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Research Article

Determination of Bacteria associated with Urinary Catheters from Patients Suffering from Urinary Tract Infections

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ABSTRACT

Urinary catheters act as a reservoir of resistant pathogens. Several factors (type, duration, procedural mistakes during insertion of catheter, associated diseases of patients, etc.) are responsible for the different catheter-associated urinary tract infection (CAUTI) rates in different healthcare setups. This study was conducted to determine bacteria that can be found in the urinary catheter of UTI patients. The samples were aseptically collected into a sterile container 48 h after insertion of catheter. Urine culture was done on blood agar and cystine–lactose–electrolyte-deficient agar. However, standard protocol of identification was done to identify the isolates. The highest prevalence in relation to age in this study was obtained in age groups 21–30 and 41–50 years, each with 11 (23.40%) uropathogens, and the lowest was obtained in the 71–80 years age bracket with zero prevalence. A higher number of uropathogens was found in female participants (26, 55.32%) than in male patients (21, 44.68%). However, different types of bacteria such as *Escherichia coli*, *Proteus mirabilis*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Proteus vulgaris*, *Klebsiella pneumoniae*, and *Staphylococcus saprophyticus* were isolated from catheters of UTI patients. Among the isolates, higher prevalence was found in *E. coli* in both male and female patients with a frequency of seven/21 (33.33%) and eight/26 (30.77%), respectively, followed by *S. aureus* with six/21 (28.57) and five/26 (19.23) in male and female patients, respectively. Catheterization of UTI patients is a very common procedure used in many hospitals, and practice is even more common in the intensive care units of most hospitals.

1. INTRODUCTION

The urinary catheter is a tube that is inserted into the bladder through the urethra of patients suffering from Urinary Tract Infection (UTI) in order to drain urine. The most commonly known urinary catheter is the Foley catheter, which is generally made of up rubber, plastic, silicone, or latex. A Foley catheter is a double lumen (tube) catheter; the larger lumen drains urine from the bladder, and the smaller lumen is used to inflate the small balloon at the tip of the catheter [1]. Catheter-associated UTIs (CAUTI) contributes approximately 30–35% of all hospital-acquired infections (HAIs) [2]. Presence of indwelling catheter is a prerequisite for CAUTI, and risk of CAUTIs varies from 3% to 7% daily [3]. However, using catheter for more than 2 days can be a significant factor for CAUTI [4]. This is as a result of the organisms attached to the catheter surfaces, leading to the formation of biofilms on the catheter, which can in turn lead to CAUTIs. Elderly individuals, people with diabetes, being female, obesity, etc., are the other risk factors [5]. Although CAUTIs can be caused by both gram-positive and -negative bacteria, most are usually caused by gram-negative bacteria, such as *Escherichia coli*, *Enterococcus* species, *Pseudomonas aeruginosa*, and *Klebsiella pneumoniae* [2].

Use of urinary catheters when required, insertion with full aseptic procedure, properly secured catheter, removal of catheter as soon as possible, and maintenance of unrestricted urine flow are important for prevention of CAUTIs [3]. A higher rate of infection often leads to increased rates of antimicrobial prescription, which in turn contributes to increase in antimicrobial resistance [6]. This study was designed to determine and detect the different bacteria that are associated with urinary catheters from patients with UTI.

2. MATERIALS AND METHODS

2.1. Sample Collection

This study was carried out in Jimeta, Yola, in Adamawa state Nigeria. A total of 50 urine samples were aseptically collected into sterile containers from catheterized patients 48 h after catheter insertion in Dawa'u and Meddy clinics within the Jimeta metropolis [7].

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Data availability statement: The authors of this article wishes to confirm that all the data supporting the findings of this study are available within the article and/or its supplementary materials. All the data that were used to support the findings of this study were properly cited within the text and they are also reference properly in the reference section of the work.

2.2. Isolation of Bacteria from Urine Samples

The urine sample was inoculated and streaked using a sterile wire loop onto cystine–lactose–electrolyte-deficient agar as well as blood agar. The inoculated plates were incubated in an incubator at 37°C for 18–24 h using standard laboratory techniques [8].

2.3. Identification of Bacteria from Urine Samples

The bacterial isolates were then identified using the standard identification procedure. The bacterial isolates were identified on the basis of their cultural characteristics, microscopy, and certain biochemical tests as described by Cheesbrough [8].

2.4. Statistical Analysis

The data generated were analyzed using the MacChi-square descriptive statistics method; the levels of significance were expressed as p-value. When the p-value is <0.05, it is considered statistically significant.

