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RESEARCH

INCIDENCE OF CATHETER-RELATED URINARY TRACT INFECIONS: A COHORT STUDY

INCIDÊNCIA DE INFECÇÃO DO TRATO URINÁRIO RELACIONADA AO CATETERISMO VESICAL DE DEMORA: UM ESTUDO DE COORTE

INCIDENCIA DE INFECCIÓN DEL TRACTO URINARIO RELACIONADA CON CATETERISMO VESICAL DE DEMORA: ESTUDIO DE COHORTE

Camila Cláudia Campos [1]
Carla Lúcia Goulart Constant Alcoforado [2]
Lúcia Maciel de Castro Franco [3]
Rafael Lima Rodrigues de Carvalho [1]
Flávia Falci Ercole [4]

[1] RN. PhD student. Substitute Professor. Federal University of Minas Gerais-UFMG, Nursing School-EE, Basic Nursing Department – ENB. Belo Horizonte, MG – Brazil.
[2] RN. PhD student. Assistant Professor. UFMG, EE,ENB. Belo Horizonte, MG – Brazil.
[3] RN. PhD student in Nursing. UFMG, EE, Programa de Pós-Graduação. Belo Horizonte, MG – Brazil.
[4] RN. PhD in Nursing. Associate Professor. UFMG, EE, ENB. Belo Horizonte, MG – Brazil.

Corresponding author: Camila Cláudia Campos. E-mail: camilacbh@hotmail.com
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ABSTRACT

This is a non-concurrent cohort study that uses data from 301 patients admitted to the intensive care unit of two public hospitals in Belo Horizonte. It aimed at analysing epidemiological aspects of urinary tract infections amongst patients with indwelling bladder catheterization, evaluating the incidence rate of the infection in the two hospitals and identifying possible risk factors related to the infection. Sample consisted of patients that underwent indwelling catheterization for a period of six months. Of the 301 patients, 23 developed infection: 56.52% were male and aged 60 years and over. The overall incidence of urinary tract infection was 6.70 infections/1000 catheter-days. The hospital using water and soap for periurethral cleaning presented higher incidence of urinary infection than the hospital using antiseptic (14.01 and 3.05 infections/1000 catheter-days, respectively). Risk factor identified was periurethral cleaning with soap and water. The most prevalent microorganisms in urine cultures were *Pseudomonas aeruginosa* (17.39%), *Candida sp.* (13.04%), *Escherichia coli* (13.04%), and *Proteus mirabilis* (8.70%). This study results contradict the literature which demonstrates the need for primary research aimed at identifying the most effective solution for periurethral cleaning in order to reduce catheter-related urinary tract infections.

Keywords: Nursing; Urinary Catheterization; Urinary Tract Infections; Povidone-Iodine.

RESUMO

Estudo de coorte não concorrente com informações de 301 de pacientes internados em centros de terapia intensiva de dois hospitais públicos de Belo Horizonte. O objetivo foi analisar os aspectos epidemiológicos das infecções do trato urinário em pacientes submetidos ao cateterismo vesical de demora, estimar a taxa de incidência nos dois hospitais, identificar possíveis fatores de risco relacionados à infecção e aos microrganismos causadores. A amostra constituiu-se de todos os pacientes internados nas duas unidades e que foram submetidos ao cateterismo vesical de demora no período de seis meses. Dos 301 pacientes, 23 desenvolveram infecção, sendo 56,52% do sexo masculino e com idade superior a 60 anos. A incidência global de infecção do trato urinário foi de 6,70 infecções/1.000 cateteres-dia. O hospital que utilizou água e sabão para a higiene periuretral apresentou maior incidência do que o hospital que utilizou antisséptico (14,01 e 3,05 infecções/1.000 cateteres-dia, respectivamente). O fator de risco identificado foi a higienização periuretral com água e sabão. Os microrganismos mais prevalentes nas uroculturas foram Pseudomonas aeruginosa *(17,39%)* Candida sp. *(13,04%),* Escherichia coli *(13,04%), e* Proteus mirabilis *(8,70%). O resultado encontrado neste estudo contradiz os achados da literatura e reforça a necessidade de estudos primários que identifiquem a solução mais eficaz para a realização da limpeza periuretral com vistas à redução da infecção do trato urinário relacionada ao cateterismo vesical de demora.*

