTI⁽¹¹⁾.

Considering the complexity of the care of ICU patients with indwelling catheter, and that this invasive procedure contributes to UTI through antimicrobial resistant microorganisms, this study aimed to analyze the prevalence of isolated microorganisms and the antimicrobial sensitivity profile in urine cultures from patients with catheter-associated urinary tract infection.

METHOD

This is a descriptive quantitative study conducted in three intensive care units at the University Hospital of Londrina, in Londrina, Paraná, Brazil.

The sample was composed of the medical records of all patients with indwelling catheters admitted to the Adult Intensive Care Unit (AICU) and the Burn Intensive Care Unit (BICU) of the Burn Treatment Center (BTC) of this institution, totaling 394 medical records. The AICU has 17 beds distributed in two units: ICU-1, for medical or surgical patients, and ICU-2, for patients with

infection and increased length of stay. The BTC comprises the third ICU of the study (BICU), with six beds available for the care of adult and pediatric patients of this specialty.

The researcher, through secondary sources, daily monitored the patients during the period of ICU hospitalization until removal of the indwelling catheter in the unit itself or in inpatient units. In the medical records, we evaluated the medical and nursing outcomes, records of examinations, notes from the nursing staff, and notifications from the Commission on Hospital Infection Control (CHIC).

For data collection, we used an instrument containing the following variables: presence of CAUTI, performance of urinalysis and urine culture, microorganisms present in urine cultures, antibiogram, and classification regarding multidrug resistance. We analyzed the urine culture results according to the criteria of the Centers for Disease Control and Prevention (CDC)⁽¹⁾ for UTI. First criterion: patient with urinary catheter at the time of urine culture collection associated with fever and urine culture with $\geq 10^5$ CFU/mL with no more than two species of microorganisms. And second criterion: patient with urinary catheter at the time of urine culture collection associated with fever and urine culture with $\geq 10^3$ and $< 10^5$ CFU/mL with no more than two species of microorganisms.

We traced the resistance profile according to the antibiogram, following the recommendations of the Clinical and Laboratory Standards Institute (CLSI)⁽¹²⁾. We classified as multiresistant (MR), according to CDC criteria^(7,13-14): *Acinetobacter baumannii* and *Pseudomonas* sp resistant to carbapenem; *Klebsiella*

pneumoniae and *Escherichia coli* resistant to carbapenem or cephalosporins (third or fourth generation); *Enterobacter* sp, other enterobacteria and *Serratia* sp resistant to carbapenem or cephalosporin (fourth generation); and *Enterococcus* sp resistant to vancomycin. We considered *Burkholderia cepacia* as MR due to intrinsic resistance to many antibiotics.

Data collection happened from April 14 to December 21, 2011, and the data analysis occurred through the Statistical Package for Social Sciences (SPSS) version 19.0. Categorical variables underwent simple and relative frequencies analysis, and we presented the results descriptively in tables.

The researcher, as the trustee, signed the Confidentiality Agreement. The Research Ethics Committee of the Universidade Estadual de Londrina, under CAAE No. 0271.0.268.000-10, approved the study.

RESULTS

During the period of data collection, 394 patients used indwelling catheter in the ICUs in study, distributed among ICU-1 (318), ICU-2 (25), and BICU (51). There were 277 urine cultures performed, with 77.3% of patients of the ICU-1, 6.1% of ICU-2, and 16.6% of BICU. We observed a 34.0% (134) rate of CAUTI.

Table 1 presents the frequency and percentage of patients with CAUTI and the isolated microorganisms according to each ICU. Some patients had more than one test with positive result, and in some cases, even two microorganisms were isolated in the same urine culture.

