ORIGINAL ARTICLE

URINARY INFECTION RATE ASSOCIATED WITH INDWELLING BLADDER CATHETERS IN INTENSIVE CARE UNITS

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Highlight: (1) Prolonged use of an indwelling urinary catheter (IUC) increases the risk of urinary tract infection (UTI) in hospitalized patients, especially in the ICU. (2) The importance of limiting the duration of IUC use, adopting preventive measures, and considering infectious agents such as Candida spp. (3) Pseudomonas aeruginosa is highlighted. Further research is recommended to improve prevention and treatment strategies for IUC-associated UTI.

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URINARY INFECTION RATE ASSOCIATED WITH INDWELLING BLADDER CATHETERS IN INTENSIVE CARE UNITS

ABSTRACT

Objective: To identify the infection rate related to the use of indwelling urinary catheters in patients admitted to intensive care units. **Method**: A cross-sectional, retrospective study was conducted at a public referral hospital in the metropolitan region of Pernambuco. Data were analyzed using SPSS software, version 26, and descriptive analyses were generated with mean, minimum, maximum, and standard deviation values. The data collected included demographics, age, and sex; clinical information; indwelling urinary catheter insertion; duration; urinary tract infection diagnosis; antimicrobial use; microorganisms; and outcome, which included discharge, transfer, or death. **Results:** A total of 192 notification forms were evaluated, of which 71.88% used indwelling urinary catheters for more than 10 days, with a maximum duration of 106 days. During hospitalization, 120 patients were suspected of having urinary tract infections and underwent urine culture tests. A total of 61 patients (31.77%) were diagnosed with infections related to indwelling urinary catheters. The most common etiological agent found in laboratory analyses was *Candida* spp., followed by *Pseudomonas aeruginosa.* **Conclusion:** The results indicate a high frequency of infections related to indwelling urinary catheters in patients admitted to the ICU, making it important to implement preventive measures.

Keywords: Urinary Infection. Prevention. Infection Control. Indwelling Catheter.

INTRODUCTION

Healthcare-associated infection (HAI) occurs when a patient acquires an infection after being admitted to a hospital or undergoing a healthcare procedure. HAIs may be closely related to these events and are characterized by: if the microorganism causing the infection has an unknown incubation period and there is no clinical or laboratory evidence of infection at the time of admission, any clinical manifestation of infection occurring after the third day of hospitalization (D3) is considered an HAI, with D1 being the first day of hospitalization([6])

Patient safety in the hospital environment is one of the key attributes for ensuring quality of care, which involves concern for infection prevention and control and risk reduction.

Negative outcomes of these actions can contribute to higher morbidity and mortality rates, as well as substantial costs to the healthcare system, such as the Unified Health System (SUS)([1-3]).

The use of invasive devices, such as indwelling urinary catheters (IUCs), is associated with HAIs in patients, especially those admitted to the intensive care unit (ICU). Several factors, such as inadequate clinical conditions of the patient, can influence this association. These infections can negatively affect the urinary system, compromising its physiological function and impacting organs such as the urethra, bladder, ureters, and kidneys. Therefore, these invasive devices represent a factor that predisposes to the onset of infections([2]).

Although they can be largely prevented, hospital infections pose a risk to hospitalized patients. It is crucial to maintain aseptic techniques during the catheterization procedure to avoid maximizing the risk of infection. Considering that catheterization is an invasive and sterile technique, the insertion of a catheter through the urethra can considerably increase the likelihood of developing a urinary tract infection (UTI)([4,5]).

UTI monitoring linked to the use of CVDs has been carried out by the Brazilian Health Regulatory Agency (ANVISA) since 2017, which has established as a priority the registration in hospitals with ICU beds, so that the incidence of this HAI can be described. After consolidating this data, ANVISA reported that, in 2019, the incidence density of urinary tract infection associated with UTI-CVD was 3.6 cases per 1,000 patients with CVD-day([2]).