Palavras-chave: *Enfermagem; Cateterismo Urinário; Infecções Urinárias; Povidona-Iodo.*

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RESUMEN

Estudio de cohorte no concurrente con información de 301 pacientes internados en centros de terapia intensiva de dos hospitales públicos de Belo Horizonte. El objetivo fue analizar la epidemiología de las infecciones del tracto urinario en pacientes sometidos a cateterismo vesical permanente, estimar la tasa de incidencia en cada hospital, identificar posibles factores de riesgo relacionados con las infecciones del tracto urinario e identificar los microorganismos causantes de la infección. La muestra estuvo constituida por todos los pacientes de las unidades sometidos a cateterismo vesical permanente en un período de seis meses. De los 301 pacientes, 23 desarrollaron la infección, siendo 56,52% del sexo masculino y edad superior a 60 años. La incidencia global de infección del tracto urinario fue de 6,70 infecciones/1.000 catéteres/día. El hospital que utilizó agua y jabón para la limpieza periuretral presentó mayor incidencia que el hospital que utilizó antiséptico (14,01 y 3,05infecciones/1.000 catéteres/día, respectivamente). El factor de riesgo identificado fue la utilización de la técnica de limpieza con agua y jabón. Los microorganismos más prevalentes en los urocultivos fueron Pseudomonas aeruginosa (17,39%) Candida sp. (13,04%), Escherichia coli (13,04%), and Proteus mirabilis (8,70%). El resultado encontrado contradice los de la literatura y refuerza la necesidad de estudios primarios que identifiquen la solución más eficaz para la limpieza periuretral con el fin de reducir la infección del tracto urinario relacionada con el cateterismo vesical permanente.

***Palabras clave**: Enfermería; Cateterismo Urinario; Infecciones Urinarias; Povidona Yodada.*

INTRODUCTION

Urinary Tract Infection (UTI) is the second most prevalent healthcare-associated infection (HAI) in North American hospitals. In Brazil, it is responsible for 30-50% of infections acquired in general hospitals.[1] Its main risk factor is the insertion of indwelling urinary catheter.[2] Approximately 14% of in-patients are inserted bladder catheters and 5% of these develop a urinary infection.[3]

Catheter-associated urinary tract infections (CAUTI) cause physical discomfort to patients and extend their length of stay which increases hospital costs and mortality. More than 13,000 deaths are due each year to UTIs.[4]

Therefore, awareness of the risk factors associated with UTI would allow the healthcare professional to reconsider health care service delivery processes in order to decrease UTI rates and minimize damage to patients' health. Among such risk factors is periurethral cleaning prior to insertion of indwelling catheter.[5]

Guidelines for the insertion/care of urinary catheters, such as the use of sterile materials for the prevention of UTI do exist. However, the question of which is the more effective solution for periurethral cleaning and antisepsis prior to catheter insertion is still contentious.

Results of national and international studies on the most effective solution for periurethral cleaning before catheter insertion are controversial.[6-9] International studies compared the use of antiseptic solutions such as local degerming polyvinylpyrrolidone iodine (PVP-I) vs. 0.1% chlorhexidine gluconate and sterile water with water and ordinary soap. Their results displayed no statistically significant differences in the incidences of UTI and bacteriuria.[7-9]

Since studies on the subject are scarce and present a low level of evidence more studies on the subject are needed. This is a recommendation found in most guidelines for there is no evidence to support that solutions are more effective than water and soap for periurethral cleaning.

Urinary tract infections have an impact on patient health and on hospital expenditures. Knowing the risk factors for the occurrence of catheter-related urinary infection is essential to provide quality patient care.

OBJECTIVES

This study aimed at analysing UTI epidemiological aspects among patients submitted to indwelling catheterization and hospitalized in the Intensive Care Units (ICU) of two hospitals in Belo Horizonte.

Specific objectives were to estimate UTI incidence rates in both hospitals, as well as to identify possible risk factors and the microorganisms that caused this disease.