Table 1 - Frequency and percentage of patients with CAUTI and microorganisms isolated in urine cultures, according to the ICUs of a university hospital. Londrina, PR, Brazil, 2012

ICU	ICU-1		ICU-2		BICU		Total	
	n	%	n	%	n	%	n	%
Patients with CAUTI	95	29.9	13	52.0	26	51.0	134	34.0
Microorganisms								
Fungi	69	50.4	11	52.4	15	39.5	95	48.4
<i>Candida</i> sp	66	48.2	11	52.4	10	26.3	87	44.4
<i>Geotrichum</i> sp	1	0.7	-	-	2	5.3	03	1.5
<i>Trichosporum</i> sp	2	1.4	-	-	3	7.9	05	2.5
Gram-negative bacteria	57	41.6	10	47.6	18	47.4	85	43.4
<i>Acinetobacter baumannii</i>	9	6.6	2	9.5	8	21.1	19	9.7
<i>Burkholderia cepacia</i>	1	0.7	-	-	-	-	01	0.5
<i>Enterobacter</i> sp	4	2.9	-	-	3	7.9	07	3.6
<i>Escherichia coli</i>	10	7.3	-	-	1	2.6	11	5.6
<i>Klebsiella pneumoniae</i>	10	7.3	-	-	2	5.3	12	6.1
<i>Morganella morganii</i>	2	1.5	-	-	-	-	02	1.0
<i>Proteus mirabilis</i>	6	4.4	-	-	1	2.6	07	3.6
<i>Providencia stuartii</i>	3	2.2	3	14.3	-	-	06	3.1
<i>Pseudomonas aeruginosa</i>	11	8.0	5	23.8	2	5.3	18	9.2
<i>Serratia marcescens</i>	1	0.7	-	-	1	2.6	02	1.0
Gram-positive bacteria	11	8.0	-	-	5	13.1	16	8.2
<i>Enterococcus</i> sp	6	4.4	-	-	5	13.1	11	5.6
<i>Staphylococcus</i> sp	4	2.9	-	-	-	-	04	2.1
<i>Streptococcus agalactiae</i>	1	0.7	-	-	-	-	01	0.5
Total	137	100.0	21	100.0	38	100.0	196	100.0

Table 1 shows that CAUTI ranged from 29.9% in ICU-1, and 51.0% in BICU, to 52.0% in ICU-2. Fungi (48.4%) and Gram-negative bacteria (43.4%) were the most common microorganisms isolated in urine cultures. Among the species, we highlight the *Candida* sp (44.4%), *Acinetobacter baumannii* (9.7%) and *Pseudomonas aeruginosa* (9.2%), with some variations according to type of ICU.

Table 2 presents the most prescribed antimicrobials, considering their modifications according to changes in the patient's condition, as well as the antibiograms.

Table 2 - Frequency and percentage of patients with indwelling catheter admitted to the ICUs of a university hospital, according to the onset of CAUTI and the antimicrobials prescribed. Londrina, PR, Brazil, 2012

Antimicrobials prescribed	CAUTI			
	Yes		No	
	n	%	n	%
Antifungal				
Caspofungin acetate	11	78.6	3	21.4
Amphotericin	14	82.4	3	17.6
Fluconazole	46	85.2	8	14.8
Antibacterial				
Amikacin	25	62.5	15	37.5
Ampicillin	5	33.3	10	66.7
Cephalothin	2	9.1	20	90.9
Ceftriaxone	6	15.0	34	85.0
Ciprofloxacin	9	42.9	12	57.1
Clindamycin	7	23.3	23	76.7
Colistin	65	59.6	44	40.4
Gentamicin	4	17.4	19	82.6
Imipenem	56	54.9	46	45.1
Linezolid	45	52.9	40	47.1
Piperacillin-tazobactam	67	46.2	78	53.8
Meropenem	40	51.9	37	48.1
Teicoplanin	17	48.6	18	51.4
Tigecycline	25	71.4	10	28.6
Vancomycin	76	48.1	82	51.9
Antibacterial/Antiparasital				
Metronidazole	9	40.9	13	59.1

In Table 2, we verify that the most prescribed antimicrobials for patients with indwelling catheter were vancomycin (158), piperacillin-tazobactam (145), colistin (109), and imipenem (102). The most prescribed antifungal drugs for patients with CAUTI were fluconazole (85.2%), amphotericin (82.4%), and caspofungin acetate (78.6%). Of all the antimicrobial

prescribed, in most cases, for patients with CAUTI, we emphasize tigecycline (71.4%), amikacin (62.5%), colistin (59.6%), and imipenem (54.9%).

