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## The effect of daily change of sterile urinary bag on bacteriuria and catheter-associated urinary tract infections

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### ABSTRACT

**Introduction:** One of the major healthcare measures in hospitals, is reducing the risk of infections. Since catheter-associated urinary tract infections (CA-UTIs) occur in 80% of cases, the prevention of these infections plays an important role in reducing infections related to the treatment care.

**Objectives:** The present study aims to determine the effect of daily change of sterile urinary bag on the incidence of bacteriuria and CA-UTIs.

**Patients and Methods:** This quasi-experimental study include all patients referred to the neurology, urology and surgery wards, as well as the ICU and CCU of Hajar and Kashani hospitals, Shahrekord, Iran. A total of 200 patients aged 18-75 years that required insertion of the urinary Foley catheter were divided into two groups: catheterization with the usual method (control group) and catheterization with daily change of sterile urinary bag (case group). In each of the two groups, immediately after insertion and during the removal of urethral catheter, the urine sample was collected using sterile method and was sent to the laboratory to conduct examinations for bacteriuria. The demographic information was prepared and collected using the researcher made questionnaire.

**Results:** In this study, the average age of the patients was  $49.81 \pm 15.11$ . The rate of CA-UTI was more in the control group than the case group (29% as compared with 16%) ( $P=0.04$ ). The average age of patients with infection due to urethral catheterization was found to be higher ( $55.4 \pm 14.52$  versus  $48.4 \pm 14.92$ ) ( $P<0.001$ ).

**Conclusion:** While a preference for closed drainage system existed, however in the present study, it was found that with daily change of sterile urinary bag even with opening of system, the rate of CA-UTI was reduced.

### Implication for health policy/practice/research/medical education:

According to the findings of the present study, in short-term catheterization, replacing sterile urine bag was more effective in decreasing bacteriuria and urinary tract infections (UTIs) as compared with the conventional method of urinary catheterization.

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### Introduction

At present, hospital acquired infections are one the main causes of the increasing rate of complications and mortality in hospitalized patients. These infections are threat to the health condition of the individuals and cause a heavy economic burden on health care systems, individuals, and insurance organizations (1). Studies have shown that the urinary system accounts for approximately 40% of all hospital-acquired infections. Infections of the urinary tract are the most common types of healthcare-associated infection in medical-surgical units, critical care units, and rehabilitation wards and approximately 80% are

associated with the use of an indwelling urinary catheter (2,3).

The prevalence of urethral catheterization is high, about 15% to 25% of patients hospitalized in the emergency department have urinary urethral catheter and more than half of them are affected by bacteriuria after five days of hospitalization; thus, it is present as a consequence of interventional procedures (4). For each day of urethral catheterization, the rate of acquiring bacteriuria is approximately 1%-3% in healthy individuals and 15% in elderly hospitalized patients (4). This rate, after 7 to 14 days of catheterization, increases between 35%

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and 75%, respectively and the bacteriuria is likely to be asymptomatic. About 20% of patients with bacteriuria are diagnosed with symptomatic urinary tract infections (3). On the other hand, the urinary tract infections occur more in lower urinary tract which has high rate of colonized bacteria. The insertion of urethral catheter could help to reduce this condition and causes bacteriuria. In creation of this problem, the biofilm formation plays an important role.

Biofilm is a polysaccharide that is formed in the urinary bag on the urethral catheter, in openings and urethral catheter balloon. It prepares the condition for bacterial growth and infection (3,5).

The responsible factors of biofilm (bacterium, fungus, and protozoan) play an important role in causing these infections. About 60% of urinary tract infections occur in the presence of biofilm (6). With biofilm formation, the bacteria can develop resistance against anti-microbial factors and immunity system, and would be able to keep the proper physical and chemical conditions for growing. The essential time for biofilm formation on instruments depends on the type of micro-organism and instrumental material.

However, on average, 24 hours is required to attain the thickness of biofilm (7). With biofilm formation, bacteria can develop resistant against antibacterial materials and this process leads to chronic or recurrent infections that is difficult to treat. In the absence of treatment, these infections can lead to pyelonephritis, bacteremia, chronic bacterial prostatitis, bacterial vaginitis, chronic pyelonephritis, bladder cancer, and in some cases, to death (7-9).