METHODS

This is an observational non-concurrent cohort study. It analysed data relating to a period of six months of patients submitted to indwelling catheterization and admitted to the ICU of two large hospitals in Belo Horizonte.

Inclusion criteria were ICU admission between 1 July 2011 and 31 December 2011 and indwelling catheterization. Patients with a positive urine culture at the time of ICU admission, whose medical records or monitoring records were not located or whose records failed to register the use of indwelling catheters during intensive care treatment were excluded.

Initial research population was 311 patients reduced to 301 after application of exclusion criteria. Study population was 180 patients in Hospital A and 131 patients in Hospital B. In Hospital A, four medical records were not found; two showed UTI prior to ICU admission and four did not record the use of indwelling catheter. Therefore, initial sample was reduced to 170 patients. In Hospital B no participants were excluded (Figure 1). There was no data loss in the variables studied in both hospitals.

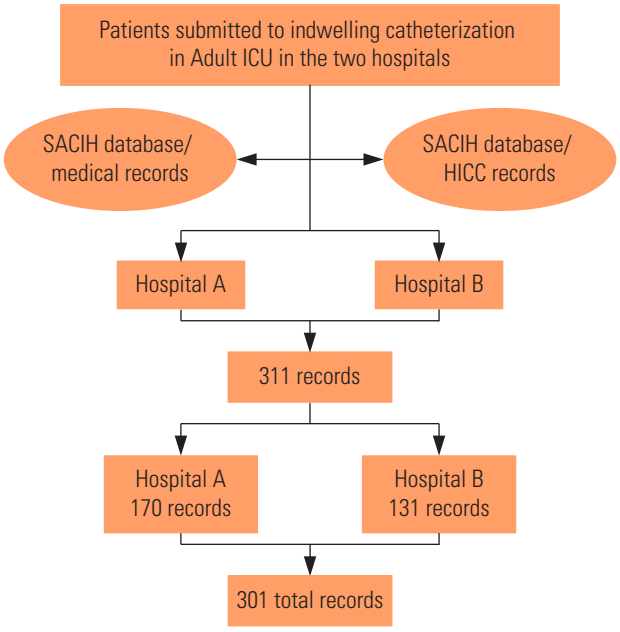

Figure 1 - Data Collection – Belo Horizonte, MG – July to December 2011.

The researcher developed a data collection tool to be used in the two hospitals. It collected sociodemographic data, information about hospital admission; clinical information related to the underlying disorders, catheterization procedure, length of time catheter remained in place, ICU data, urine culture performed and microorganism identification.

Data was obtained from the Automated System of Hospital Infection Control Program (SACIH) of each hospital and from electronic medical records (Hospital A). There was no need for extra data from Hospital B since information from the database of the Hospital Infection Control Commission (CCIH) was complete. Subsequently, data were entered in EXCEL and then in STATA version 12 for statistical analysis.

Patients submitted to indwelling catheterization and who met the inclusion and exclusion criteria had their information collected daily until they developed UTI or catheter was removed. SACIH was updated by the CCIH professionals of each institution through an active search of patients with indwelling catheterization.

In both hospitals, indwelling catheterization was performed by trained nurses according to the procedures in place. Procedures were standardized in each institution and thoroughly described in the Standard Operating Procedure (SOP).

Indwelling catheterization protocols in both hospitals contained three stages: stage 1 consisted of periurethral cleaning with degerming solution (PVP-I + saline or liquid soap + ordinary water); stage 2 involved the antisepsis of the mucous membrane with antiseptic solution in PVP-I aqueous carrier in an aqueous vehicle without removal of the solution; and stage 3 comprised the aseptic insertion of sterile indwelling catheter.

Stage 1 differed in the two hospitals: Hospital A used germ solution of PVP-I removed subsequently with sterile saline; Hospital B used liquid soap removed with ordinary water. In stage 2, both hospitals used antiseptic solution of PVP-I in an aqueous vehicle; and in stage 3 both hospitals performed catheterization with sterile technique (Figure 2).