Of the 134 patients with CAUTI, 50 (37.3%) presented antibiogram for the isolated bacteria in urine, totaling 61 isolated pathogens, whose sensitivity profile is shown in Table 3.

Table 3 - Frequency and percentage of antimicrobial resistance to isolated pathogens (n=61) in patients with CAUTI hospitalized in intensive care units of a university hospital. Londrina, PR, Brazil, 2012

Antimicrobial pathogen	Number of isolated pathogens	Number (%) of resistant pathogens
<i>Acinetobacter baumannii</i>	12	
Imipenem/Meropenem		10 (83.3)
<i>Burkholderia cepacia</i>	1	
Imipenem/Meropenem		---
Cefepime		---
<i>Enterococcus faecalis</i>	6	
Vancomycin		---
Ampicillin		---
<i>Enterococcus faecium</i>	1	
Vancomycin		1 (100.0)
Ampicillin		1 (100.0)
<i>Escherichia coli</i>	6	
Imipenem/Meropenem		---
Cefepime		2 (33.3)
Ceftriaxone/Piperacillin-tazobactam		---
Ciprofloxacin/Levofloxacin/Norfloxacin		3 (50.0)
<i>Klebsiella pneumoniae</i>	8	
Imipenem/Meropenem		6 (75.0)
Ceftazidime/Cefotaxime/Ceftriaxone		7 (87.5)
Cefepime		7 (87.5)
Aztreonam		7 (87.5)
<i>Pseudomonas aeruginosa</i>	15	
Imipenem/Meropenem		9 (60.0)
Ceftazidime/Cefotaxime/Ceftriaxone		13 (86.7)
Cefepime		10 (66.7)
Aztreonam		12 (80.0)
Ciprofloxacin/Levofloxacin/Norfloxacin		9 (60.0)
Piperacillin-tazobactam		5 (33.3)
Amikacin		9 (60.0)
<i>Serratia marcescens</i>	1	
Imipenem/Meropenem		---
Cefepime		1(100.0)
Other enterobacteria ¹	11	
Imipenem/Meropenem		3 (27.3)
Ceftazidime/Cefotaxime/Ceftriaxone		10 (90.9)
Cefepime		8 (72.7)

¹*Enterobacter cloacae*, *Morganella morganii*, *Proteus mirabilis*, and *Providencia stuartii*

Among the 61 pathogens isolated, 55 (90.2%) were resistant to the choice of antimicrobial therapy, with 43 (70.5%) classified as MR.

Table 3 reveals that the most frequently pathogens shown in antibiograms were *P. aeruginosa*

(15), *A. baumannii* (12), *K. pneumoniae* (8), and *E. coli* (6).

P. aeruginosa presented 86.7% resistance to third-generation cephalosporins and 80.0% to aztreonam (beta-lactam). *A. baumannii* had 83.3%

resistance to carbapenems (imipenem/meropenem). *K. pneumoniae* showed 87.5% resistance to cephalosporins of third and fourth generation, the same result of resistance to beta-lactam antibiotic (aztreonam), and 75.0% to carbapenems. *E. coli* had 50.0% resistance to quinolones and 33.3% to fourth-generation cephalosporins. We also observed that, the group designated as "other enterobacteria" presented 90.9% resistance to third-generation cephalosporins and 72.7% to fourth-generation cephalosporin. The pathogen *E. faecium*, found in only one urine culture, showed antibiogram resistance to glycopeptides (vancomycin) and to beta-lactam antibiotic (ampicillin). The *S. marcescens* pathogen, present in one urine culture, showed resistance to fourth-generation cephalosporin.

Among the 134 patients with CAUTI, 3 (2.2%) had a diagnosis of sepsis from urinary and lung infection, all classified as MR, of which two of them died.

