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CATHETER ASSOCIATED URINARY TRACT INFECTION - A SINGLE CENTRE RISK FACTORS ANALYSIS

General Surgery

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ABSTRACT

Background and Aim: The most frequent causes of UTIs in patients in intensive care units (ICUs) are catheter-associated urinary tract infections (CAUTIs). There are several risk factors linked to its occurrence. The purpose of this study was to identify contaminated bacteria species and their susceptibility profiles to the most widely used antimicrobial drugs, as well as to discover relevant risk factors for urinary tract infections. **Methods:** From October 2022 to March 2023, the study was carried out at the Government Villupuram Medical College and Hospital.This study comprised 180 catheterized patients from several clinical ICU units. Before and after catheterization, two urine samples were collected from each patient. According to accepted microbiological practises, the samples were cultivated. By using standard identification techniques, isolates were identified. All patients were given the questionnaire, which asked questions about their age, gender, and state of health. **Results:** The patients' ages ranged from 15 years old at the youngest to 73 years old at the oldest, with a mean age of 37.82 years. Among them, 84 of the patients were women and 96 (53.33%) were men. Only 93 (51.67%) of the 180 catheterized patients displayed noticeable growth. Age, sex, the length of catheterization, and diabetes were discovered to be the significant risk variables for CAUTI (p 0.05) on multivariate analysis. The urine cultures were all single-microbe cultures. Gram-positive isolated species 24 (25.81%) and Gram-negative isolated species 69 (74.19%) respectively. Most common organism grown in culture was Escherichia coli 27 (29.03%) followed by Klebsiella pneumoniae 18 (19.36%), Pseudomonas aeruginosa 12 (12.90%), Enterococcus fecalis 12 (12.90%), Staphylococcus aureus 9(9.67%), Enterobacter spp 6(6.45%), and Citraobacter spp, Acinetobacter spp, Streptococcus spp 3(3.23). **Conclusion:** Knowing the risk factors that contribute to the development of CAUTI greatly lessens the additional strain on the healthcare system.

KEYWORDS

Urinary catheter, Microbial Infections, Risk Factors, Antimicrobial Susceptibility.

INTRODUCTION

An estimated 35% of people globally experience urinary tract infections [1]. UTI among catheterized patients is on the rise, and inconsistent antibiotic treatment is to blame for the poor patient response to antibiotics. Increased morbidity, death, and extended hospital stays were all associated with catheterized UTI [2,3]. One of the risk factors for CAUTI is the installation of a urinary catheter. The microorganisms linked to CAUTI include bacteria, fungus, and other pathogens [4]. Due to incorrect catheter placement, urine flow restriction, or urine buildup in the bladder that promotes the growth of bacteria, infectious pathogens can enter the bladder through the catheter tubing [5]. Due to the presence of additional CAUTI risk factors, such as advanced age, abnormalities in urinary function, the presence of chronic diseases, and immune dysfunction, as well as reports of inappropriate indwelling urinary catheter use in this population, they are particularly common in elderly patients [6].

The clinical signs and test evidence of a UTI in a patient with an indwelling urethral catheter in situ for more than two days are known as CAUTI, according to the Centres for Disease Control and Prevention. Patients with CAUTI report feeling sick, having a temperature, stiffness, mental changes, weakness, flank pain, blood streaks in the urine, pelvic discomfort, frequent or difficult urination, and suprapubic pain or tenderness [7]. Hospitals are recognised for overusing indwelling urinary catheters, which are frequently utilised as a bladder management method in healthcare [8,9]. They are often employed; according to estimates, 15% to 25% of hospitalised adult patients utilise an indwelling catheter for at least part of their stay [10]. In the intensive care unit (ICU), incidence rates of CA-UTI vary from 3.6 to 14.71 per 1000 urine catheter days [11].

For approximately half of the patients who need an indwelling urine catheter for longer than five days, bacteriuria or candiduria is practically a given. The main factor affecting bacteriuria is the length of catheterization. When an indwelling urinary catheter is in place, there is a 3-7% daily risk of developing CAUTI; the risk is higher in women and older people [12]. Additionally, even asymptomatic bacteriuria may be linked to increased hospital mortality rates, and patients with catheter-associated bacteriuria have a 3% risk of developing bacteremia. [13].

The bacteria that cause CAUTI can be acquired from the hospital as well as from exogenous sources like contaminated healthcare workers' hands or equipment or endogenous sources like rectal, meatal, or vaginal colonisation. In addition, many of these bacteria are already present in patients' endogenous bowel flora. There, they can grow and spread an illness. Bacterial migration in the drainage system may also be caused by contamination of the drainage bag during insertion or rupture in the tubing connection. Additionally, the catheter bag's urine may leak backward into the bladder or the drainage bag may not be changed frequently enough. Improper cleaning of a catheter can also lead to contamination. thereby raising the possibility of CAUTI.

Numerous bacterial species, such as the uropathogenic strains of Staphylococcus aureus, Enterococcus faecalis, Group B Streptococcus, Escherichia coli, Klebsiella pneumoniae, Proteus mirabilis, Pseudomonas aeruginosa, and Enterobacter spp., can result in UTIs, including CAUTIs. Uropathogenic Escherichia coli, however, is the most frequent cause of UTI and CAUTI [16,17]. Therefore, the purpose of this study was to identify contaminated bacterial species and their susceptibility profiles to the most widely used antimicrobial agents, as well as to identify patient- and catheter-related risk factors causing urinary tract infections.