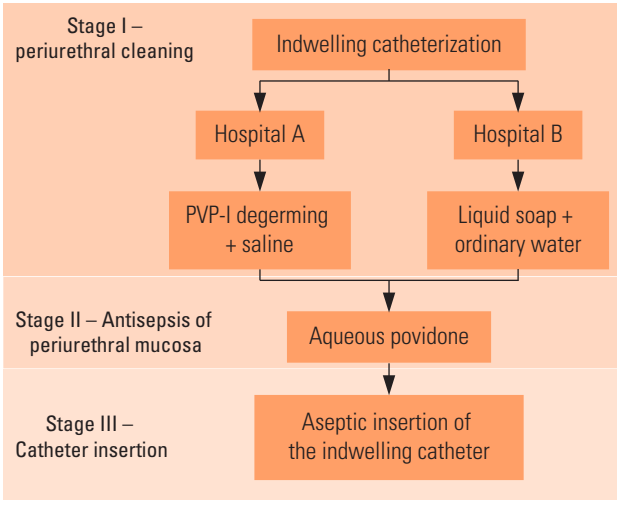

Figure 2 - Flowchart of indwelling catheterization in the two hospitals – Belo Horizonte, MG – July to December 2011.

Variables in both hospitals were: UTI (yes/no); sex (male/female); age (years/ continuous); ICU length of stay (days/continuous); length of stay of urinary catheter (in days/continuous); medical diagnosis for hospitalization (nominal variable/categorized later by disease groups); indwelling catheter insertion procedure (procedure A and procedure B); and results of urine culture (nominal variable/microorganism). Variables "age" and "indwelling insertion procedure" were statistically different in the two hospitals. The discrepancy was controlled in the statistical analysis.

Detailed analysis of the database variables was performed for evaluation of interaction and confounding variables. The analysis of data consistency was performed on each variable. Data were double entered in order to detect typos.

Distribution of simple frequencies, measures of central tendency, such as average and median and variability measures, such as standard deviation (SD) were used to characterize the study population. Incidence rates were obtained via incidence density (ID) calculation and considering number of catheter-days.

Univariate and multivariate analyses used Cox regression: Hazard Ratio (HR), Confidence Interval (CI) of 95% and $p < 0.05$. Variables with $p < 0.20$ in the univariate analysis were selected for inclusion in the multivariate analysis. Variables with $p > 0.20$, but whose significance was recognized in the literature were also included. Cox regression was used because of the proportionality of risk throughout observation period.

The present study was carried out after approval by the Ethics Committee of the Federal University of Minas Gerais (CAAE 16294813.4.0000.5149), and the Education Research and Extension Centres of Hospital A and the Board of Directors of Hospital B.

RESULTS

Of the 301 participants, 170 (56.48%) were male and 131 (43.52%), female; mean age was 62.87 years (SD ± 16.85, minimum of 14, maximum of 95 and a median of 66 years). Mean ICU length of stay was 14.65 days (SD ± 21.40, minimum 01, maximum 146 and a median of six days). Average length of stay of catheter was 11.39 days (SD ± 14.20, minimum 01, maximum of 106 and a median of six days).

On admission, 49 patients (16.33%) were diagnosed with pulmonary diseases; 42 (14%) with neurological diseases; 41 (13.67%) with gastrointestinal disorders; and 36 (12%) with heart complaints.

Regarding stage 1 (periurethral cleaning), 170 (56.48%) patients were submitted to procedure A (PVP-I and saline) and 131 (43.52%) to procedure B (water and soap).

Concerning the incidence of UTI among the 301 patients, 23 (7.64%) presented the infection: incidence density was 6.70 UTI/1000 catheter-days. Of these, seven (30.43%) were submitted to procedure A of periurethral cleaning, and 16 (69.57%) to procedure B. UTI incidence density among patients undergoing procedure A was 3.05 ITU/1000 catheter-days and 14.01 UTI/1000 catheter-days.

Results regarding the occurrence of UTI in relation to the variables are shown in Table 1.

Based on the results of the univariate analysis, only variable "indwelling catheterization procedure" (p = 0.000, 95% CI [2.05 to 2.22]) showed a p-value < 0.20. Although variables "sex", "age" and "length of ICU stay" presented a value of p > 0.20, the researcher included them in the multivariate analysis as they are recognized in the literature as risk factors for the occurrence of UTI (Table 1).