DISCUSSION

We monitored 394 patients with indwelling catheter during the period of this study, identifying a CAUTI rate of 34.0%. This result is similar to that found in a research conducted at a teaching hospital of Belo Horizonte-MG, Brazil, which evaluated 1,886 patients in an ICU, identifying that 20.3% (383) developed HAI, and that the urinary tract was the most common site of infection, affecting 37.6% (144) of the patients⁽¹⁵⁾. We observed a lower CAUTI rate in a multicenter international study involving 1,235 Brazilian patients from 90 ICUs in the country. As for the site of infection, 71.2% of infected patients had pneumonia and 16.6% had CAUTI⁽¹⁶⁾.

As expected, the CAUTI rate was lower among patients in the ICU-1 (29.9%), unlike the ICUs of longer permanence: ICU-2 (52.0%) and BICU (51.0%). They treat, respectively, chronic and burn patients at higher risk for healthcare infections.

Among the most common microorganisms isolated in this study, we highlight the fungi, with a predominance of *Candida* sp in all ICUs (Table 1).

The presence of fungi in the urine of hospitalized patients is relatively frequent, ranging from asymptomatic colonization to cystitis, pyelonephritis, and even to sepsis⁽¹⁷⁾. A study conducted with 294 ICU patients from a Greek university hospital showed that the pathogen most frequently isolated in cases of CAUTI was *Candida* sp (66.7%)⁽¹⁸⁾.

Among bacteria, the highlights were *P. aeruginosa* (8.0%), *K. pneumoniae* (7.3%), and *E. coli* (7.3%) in ICU-1; *P. aeruginosa* (23.8%) in ICU-2; and *A. baumannii* (21.1%) in BICU, revealing the prevalence of Gram-negative bacteria in these sectors.

A U.S. multicenter study of the National Healthcare Safety Network (NHSN), involving 2,039 hospitals, showed that the most common microorganisms isolated from patients with CAUTI were *E. coli* (26.8%), *P. aeruginosa* (11.3%), *Klebsiella* sp (11.2%), and *Candida* sp (12.7%)⁽¹⁴⁾, thereby constituting a high frequency of Gram-negative bacteria. Comparing the occurrence of fungal infections, we detected a much lower percentage of *Candida* sp in the abovementioned study⁽¹⁴⁾, especially when compared to ICU-1 (48.2%) and ICU-2 (52.4%), where there is a widespread use of antibacterial, favoring the selection of fungi.

In Table 1, we also identify the *Enterococcus* sp among the most isolated Gram-positive bacteria in urine cultures (5.6%), a percentage lower than that found in the U.S. multicenter study, with 14.9%⁽⁷⁾ and 10.3%⁽¹⁴⁾. Nevertheless, when comparing these percentages in the different ICUs, there is similarity to BICU, in which 13.1% of urine cultures presented this microorganism.

In the present study, we detected a high percentage of patients with CAUTI who received 1-4 (49.3%) and 5-8 (41.8%) antimicrobials during hospitalization, which may indicate other infections

associated with and/or the readjustment of these drugs to the sensitivity test results in one or more sites of infection.

Table 2 shows the most frequently prescribed antimicrobials for patients with indwelling catheter, especially vancomycin, piperacillin-tazobactam, colistin, and imipenem. However, some drugs were prescribed more often in cases with CAUTI, confirming the high prevalence of fungi in urine cultures, such as fluconazole, amphotericin B, and caspofungin acetate. For bacterial infections in these patients, we highlight tigecycline, amikacin, colistin, and carbapenems.

Analyzing a study with 139 critically ill patients from the Clinical Hospital of Uberlândia-MG, Brazil, that assessed the antimicrobial resistance phenotypes, we observed that 75.0% (90) of patients received two or more kinds of these drugs. The most prescribed antimicrobials were cephalosporins (49.6%), vancomycin (37.4%), and carbapenems (26.6%)⁽⁶⁾.

The most frequent pathogens in the results of antibiograms were *P. aeruginosa*, *A. baumannii*, *K. pneumonia*, and *E. coli* (Table 3).