The prevention and control of HAIs is a legal obligation for hospitals, as defined in Law 9.431/1997 and Ordinance 2.616/1998. For this regulation to be effective, it is necessary to identify weaknesses in this care practice so that targeted interventions can be carried out and professionals can be made aware of the regular practice of indicating, using, keeping, managing, and maintaining CVD([6]).

The increasing infection rate indicates the need for research to support the practice of reducing UTI in critically ill patients, justifying the need for this study. The aim is therefore to identify the infection rate due to the use of CVD in patients hospitalized in the ICU and thus promote interventionist health measures to reduce mortality from complications of invasive urinary devices.

METHODS

This is a cross-sectional, retrospective, quantitative study conducted in a public referral hospital in the metropolitan region of Pernambuco, which has 830 beds, exclusively affiliated with the SUS, with 19 beds allocated to the general adult ICU.

Using a semi-structured instrument, demographic data were collected, including information on age and sex, and clinical information, such as treatment specialty at admission, CVD insertion, duration, UTI diagnosis, use of antimicrobials during hospitalization, microorganisms identified in urine cultures, duration of CVD use, and outcome, which included discharge, transfer, or death. The occurrence of UTI was considered the dependent variable.

Data were collected retrospectively from internal infection control forms provided by the Hospital Infection Control Service (SCIH) of the referral hospital. Forms of patients over 18 years of age admitted to the general ICU between July 2021 and July 2022 were selected as participants in this study. Records with insufficient information, those referring to patients who had already been diagnosed with UTI at the time of admission, and those that were not located during data collection were excluded.

To access the internal infection control records, it was necessary to request them through the SCIH department. The records were completed by ICU nurses and updated daily according to the interventions performed on each patient, such as invasive procedures and culture results. After completion, the records were archived and kept available for consultation for approximately one year.

The criteria used to define ITU-CVD were those established by ANVISA[2] and are used by the SCIH of the aforementioned hospital, which consist of: patients who have undergone catheterization for more than 48 hours or after removal of the CVD within 48 hours, who have fever (≥38ºC) and/or suprapubic or lumbar pain, with no other recognized causes, and positive urine culture with a maximum of two species of microorganisms with growth ≥10([5])colony-forming units per mL of urine (CFU/mL)([7]).

The data were organized in Microsoft Excel spreadsheets and analyzed using *Statistical Package for the Social* Sciences® (SPSS) *software*, version 26.0. Quantitative data generated descriptive analyses with mean, minimum, maximum, and standard deviation values.

Additionally, time variables were also presented descriptively with intervals between "up to 7 days," "between 7 and 30 days," and "more than 30 days."

This study was conducted in compliance with the legislation that regulates research involving human subjects, in accordance with Resolution 466/2012 of the National Health Council. The project was approved by the ethics committee under opinion number: 64419122.6.0000.5198.

RESULTS

A total of 192 records of patients who used CVD between July 2021 and July 2022 were analyzed; of these, they used CVD for more than 24 hours. The average time of CVD use was 21 days, with a maximum time of use of 106 days. The patients identified in the records had a mean age of 43.15 years, with a standard deviation of ±18.79. Of the 192 patients, 132 (68.75%) were male and 60 (31.25%) were female, with a predominance of male patients. The age range varied from 18 to 86 years.

Regarding the time elapsed between hospital admission and ICU admission, an average time of 10.48 days was found. When analyzing the duration of CVD use at regular intervals, the results showed that among patients admitted to the ICU, 19.27% (n=37) used the catheter for up to 7 days, 8.85% (n=17) used it for between 7 and 10 days, and 71.88% (n=138) used it for more than 10 days. The results indicate that most patients used the catheter for more than 10 days, with a maximum duration of 106 days.

Regarding clinical history, most patients admitted to the ICU came from the red trauma unit, surgical block, and neurosurgery. Table 1 shows the clinical history of these patients, with 147 (77.08%) having no comorbidities or underlying diseases. Hypertension was identified in 8 (4.17%) patients.