Multivariate analysis using Cox regression revealed that procedure B increased in 5.01 the patient´s chance of developing UTI compared to procedure A, controlled by "length of ICU stay", "gender" and "age" (Table 2).

Therefore, the use of soap and water for periurethral cleaning prior to indwelling catheterization was found to be a risk factor for the occurrence of UTI.

Polymicrobial growth and *Pseudomonas aeruginosa* were present in four (17.39%) urine cultures; *Escherichia coli* and *Candida sp* 03 species in three (13.04%); *Proteus mirabilis* in two (8.70%); and other microorganisms in seven (30.44%).

Table 1 - Univariate analysis of urinary tract infection and independent variables – Belo Horizonte, MG – July to December 2011

Variable	UTI				
	Yes n = 23	No n = 278	*Hazard ratio*	IC 95%	p -value
Sex					
Female	10 (7.63%)	121 (92.37%)	1.48	0.64 – 3.38	0.35
Male	13 (7.65%)	157 (92.35%)			
Age (in years)			1.00	0.99 – 1.00	0.74
Median	73	65			
Quartile 1/ Quartile 3	60/80	54/75			
Length of ICU stay (in days)			1.00	0.99 – 1.02	0.58
Median	27	05.5			
Quartile 1/ Quartile 3	14/52	02/16			
Duration of catheterization (in days)					
Median	10	05			
Quartile 1/ Quartile 3	06/20	02/13			
Indwelling catheterization procedure					
Procedure A	07 (4.12%)	163 (95.88%)	5.01	2.05 – 2.22	0.00
Procedure B	16 (12.21%)	115 (87.79%)			

Table 2 - Multivariate analysis of urinary tract infection with independent variables – Belo Horizonte, MG – July to December 2011

Variable	*Hazard ratio*	IC 95%	p - value
Indwelling catheterization procedure	5.01	2.05 – 12.22	0.00

DISCUSSION

UTI is an important cause of morbidity and mortality and catheterized patients are at an increased risk of being infected.[10]

Multivariate analysis using Cox regression revealed that patients who underwent procedure B of indwelling catheterization (ordinary soap and water) are 5.01 times more likely to be infected compared to those submitted to procedure B (PVP-I and saline solution).

Among the 23 patients who developed UTI, 16 (69.57%) underwent periurethral cleaning with procedure B and seven (30.43%) with procedure A. Of these 23 patients, 56.52% were male with a median age of 73 years.

Although the literature describes female patients as a risk factor for the occurrence of UTI[11-13], there was a higher incidence among males. The difference was not statistically significant (p = 0.35; 95% CI [0.64 to 3.38]). This can be explained by the fact that elderly male patients with prostatic hyperplasia (HP) are submitted more often to indwelling catheterization

that can damage the urethra, which may cause urinary infections.[14] Nevertheless, there were no HP diagnoses on the medical records consulted.

Median age was higher among patients with UTI (73 years) than among patients who did not have the infection (65 years). Difference was not statistically significant (p = 0.74; 95% CI [0.99 to 1.00]), however. Such results are in line with those found in the literature that describes that the condition occurs more frequently in the population over 60 years.[15-17] Biological changes associated with aging mean that this age group is less able to control homeostasis when exposed to a physiological stress. [18]

The length stay of patients affected by UTI (median 27 days) was higher than that of patients who did not have the infection (median 05.5 days). This difference was not statistically significant (p = 0.58; 95% CI [0.99 to 1.02]). A prolonged ICU stay may indicate that the patient´s condition is serious. This condition exposes patients to invasive procedures which are a gateway to infections caused by microorganisms. According to Leone[13], a hospital stay of over 25 days is associated with UTI in patients with indwelling catheterization.