Among the 61 pathogens evaluated in antibiograms, 90.2% were resistant to the choice of antimicrobial therapy, of which 70.5% were also classified as MR. Given these data, we emphasize the importance that the indwelling catheter, present in the majority of patients admitted to intensive care, should not be seen by the team as something routine. In other studies^(6,15), we observe that CAUTI favors the infection by antimicrobial resistant microorganisms used in the ICU environment. This resistance interferes with the recovery of critically ill patients^(7,19), thus, it is recommended that the indwelling catheter is used only during the time needed for clinical treatment to prevent CAUTI and decrease the incidence of this problem^(3,19).

Observing these antimicrobial resistant microorganisms, we found that *P. aeruginosa* presented 86.7% resistance to third-generation cephalosporins. This result corroborates a Brazilian study that assessed

the antimicrobial resistance phenotypes in 66 urine cultures from patients with CAUTI, in which 83.3% of microorganisms isolated were resistant to this class of drugs⁽⁶⁾. However, it differs from the U.S. study that showed 22.5% of resistance to these drugs in ICU patients with CAUTI⁽¹⁴⁾. Table 3 also shows that the majority of *P. aeruginosa* isolated were resistant to carbapenems (60.0%), a percentage lower than the Brazilian study aforementioned, in which 72.2% were resistant to these antimicrobial drugs⁽⁶⁾.

A. baumannii was resistant to carbapenems in 83.3% of tests, corroborating the findings from the multicenter study abovementioned (73.8%)⁽¹⁴⁾.

K. pneumoniae showed 87.5% resistance to third and fourth generation cephalosporins, distinct from the results reported in U.S. studies that showed resistance to third-generation cephalosporin in 21.2%⁽⁷⁾ and 24.6%⁽¹⁴⁾ to fourth-generation. As for the resistance to carbapenems, the current study showed a high frequency (75.0%), different from the aforementioned studies, 10.1%⁽⁷⁾ and 12.4%⁽¹⁴⁾.

As for sepsis, 2.2% of patients with CAUTI had this diagnosis as a complication originated from urinary or lung infection, of which two patients died.

An international study registered a higher rate for sepsis from urinary infection, indicating a 7.0% rate for a population of 3,877 patients investigated in Germany, in a random sample of 310 hospitals with 454 ICUs⁽¹⁷⁾.

A national research, that analyzed prognostic factors in 152 elderly patients admitted to the ICU with severe sepsis and septic shock, found that 84.0% of these patients had an initial diagnosis of sepsis from pulmonary infection and 32.2% of sepsis from urinary infection⁽²⁰⁾.

Sepsis from urinary infection in adults comprises approximately 25.0% of all cases of sepsis, which can be caused by a complicated UTI, since CAUTI presents a high mortality rate, ranging from 20 to 40%^(3,19).

The rate of sepsis in this study was lower than the information previously presented, which can be the

result of failing to note this information in the medical records, the database of this research.

Given the results identified, we recommend systematic reviews of interventions and propositions of well-structured educational strategies⁽¹¹⁾, as well as the close monitoring of the antimicrobial sensitivity profile, seeking a control and appropriate treatment of CAUTI associated with MR microorganisms.

CONCLUSION

The results of this study showed a high frequency of antimicrobial bacterial resistance in patients with CAUTI in different types of ICU, which can interfere with the successful treatment and patient's prognosis.

Because of multiple invasive procedures performed in the intensive care unit and the use of broad-spectrum antimicrobials, the patients admitted to these units are more vulnerable to infections and selection of MR strains. Thus, the professionals who deliver care to patients with indwelling catheter should follow the recommendations such as appropriate insertion technique, proper handling of the catheter, controlling the length of stay, as well as participation in continuing education programs, and training of clinical staff in order to prevent urinary infection and dissemination of MR microorganisms.

COLLABORATIONS

Barros SKSA participated in the design, data collection, analysis, and interpretation, drafting and final approval of the version to be published. Kerbauy G participated in the analysis, interpretation of data, drafting and final approval of the version to be published. Dessunti EM participated in the design, analysis, interpretation of data, drafting and final approval of the version to be published.

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