Of the 192 patients, 115 (59.90%) were admitted due to traumatic accidents. Their initial diagnoses included surgical specialties such as general surgery, medical and surgical clinic, neurology, neurosurgery, trauma, and vascular cases. The specialty with the highest number of hospitalizations was neurosurgery (22.40%), followed by neurology (7.81%).

Table 1 - Variables related to clinical history, initial diagnosis, and outcome of patients admitted to the ICU from July 2021 to July 2022.

Variables	n (%)
Clinical History	
Not stated	1(0.5)
HIV*	2(1.0)
Heart disease	1 (0.5)
Cardiovascular	5(2.6)
DM*	2 (1.0)
DM and obesity	1 (0.5)
DM I	1 (0.5)
DM, SAH, and obesity	1 (0.5)
Alcoholic	2 (1.04)
HAS*	8 (4.17)
HAS and DM	6 (3.13)
HAS and COPD*	1 (0.52)
HAS, DM, and HF*	1 (0.52)
HAS, DM, and obesity	1(0.52)
HAS, alcoholism	1(0.52)
HAS, obesity	1(0.52)
Neurological	2(1.04)
Obesity	2(1.04)
Respiratory	2(1.04)
No history	148 (77.08)
Smoker	1 (0.52)
Tumors	2 (1.04)
Initial diagnosis	
General surgery	2(1.04)
Surgical clinic	2(1.04)
Medical clinic	8(4.17)
Not registered	1(0.52)
Neurosurgery	43 (22.40)
Neurology	15 (7.81)
Trauma	115 (59.90)
Vascular	6 (3.13)
Outcome	

Not stated	1 (0.52)
Death	82 (42.71)
Transfer	109 (56.77)

Legend: *HIV= Human immunodeficiency virus, DM=Diabetes Mellitus, SAH= Systemic arterial hypertension, COPD= Chronic obstructive pulmonary disease, HF= Heart failure.
Source: Authors.

During ICU admission, 120 (62.50%) patients had clinical indications for urine culture testing. Of this group, a total of 61 (31.77%) patients were diagnosed with UTI-CVD. Patients using CVD received antimicrobial treatment for infections associated or unrelated to the subject of this study. Of the 192 patients observed, all received antibiotic therapy, with the majority receiving β-lactam agents (150=78.13%), followed by glycopeptides (n=138, 71.88%), aminoglycosides (122=63.54%), and cephalosporins (40=63%). As shown below in Table 2.

Table 2 - Variables related to urine culture and antimicrobials in patients admitted to the ICU from July 2021 to July 2022.

Variables	**Yes**	**No**
	n (%)	**n**
Urine culture	120 (62.50)	72 (37.5)
ITU per CVD*	61 (31.77)	131 (68.23)
Antimicrobials		
B-lactams	150 (78.13)	42 (21.88)
Cephalosporins	78 (40.63)	114 (59.38)
Aminoglycosides	122 (63.54)	70 (36.46)
Polymyxins	64 (33.33)	128 (66.67)
Antifungals	21 (10.94)	171 (89.06)
Glycopeptides	138 (71.88)	54 (28.13)
Quinolones	4 (2.08)	188 (97.92)
Nitroimidazoles	13 (6.77)	179 (93.23)
Oxazolidinones	1 (0.52)	192 (99.48)
Rifamycins	1 (0.52)	192 (99.48)
Antiviral	4 (2.08)	188 (97.92)
Lincosamides	18 (9.38)	174 (90.63)
Macrolides	2 (1.04)	190 (98.96)

Sulfonamides	1 (0.52)	192 (99.48)
Penicillins	8 (4.17)	184 (95.83)

Legend: *CVD= Indwelling urinary catheter,

Source: Authors.