Several strategies have been suggested with the aim of reducing the rate of catheter-associated urinary tract infection (CA-UTI), including training of the patients and their health providers and personnel to wash their hands, restricting the use of urethral catheter only for emergency cases, using aseptic techniques for urethral catheterization, using antibiotics only for special cases, keeping a closed (drainage) system, repeated emptying of the urinary bag in order to prevent urinary reflux, minimizing the duration of catheterization, and using catheter coated with anti-biotics or antiseptics (10).

Furthermore, several studies have been carried out on the application of strategies to reduce CA-UTI and bacteriuria in patients. Koskeroghlo et al (11) in their study, showed that using antiseptics in the urinary tract was not effective in reducing the rate of acquiring bacteriuria. Also, Schumm et al (12) demonstrated that none of the bladder washing solutions (acetic acid, neomycin- polymyxin, and sodium chloride 0.9%) could serve as a suitable antibacterial agent to prevent catheterization-related bacteriuria. In another study, it was shown that the application of betadine on urinary tract once and twice a day was associated with prevention of CI-UTIs in men and women, respectively (13,14).

## Objectives

This study was conducted with the aim of determining the effect of daily change of sterile urinary bag on incidence of bacteriuria and CA-UTIs.

## Patients and Methods

### Study population

This quasi-experimental study included all patients referred to the neurology, urology, and surgery wards, as well as the ICU and CCU of Hajar and Kashani hospitals, Shahrekord, Iran. The inclusion criteria were staying in the studied wards of the two hospital, needing urinary catheter, and being 18-75 years. The exclusion criteria were positive urinary culture at baseline, having undergone any surgery on the urinary tract, and taking antibiotics.

The sample size was estimated to be 200 persons. Data collection was conducted using a researcher-developed questionnaire that consisted of items on demographic characteristics and underlying information on the wards of hospitalization, catheterization indications, the type of catheter, and the technique of catheterization. This questionnaire was developed according to the relevant textbooks and articles, and the viewpoints of the faculty members of the departments of urology and infectious diseases. The viewpoints of 10 faculty members of the departments of urology and infectious diseases were used to validate the questionnaire according to content validity. The sampling was done based on the objective and samples specification in the two groups, randomly. About 200 qualified cases were considered for the study and were divided into two groups. In the case group of 50 female and 50 male, the silicon urethral catheter was established using aseptic method. Then, after filling each urinary bag, it was intermittently emptied and changed daily. In the control group (50 female, 50 male), also the silicon urethral catheter was established using routine and aseptic methods, and the urinary bag was emptied after each filling.

In all two groups of the study, the urinary catheter was inserted using the sterile technique. Simultaneously, urinary samples were collected from the urinary catheters using 10-cc sterile syringe and sent to the laboratory in less than 30 minutes to conduct examinations for bacteriuria. In both groups, immediately after removing the urinary catheter, the urinary samples were collected again from the catheters by aseptic technique using a 10-cc sterile syringe and sent to the laboratory under similar conditions. The urinary samples were examined for bacterial infection (over 1000 CFU/mL) (15).

To conduct urinary tests, sterilized test tubes with cotton lids, blood agar, McConkey culture medium, optical microscope, and incubator were used. All urinary tests were conducted by a single person and in a laboratory.

### Ethical issues

The study protocol was in accordance with the

Declaration of Helsinki. Ethical permission was obtained from the ethical committee of Shahrekord University of Medical Science. Before collecting the urinary samples, the research purposes were explained to the patients, and then they provided informed consent to participate in the study.

**Statistical analysis**

Data analysis was conducted by descriptive (frequency, relative frequency, mean, and standard deviation) and analytical statistics by SPSS. The Kolmogorov-Smirnov statistical test showed that the data had normal distribution. Thus, the parametric (chi-square and independent *t* test) tests were used to analyze the data. Additionally, *P*<0.05 was considered statistically significant.

**Results**

A total of 200 patients were enrolled in this study. The mean age of the patients was 49.81 ± 15.11 years. The duration of catheterization ranged from 3 to 10 days. About 36 patients were hospitalized in the neurology ward, 44 in the urology ward, 40 in the ICU, 20 in the CCU, and 60 in the surgical ward. There were no significant differences in age, gender, and catheter survival among the studied groups (*P*<0.05).

Table 1 shows that the most prevalent causative organism of CA-UTIs was *Escherichia coli* (25 patients).

Comparison of the uninfected and infected groups by chi-square test showed a significant difference of urinary tract infection in the two methods of urethral catheterization (*P*=0.033). The urinary infection rate was reported as 16% in the case group and 29% in the control group.