3. RESULTS

Urine samples were observed to have different colors, and results of this observation are shown in Table 1. Twenty-five (50%) of the urine samples were yellow, nine (18.0%) were pale yellow, nine (18.0%) were white, and seven (14.0%) were red.

3.1. Color of Urine Samples

Details on the color of urine samples are shown in Table 1.

3.2. Appearance of Urine Samples

The appearance of the urine samples was observed; 29 (58.0%) of the samples had a clear appearance whereas 21 (42.0%) were described as turbid (Table 2).

Table 1 | Color of urine samples

Color	No. of samples	Frequency (%)
Yellow	25	50.00
Pale yellow	9	18.00
White	9	18.00
Red	7	14.00
Total	50	100

Chi-square = 0.000, df = 3, p = 0.9999.

Table 2 | Appearance of urine samples

Appearance	No. of urine samples	Frequency (%)
Clear	29	58.00
Turbid	21	42.00
Total	50	100

Chi-square = 0.000, df = 1, p = 0.9999.

3.3. Sex Distribution

The sex distribution of the study participants is described in Table 3. The study group consisted of 19 (38.0%) male and 31 (62.0%) female volunteers.

3.4. Age Distribution

The number of uropathogens isolated in relation to the age distribution of the study participants is presented in Table 4. The results revealed that the highest prevalence was in the 21–30 years and 41–50 years age groups, with 11 uropathogens isolated from each group. Meanwhile, the lowest number of uropathogens was found in the 71–80 years age group with zero isolate.

3.5. Biochemical Analysis

Table 5 shows the results of the biochemical identification of isolates. Several biochemical tests were conducted, and results showed that several bacteria were associated with urinary catheters. Although these organisms included both gram-positive and -negative bacteria, the most prevalent were gram-negative bacteria such as *E. coli*, *K. pneumoniae*, *Proteus mirabilis*, *Proteus vulgaris*, and *P. aeruginosa*. Meanwhile, the gram-positive bacteria included *Staphylococcus aureus* and *Staphylococcus saprophyticus*.

3.6. Prevalence of Uropathogen in Relation to Sex

The prevalence of uropathogens in relation to sex of the study participants is given in Table 6. The results showed that in both male and female participants, *E. coli* has the highest prevalence, with 14.89% and 17.02% for male and female participants, respectively. Meanwhile, *S. saprophyticus* has the lowest prevalence among male participants (0% prevalence).

Table 3 | Sex distribution of study population

Sex	No. of participants	Frequency (%)
Male	19	38.00
Female	31	62.00
Total	50	100

Chi-square = 0.000, df = 1, p = 0.9999.

Table 4 | Age distribution of study population

Age (years)	No. of uropathogen	Frequency (%)
10–20	6	12.77
21–30	11	23.40
31–40	6	12.77
41–50	11	23.40
51–60	4	8.51
61–70	7	14.89
71–80	0	0.00
81–90	2	4.26
Total	47	100

Chi-square = 0.000, df = 7, p = 0.001.

Table 5 | Results of biochemical analysis

S/N	Gram staining	Biochemical test									Suspected organism
		Catalase	Indole	Urease	Citrase	Nitrate reduction	Coagulase	Oxidase	Methyl red	Novobiocin susceptibility	
1	−Rod	+	+	−	−	+	−	−	−	Nt	*Escherichia coli*
2	−Rod	+	−	+	+	+	+	−	−	Nt	*Klebsiella pneumoniae*
3	+Cocci	+	−	−	−	−	+	−	+	S	*Staphylococcus aureus*
4	−Rod	−	−	+	+	+	−	−	+	Nt	*Proteus mirabilis*
5	−Rod	+	+	+	−	+	−	+	+	Nt	*Proteus vulgaris*
6	+Cocci	+	−	+	−	−	−	−	+	R	*Staphylococcus saprophyticus*
7	−Rod	−	−	−	+	−	−	+	−	Nt	*Pseudomonas aeruginosa*

+, positive; −, negative; Nt, not tested; R, resistance; S, susceptible.

Table 6 | Prevalence of uropathogen in relation to sex

Organisms	Male		Female	
	No. of organisms	Prevalence (%)	No. of organisms	Prevalence (%)
Escherichia coli	7	33.33	8	30.77
Staphylococcus aureus	6	28.57	5	19.23
Pseudomonas aeruginosa	2	9.52	2	7.69
Proteus mirabilis	2	9.52	3	11.54
Proteus vulgaris	3	14.29	2	7.69
Klebsiella pneumoniae	1	4.76	2	7.69
Staphylococcus saprophyticus	0	0.00	4	15.39
Total	21	100	26	100

Chi-square = 4.409, $df = 6$, $p = 0.6215$.