Regarding the etiological agents of UTI-CVC, the following microorganisms were identified in the urine analysis: *Candida* spp. (14.37%), *Pseudomonas aeruginosa* (5.45%), *Klebsiella pneumoniae* (2.97%), *Acinetobacter baumannii* (1.49%), *Enterococcus faecalis* (1.49%), *Escherichia coli* (0.50%), *Proteus* spp. (3.48%), *Providencia* spp. (2.48%), *Serratia marcescens* (0.99%), *Trichosporon asahii* (1.49%). In 65.35% of cases, no pathogens were found in urine culture.

Gram-negative bacteria were the most common causative agents of CVD-UTI, with an incidence of 14.28%, followed by fungi with an incidence of 14.06%. In contrast, Gram-positive bacteria had an incidence of 1.04%.

Table 3 categorizes the identified pathogens associated with the average duration of CVD use. The results revealed an increasing prevalence of Gram-negative bacteria as the duration of CVD use increased. *Acinetobacter baumannii*, a multidrug-resistant bacterium, was found with an average of 18 days of CVD use (standard deviation ± 4; minimum of 15 and maximum of 20 days).

Table 3 - Descriptive analysis of pathogens identified in urine cultures of ICU patients causing UTI, July 2021-July 2022.

	Duration of CVD use in days			
	Average	**Standard deviation**	**Minimum**	**Maximum**
Pathogens				
Acinetobacter baumannii	18	4	15	20
Candida albicans	25	19	5	80
Candida dubliniensis	32	.	32	32
Candida glabrata	26	12	9	38
Candida krusei	6	.	6	6
Candida parapsilosis	7	.	7	7
Candida tropicalis	28	11	15	42
Enterococcus faecalis	22	16	10	33
Escherichia coli	8	.	8	8
Klebsiella pneumoniae	27	15	11	53
Negative	18	13	1	66
Proteus mirabilis	60	39	30	104
Proteus penneri	22	.	22	22
Providencia rettgeri	60	58	19	101
Providencia stuartii	5	.	5	5
Pseudomonas aeruginosa	26	29	6	106
Serratia marcescens	7	1	6	7
Trichosporon asahii	35	37	11	78

Source: Authors.

Table 4 shows the data on UTIs stratified by duration of CVD use, indicating a decrease in the proportion of UTIs among patients who used CVD for up to 7 days compared to those who used it for 7 to 30 days. The "Percentage reduction" column in the table indicates the percentage change in the proportion of UTI cases between these two groups, showing a 154.55% reduction among those who used CVD for up to 7 days compared to those who used CVD between 7 and 30 days, and a 50.00% reduction among those who used CVD for more than 30 days compared to those who used CVD between 7 and 30 days.

The increase in the proportion of UTI cases among patients who used CVD for more than 30 days. The "Percentage increase" column shows the percentage change in the proportion

of UTI cases among those who used CVD for 7 to 30 days and those who used CVD for more than 30 days, indicating a proportional increase of 736.36% in the number of UTI cases.

Table 4- Duration of CVD use associated with CDV-UTI and outcome, percentage reduction and increase, July 2021-July 2022.

		UTI due to CVD	
		No	**Yes**
		n (%)	n (%)
Duration of urinary catheter use	Up to 7 days	28 (21.37)	9 (14.75)
	Between 7 and 30 days	11 (8.40)	6 (9.84)
	More than 30 days	92 (70.23)	46 (75.41)
Percentage reduction between people with CVD of up to 7 days and those who remained in the interval between 7 and 30 days		154.55	50
Percentage increase between those who remained in the range between 7 and 30 days and those who were over 30 days		736.36	666.67

		Outcome	
		Death	**Transfer**
		n (%)	n (%)
Time with CVD	Up to 7 days	18 (21.95)	19 (17.43)
	Between 7 and 30 days	11 (13.41)	6 (5.50)
	More than 30 days	53 (64.63)	84 (77.06)
Percentage reduction between people with CVD of up to 7 days and those who remained in the interval between 7 and 30 days		63.64	216.67
Percentage increase between those who remained in the interval between 7 and 30 days and those who were over 30 days		381.82	1300.00

Source: Authors.