The average age of patients with infection due to the urethral catheterization was reported as 55.4 ± 14.52 years, and for patients without infection as 48.4 ± 14.92 years. The independent *t* test demonstrated a significant difference between age and urinary tract infection rate (*P*<0.001). This finding shows that infection rate is more prevalent among older people.

Furthermore, the independent *t* test demonstrated a significant difference in duration time of urethral catheter and CA-UTIs (*P*<0.001).

Moreover, there was no significant difference in CA-UTIs in the two genders (*P*>0.05; chi-square test). Although the urinary infection incidence was more in women (female) than in men (male) (31% versus 14%), however, it was not statistically significant. There was a significant difference

in CA-UTIs among the males of the two groups (*P*=0.4; chi-square test). However, the females in the two groups had no significant difference in CA-UTIs (*P*=0.13; chi-square test). Hence, only the males in the two groups had significantly different incidence rate of CA-UTIs.

The most infection rate was observed in ICU unit (47.2%), while the least infection rate was observed in CCU (20%).  $\chi^2$  tests showed that the effect of hospitalization unit was significant in CA-UTIs (*P*<0.001). The incidence rate of different complication in the control group was 41% and in the case group was 33%.

Additionally, dysuria was observed more than other complications (37%), and it was 19% in the control group and 17% in the case group (Table 2).

**Discussion**

Control measures to decrease healthcare-associated infections are a priority in hospitals of developed countries. While, catheterization-related UTIs are one of the most common hospital acquired infections and occur in 80% of cases following catheterization, preventing such infections plays an important role in decreasing healthcare-associated infections. Therefore, the present study was conducted to compare the efficacy of urinary catheterization using daily urine drainage bags and catheterization using daily replacement of urine bag on bacteriuria and catheter-related UTIs.

Based on the findings of the present study, urine bag replacement instead of its drainage was effective in decreasing bacteriuria and UTIs following urinary catheterization as compared with the conventional method of urine drainage bags. Our finding represents the effectiveness of urine bag replacement in decreasing biofilm development, because biofilms are polysaccharides that protect bacteria.

In this regard, no similar study has been conducted. However, the adoption of strategies recommended by the disease control and prevention (CDC) to prevent or decrease the catheterization-related UTIs has been frequently studied. It is not possible to reach a definite conclusion due to inconsistency in the available findings. For example, Makuta et al (10) investigated the efficacy of antibacterial catheters. To achieve this purpose, they compared the use of silver and nitrofurazone-impregnated catheters and conventional catheters to decrease catheter-related UTIs. The findings showed that the use of silver and nitrofurazone-impregnated catheters was ineffective

**Table 1.** The distribution of urinary tract infection (UTI) in terms of organism type and treatment methods

Groups	Infection						Total
	Uninfected			Infected			
	Lack of infection	Sterile pyuria	Mixed	<i>E. coli</i>	<i>Pseudomonas</i>	Others	
Intermittent urinary bag drainage (control group)	62	9	7	17	3	2	100
The sterile bag change (the intermittent urinary bag and daily change of the urinary bag) (case group)	76	8	5	8	1	2	100
Total	138	17	12	25	4	4	200

**Table 2.** The frequency of the created problems in the two groups as a consequence of urethral catheterization

Groups		Complications							Total	
		Fever	Flank pain	Catheter obstruction	Urinary incontinence	Dysuria	Hematuria	Wound		Urinary tract obstruction
Control group <sup>a</sup>	No.	5	6	3	0	19	6	1	1	41
	%	2.5	3	1.5	0	9.5	3	1	1	20.5
Case group <sup>b</sup>	No.	6	3	0	0	18	6	0	0	33
	%	3	1.5	0	0	9	3	0	0	16.5
Total	No.	11	9	3	0	37	12	1	1	74
	%	5.5	4.5	1.5	0	18.5	6	.5	.5	37

<sup>a</sup>Intermittent urinary bag drainage (usual method).

<sup>b</sup>The sterile bag changes (the intermittent urinary bag and daily change of the urinary bag).

in decreasing such infections as compared with the conventional catheters without any benefits. Their finding did not support the use of antibacterial catheters instead of conventional methods. Therefore, healthcare providers are recommended to adopt simple strategies to prevent catheter-related UTIs and decrease the need for catheterization. In this regard, the present study also showed that the method of replacing sterile urine bag was effective in decreasing UTIs as compared with the urine drainage bags.