4. DISCUSSION

Different gram-negative and -positive bacteria are responsible for CAUTI in patients suffering from UTI. However, the most commonly encountered bacteria are gram-negative bacteria such as *E. coli*, *P. aeruginosa*, *K. pneumoniae*, *P. mirabilis*, and *P. vulgaris* [9]. The age distribution of the study participants was presented at an interval of 10 years; the higher prevalence of bacteria associated with UTIs was found in the age groups 21–30 years and 41–50 years, each with 11/47 (23.40%) uropathogens. However, in a study conducted by Adane et al. [10], the age groups of 25–44 years and 45–64 years had higher UTI infection rate compared with other age groups. This difference could be attributed to differences in class interval used in these studies. In a previous study conducted in Bushenyi, Uganda, Martin et al. [11] reported a prevalence of (32.2%), which is higher than the prevalence obtained in the present study. Significant bacteriuria of 29/40 (72.5%) in asymptomatic patients was also reported in a previous study [12]. In another study conducted in Mulago, higher proportions of females were found to have higher risk of CAUTI [13].

However, in terms of the sex status of study participants, female participants were found to have a higher prevalence of CAUTIs than their male counterparts. This study shows that the majority of UTIs were found in females, which indicates that women are more likely to develop UTIs than men. The result of this study is in line with that of another study [14], which also discovered that women are more prone to UTI infections than men. Women are more prone to develop UTI than men probably because of their anatomical and physiological characteristics [15].

Escherichia coli is the most prevalent bacterial uropathogen associated with CAUTI (7/21; 14.89%). This is in agreement with other studies reporting that *E. coli* is the most prevalent uropathogen associated with UTIs, with a percentage frequency of 40–46% [16–18]. Furthermore, the proximity of the anus to the female vagina is a very important factor that accounts for the higher prevalence of UTIs in women. Moreover, our study reported a high prevalence of *E. coli* in females, which also supports the findings of previous studies. However, this high prevalence of UTIs in females can also be attributed to the inherent virulence of *E. coli* for urinary tract colonization such as its ability to adhere to the urinary tract in females and its ability to associate with other microorganisms moving from the perineum areas contaminated with fecal microbes to the moist warmth environment of the female genitalia [19,20].

Among the gram-positive bacteria isolated in this study, *S. aureus* was found to be the second most frequently found uropathogen. *S. aureus* had a frequency of six/21 (28.57%) and five/26 (19.23%) for male and female participants, respectively. A higher prevalence of *S. aureus* was also reported by Martin et al. [11], in a study they conducted in Bushenyi, Uganda, with a frequency of 27/86 (31.4%). However, several studies have reported a higher frequency of *S. aureus* in UTIs. An earlier study performed in Awka, Nigeria, also reported a high frequency rate of *S. aureus* of 60/215 (28.00%) [21]. Bladder catheter contributes immensely to the increasing populations of *S. aureus* in UTIs [22,23].

Other uropathogens including *P. aeruginosa*, *P. mirabilis*, *P. vulgaris*, *K. pneumoniae*, and *S. saprophyticus* were also isolated in this study. Previous studies conducted by Alsammani et al. [24] also showed that *P. aeruginosa*, *K. pneumoniae*, and *P. mirabilis* were associated with uropathogens. In addition, a study conducted by Ochada et al. [25] in two teaching hospitals at Osun state also reported the presence of *K. pneumoniae*, *P. aeruginosa*, and *S. saprophyticus* in patients with UTIs.

5. CONCLUSION

The present study revealed the presence of bacteria associated with urinary catheters in individuals with UTIs. The bacteria were found to be more associated with female UTI patients than male UTI patients. This could be because the urethra is very close to the anus in females. Moreover, most frequently isolated uropathogen in this study was *E. coli* followed by *S. aureus*.

CONFLICTS OF INTEREST

The authors declare they have no conflicts of interest.

AUTHORS' CONTRIBUTION

MB, AB and MBn contributed in conceptualization, designing and writing which includes review and editing the manuscript. MB and AB contributed in data collection. MBn contributed in formal analysis. MB writes the original draft. MB, AB and MBn supervised the project. MB, AB and MBn source the funding for the project. However, all the authors review the manuscript and approve the final draft of the manuscript.

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