Table 4 also shows patients categorized by duration of CVD, related to the outcome. The percentage reduction in mortality among patients with CVD of up to 7 days compared to those in the 7-30 day range was 63.64%, while the percentage increase in mortality rates among those in the 7-30 day range and those with more than 30 days was 381.82%.

DISCUSSION

The rate of UTI-CVD infection in patients hospitalized in the ICU, identified in 66 (31.77%) patients, emphasizes the importance of UTI prevention and control in the hospital setting. UTI not only causes damage to patients' health, but also increases hospital costs[1-3].

However, the infection rate is still high, and this reality points to the importance of identifying and addressing the possible causes of high infection rates. Studies show that the length of time the catheter remains in the urinary system contributes to the onset of UTI after catheter removal[9] .

Therefore, it is crucial that healthcare staff are adequately trained to implement effective preventive measures and that resources are available to ensure the implementation of effective infection control measures. Authors emphasize that a collective effort by healthcare staff, together with hospital management, is necessary to reduce the rate of infection due to the use of CVDs in patients hospitalized in the ICU. With the implementation of effective infection prevention and control measures, it will be possible to achieve better outcomes for patients, reduce hospital costs, and improve the safety of hospital environments.

Regarding age and gender, the study presented shows a mean age of 43 years and a predominance of males among patients hospitalized in the ICU. Studies highlight that advanced age, male gender, and the presence of comorbidities, as well as prolonged use of CVDs, predispose patients to the emergence of risk factors for the development of CVC-UTI in hospitalized patients[17-18] .

Regarding the use of CVDs for more than 24 hours, studies show that prolonged use of CVDs for more than 24 hours is associated with an increased risk of UTI [and]may lead to additional hospital costs[12-13], as identified in the study, which found a proportional increase of 736.36% in the number of UTI cases when related to the duration of use.

Although the use of CDCs is common in many clinical cases([12)] ,caution should be exercised when deciding to extend their use beyond 24 hours. Studies reinforce that duration is associated with UTI rates. It is therefore understood that increasing the duration of CVD use to 28 days raises the urinary tract infection rate to 100%, which further accentuates the negative prognosis for these patients([16-20)] .

The aforementioned study highlights the high average duration of CVD use identified among patients hospitalized in the ICU, which is approximately 21 days, in addition to prolonged use for more than 10 days. Previous studies also report an increased risk of UTI in hospitalized patients who used CVD for more than 21 days, as identified in a systematic review of the literature([14] ·The literature points out that to prevent and control complications in hospitalized patients, it is necessary to adopt effective measures, one of the most important being limitations on the duration of use of certain devices([15].

Other studies conducted at the national level indicate that urine culture, a test used to diagnose UTI, was positive in 35.1% of patients with CVD. However, an important limitation of these results is that a large proportion of these patients (70.9%) were already using antibiotics before the urine culture, which can hinder bacterial proliferation and result in false-negative results([20] .

In addition, another factor that deserves attention is the inappropriate use of antibiotics, which can occur in relation to the duration, choice, dose, and frequency of treatment. A study conducted in an ICU of a tertiary hospital evaluated antibiotic prescribing patterns and identified inappropriate prescriptions, as well as excessive use of broad-spectrum antibiotics([21-24).Among the most commonly used antibiotics, the highest resistance was observed against beta-lactams, especially in Gram-negative bacteria([25).

The irrational use of antibiotics can lead to the emergence of multidrug-resistant bacteria, increasing the risk of hospital infections. This study discusses how increased antimicrobial resistance in ICUs can make it difficult to treat SARI. In addition, antimicrobial resistance can also affect the effectiveness of empirical therapy, which is initiated in cases of severe infections before the cause is confirmed. This problem is especially concerning in ICUs, where patients are often immunocompromised, making them vulnerable to infections.