Pickard et al (16) studied the effects of different types of urinary catheters in decreasing symptomatic UTIs in hospitalized adults. They compared nitrofurazone-impregnated silicone catheters and silver alloy-impregnated hydrogel latex catheters with PTFE (polytetrafluoroethylene) coated latex-impregnated catheters. According to the findings, using the nitrofurazone-impregnated catheters was not effective in decreasing UTIs but was more economical than the PTFE-impregnated latex catheters.

In addition, the use of the silver alloy-impregnated catheters was neither more effective in decreasing UTIs nor more economical than the PTFE-impregnated catheters. Due to discrepancy in the results of the study by Pickard et al (11), our findings can be related to the duration of catheterization. Moreover, a systematic review by Schumm and (12) to comparatively investigate the effects of silver alloy-impregnated catheters and silver oxide-impregnated method to decrease catheter-related UTIs in short-term catheterization, it was shown that the silver alloy-impregnated catheters were more effective. This review also reported that in short-term (less than one-week) catheterization, antibacterial agent-impregnated catheters were effective in decreasing bacteriuria, but in long-term catheterization, the results were tentative (12). However, a study by Saint et al (13) demonstrated that the use of silver alloy-impregnated catheters and silver acid-impregnated catheters did not show significant difference in terms of prevention of UTIs.

A review to investigate the effects of antibacterial catheters to decrease bacteriuria and funguria showed that these catheters were effective in decreasing bacteriuria

and funguria, but did not report their effects on UTIs rate (14). These findings are in line with the systematic review conducted by Johnson et al (15) who reported that antibacterial agent-impregnated catheters were effective in decreasing UTIs. In the present study, in the short-term catheterization, the replacement of sterile urine bag caused a decrease in the rates of bacteriuria and UTIs. Accordingly, a study by Koskeroglu et al (11) showed that applying disinfectant agents on urinary meatus was ineffective in decreasing bacteriuria rate. Also, Fukunaga et al (17), in their study, showed that applying iodine povidone on the dressing site of subclavian venous catheter caused a decrease in infection in the catheter site. In contrast, Bastable et al (18) reported that washing was ineffective in decreasing bacteriuria rate.

In the present study, the incidence rate of UTIs following urinary catheterization was 45%. In the study of Haley et al (19), this rate was 10%-20%. Edmond et al (20) reported that UTIs represent 40% of hospital acquired infections, while 80% of which are developed after catheterization. The duration of catheterization is an important risk factor for the development of catheter-related bacteriuria (21,22). For each 24-hour of catheterization, the likelihood of bacteriuria development increases by 1-3 and 15% in healthy people and older patients, which increase to 35% and 75%, respectively after 7-14 days of catheterization (3).

In the present study, the duration of catheterization was directly associated with the development of bacteriuria. As reported by Tambyah et al (23), having urinary catheter for more than six days is a modifiable and known risk factor for developing UTIs. Samimi et al (24) also reported bacterial colonization of bladder after 17 days in both groups. Similarly, Al-Hazmi (25), in a study, showed that reduction in the length of hospital stay and duration of catheterization was effective in decreasing the rate of catheter-related UTIs.

In the present study, the highest rate of catheter-related UTIs was reported in ICU, which is in line with the findings of Chen et al (26). Wu et al (21) reported that *E. coli* (80%) is the most common cause of community-acquired infections, followed by *Staphylococcus saprophyticus* (10%-

15%), *Klebsiella*, *Enterobacter*, and *Proteus*. Consistently, *E. coli* was the most common cause of UTIs in the present study. This finding is in agreement with those of previous studies (27-29). In the present study, the most frequent complaint following catheterization, by all methods, was dysuria. Urinary catheter can cause dysuria through the development of inflammation and infection in the bladder (30).

### Conclusion

Based on the findings of the present study, in short-term catheterization, replacing sterile urine bag was more effective in decreasing bacteriuria and UTIs as compared with the conventional method of urinary catheterization, that is, urine bag drainage. Decreasing the inflammation status in the body and provocation of oxidative stress would be accompanied by this modality. It should also be noted that prolonged UTI may gradually involve the upper urinary system.

### Limitations of the study

The limitations of the study were the small sample size and short time follow-up. Therefore, further studies with large sample size and longer duration of follow-up of patients are required.

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### Authors' contribution

MH conducted the research. KN gathered the data. KN analyzed the data. MRI and MH prepared the primary draft. KN edited the manuscript. KN prepared the final paper. All authors read and approved the final manuscript.

### Conflicts of interest

The authors declare no conflict of interest.

### Ethical considerations

Ethical issues (including plagiarism, data fabrication, double publication) have been completely observed by the authors.

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