The duration of indwelling catheterization was higher among patients with urinary infection (median 10 days) compared to patients who were not infected (median five days). The duration of catheterization is the main risk factor for catheter-related UTI:[11-13] the longer the duration of indwelling catheterization, the more likely is the formation of biofilms on the catheter surface.[19] The role of biofilms in the pathogenesis of UTI is not well known, but patients using catheters impregnated with antibiotics or silver salts present lower rates of UTI.[20]

The incidence density rate of UTI in this study was 6.34/1000 catheter-days. This value is consistent with Rosenthal finding[21], whose value was 6.3 UTI/1000 catheter-days. These data refer to a period of six years of information on ICU-acquired infections in Latin America, Asia, Africa and Europe. Values found in this study were lower than those found in other Brazilian studies, whose incidence density rates were 8.68/1000 catheter-days[22] and 8.2/1000 catheter-days.[17] However, the incidence density rate of this study was higher than the rate found in ICU and registered in the National Healthcare Safety Network (NHSN) that was UTI 2.4/1000 catheter-days.[23]

There are numerous variations in infection rates. However, the values found in this study are similar to others observed in developing countries. This context demonstrates that infection surveillance systems in these countries are still in a structuring stage.

According to Rosenthal[21], surveillance of healthcare associated infections is essential to reduce the risks of infections. The objective of such programmes is to describe and act on hazardous conditions created by HAIs.

Considering UTI rates in relation to cleaning techniques, among the 23 patients who developed urinary infection, 16 were submitted to procedure A and seven to procedure B, with a statistically significant difference of p = 0.00; 95% CI [2 , 05-2.22]. The use of soap and water for periurethral cleaning increased 5.01 times the risk of UTI infection compared to the use of PVP-I and saline solution.

Such finding disagrees with the literature. An English clinical trial compared the use of chlorhexidine to tap water for periurethral cleaning of surgical patients. The results showed no statistically significant difference in urinary infection rates.

Another clinical trial showed no statistically significant difference in UTI rates when comparing the use of chlorhexidine to water for periurethral cleaning in obstetric patients.[8]

Cheung[24] compared the use of chlorhexidine to sterile water in long-term patients in nursing care homes. There were no statistically significant differences in UTI rates.

An Iranian clinical trial showed that there were also no statistically significant differences between the use of PVP-I and water for periurethral cleaning in preoperative gynaecologic patients.[7]

A Portuguese systematic review demonstrated that there was also no statistically significant difference in UTI rates when water/saline or antiseptic solutions were used for periurethral cleaning.[6]

The discrepancy between the results of this study and the literature may be related to the research methods used since a cohort study presents lower levels of scientific evidence than those of a clinical trial or a systematic review with or without meta-analysis.[25]

The lack of consistency and the unreliability of databases and electronic records can be a limitation to research and produce inconsistent results. Health professionals should try to generate consistent and realistic health care information.

Both hospitals recommended that indwelling catheterization and protocol supervising should be performed by a qualified nurse. However, there is no way of ascertaining that the procedure was done in accordance with quality-control measures established by the hospitals.

A cohort study is an observational study in which the researcher does not interfere with variables related to the studied event. As already stated, a non-concurrent cohort research deals with data already collected; in case it is methodologically well conducted it generates knowledge about the impact of a particular event and its causal factors on a population at risk.

The present research studied a limited population of only two hospitals. Critical ICU patients are more at risk of acquiring an infection by exposure to a greater number of invasive procedures and the severity of the underlying diseases and comorbidities. Thus, more multicentre studies with ICU patients should be carried out.

Considering that indwelling catheterization is extensively used in critically ill patients and the serious consequences of urinary infections for patients and the health system, the pres-

ent study emphasizes the need of experimental studies to determine the most effective solution for periurethral cleaning prior to insertion of indwelling catheter.

CONCLUSION

According to this study results, periurethral cleaning with PVP-I degerming prior to indwelling catheterization lowers the risk of patient acquiring urinary infections if compared to cleaning with soap and water.

UTI incidence rate in the hospital using soap and water was approximately 4.6 times higher than in the hospital using PVP degerming agents and saline.

The use of soap and water for periurethral cleaning (procedure B) is a risk factor for catheter-related urinary infections.

Polymicrobial growth, *Pseudomonas aeruginosa* and *Escherichia coli* were the microorganisms found in the urine cultures performed.

Such results reinforce the need of primary studies aiming at identifying the safest solution for periurethral cleaning in order to reduce indwelling catheter-related urinary infection.

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