The findings of this study are consistent with other studies that also point to frequent antibiotic use in patients with CVD. In fact, in this study, the data indicate that all (100%) patients with CVD were using antibiotics at the time of data collection[23] .

The results of this study indicate that the most frequently identified pathogens were *Candida* spp. (fungi) and *Pseudomonas aeruginosa and Acinetobacter baumannii* (gram-negative bacteria), which is consistent with findings from other studies that point to the

prevalence of gram-negative microorganisms, such as *Kleibsiella pneumoniae* and *Escherichia coli,* being the most common etiological agents of UTI in patients with CVD([25) ·

Other studies corroborate the results of this research, indicating that *Escherichia coli* (68%) and *Klebsiella pneumoniae* (17.6%) are responsible for 86% of all UTI cases, as observed in this study[26]. In addition, another study identified a high frequency of the gram-negative bacterium *Pseudomonas aeruginosa* in urine culture samples, present in 2.7% of cases in a referral hospital([29) ·

The main etiological agents causing urinary tract infection are bacteria[8]. The high frequency of these multidrug-resistant bacteria is a considerable concern. This study presented results similar to those obtained in a study conducted at a Brazilian university hospital, in which multidrug-resistant bacteria were identified, notably *Klebsiella pneumoniae, Escherichia coli, Acinetobacter baumanii, Staphylococcus aureus*, and *Pseudomonas aeruginosa*([27) (·)Other findings identified microorganisms such as *Klebsiella, Proteus, Enterobacter, Citrobacter, and Pseudomonas* as the most prevalent in UTIs(8) ·

However, *Candida* spp. was predominant in 14.37% of cases. A previous study evaluated the prevalence of urinary tract infections caused by *Candida* spp. and concluded that urinary tract candidiasis is a common complication in ICU patients, in which the use of CVDs and antimicrobial treatments are among the risk factors for Candida infection([28) .

Regarding the outcomes of these cases, one study investigated the impact of prolonged use of CVDs in ICU patients, including the effect on mortality. It was found that prolonged use of these invasive catheters is associated with an increase in the mortality rate, results that coincide with the findings of this study. Therefore, frequent use of CVDs may be a significant factor in increased mortality in cases of UTI.

CONCLUSION

Based on the results of this research, we can affirm that the length of time the CVD remains in the urinary tract triggers the onset of signs and symptoms of UTI. It was found that the longer the CVD remains in the patient's urinary tract, the greater the chances of developing this infection. Therefore, it is important to consider the duration of CVD use as a relevant risk factor in the prevention and treatment of CVD-UTI.

Therefore, a high incidence of CVD-UTI was observed in patients admitted to the ICU. The findings demonstrate the need for preventive measures, such as limiting the duration of CVD use and implementing appropriate insertion and maintenance procedures to reduce the risk of infection.

In addition, healthcare professionals should be aware of the potential for infections caused by *Candida* spp. and *Pseudomonas aeruginosa* in patients with prolonged CVD use. By identifying the risk factors associated with CVD-related infections and implementing effective prevention strategies, we can improve the infection rate in patients and reduce the burden of related complications in cases of established UTI.

It is important to highlight the importance, applicability, and recognition of these data in the healthcare field, as this knowledge will bring challenges and goals to be applied in the prevention of CVD-UTI.

Although we have shown that CVD-UTI is often caused by *Candida*, the previous presence of urinary catheters and irrational antimicrobial treatments, it is important to note that there is still much to be explored in this area. Further studies are needed to deepen our understanding of other possible risk factors and their interaction with the development of this technology.

Furthermore, future research may contribute to the development of more effective and targeted prevention strategies. Therefore, it is essential that more research be conducted in this area to advance our knowledge and improve the clinical approach to combating CVD-UTI.

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