METHODS

Study Design

The Government Villupuram Medical College and Hospital served as the study's site, and samples were gathered there between October 2022 and March 2023. All patients were given the questionnaire, which asked questions about their age, gender, and state of health.

Study Population

The research had 180 patients in all, 96 men and 84 women. Ages ranged from 15 to 73. The participants who took part in the study were from various ICU units. Urine samples from patients before catheterization and urine samples from a bag of catheterized

individuals who were on a catheter for more than 48 hours were both obtained for this investigation.

Sample Collection And Transport

Urine samples were taken straight from the catheter or tubing after the drain end-piece had been cleaned with 0.5% chlorhexidine-alcohol. A sterile needle and syringe were used to aseptically collect urine samples from the distal end of the catheter tube into a sterile urine container, which were then immediately transferred to the microbiology lab for examination. Tests included urine analysis, culture, and testing for antibiotic susceptibility. Data was gathered using Performa for sample characteristics, Performa for the microbiological count in accordance with Centres for Disease Control and Prevention recommendations, and Performa for the CAUTI evaluation checklist, which included a checklist for signs and symptoms of CAUTI. The features of a sample Performa included nine pieces. The CAUTI assessment checklist, for example, includes evaluating the presence of at least one of the following signs or symptoms for the occurrence of symptomatic CAUTI: Feel fever and chills; feel pain in the lower abdomen or groin , experience urinary urgency; experience urinary frequency; dysuria; experience a burning sensation during urination; urine look cloudy and have a strong odour; have blood in the urine; have deposits in the catheter tube.is necessary in accordance with CDC recommendations and Performa for the microbiological count, which entails evaluating the patient to see if they have a positive urine culture with a microbiological count of 105 or above, as advised by CDC recommendations

Isolation And Identification Of Microorganisms

Using a calibrated, sterile wire loop with a transfer capacity of 0.001 mL, urine samples were inoculated onto nutrient agar plates. The inoculation plates were kept at 37°C for 24 hours while being watched for bacterial development. If no growth was seen, the plate was kept for up to 48 hours before being deemed free of bacteria. When one or more organisms are present at quantitative counts 105 CFU/ml from an appropriately collected urine specimen in a patient who has no symptoms suggestive of urinary infection, the bacterial growth on the cultures isolated onto blood agar, mannitol salt agar, MacConkey agar, CLED agar, and CA-ASB is diagnosed after incubation. Prior to the presence of 105 CFU/ml, lower quantitative counts may be isolated from urine specimens, but these lower counts are more likely to represent the presence of microorganisms in biofilms along the catheter than bladder bacteriuria [18]. The commonplace standard laboratory approach allowed for the identification of all strains isolated from the patient. Colony morphology, hemolytic pattern, microscopic analysis, and biochemical testing serve as the foundation for this.

Bacterial Antibiotic Susceptibility Testing

Based on the Kirby Bauer disc diffusion method and the Clinical and Laboratory Standard Institute's recommendations, antimicrobial susceptibility testing was completed. [19-21]. Mueller Hinton agar plates were inoculated with a pure culture of the relevant bacterial isolates. The inoculation plates were put on a set of antibiotic discs after being allowed to dry for 3-5 minutes at room temperature. The following antibiotic discs with their respective concentrations were used: erythromycin [E, 15 µg]; amikacin [AK, 30g]; ampicillin [AM, 10g]; cephalexin [CL, 30g]; gentamycin [GM10 µg]; ciprofloxacin [CIP, 5 µg]); ceftriaxone [CRO 30 µg]; amoxicillin, (AML, 25 µg); nitrofurantoin [F,300 µg]; tetracycline [TE,30 µg].

STATISTICALANALYSIS

In order to import the raw data into SPSS software version 26 (IBM Corp., Armonk, New York, USA), spreadsheets with the raw data were first inputted into. A percentage, mean with corresponding standard deviation for continuous data, frequencies and percentages for categorical variables, and descriptive statistics of demographic and clinical factors were combined and presented. Age was divided into two groups: those under 50 and those above 50. To determine the most common species implicated in CAUTIs, several species of bacteria were sorted out and their proportions in each isolated bacterium were compared. In order to compare CAUTI instances by age group and gender, the Chi-square test was utilised; assessments were conducted at a 95% confidence level, and P 0.05 was regarded as statistically significant. Tables were used to show the results.

RESULTS

The research had 180 patients in all. Table 1 lists the research participant's demographic and medical characteristics. The patient's ages ranged from 15 years old at the youngest to 73 years old at the oldest, with 44 years old as the mean. According to the data, 96 (53.33%) of the 180 patients were male and 84 (46.67%) were female. After 48 hours of catheterization, the urine culture from 180 catheterized patients exhibited substantial development, indicating an overall CAUTI incidence of 93 (51.67%) individuals.

Table 1. Demographic And Clinical Characteristics Of Study Participants

Variable	Total tested (180)	Bacterial CAUTIs, 93(52%)	P value
Male Female	96(53.33%) 84(46.67%)	36(38.71%) 57(61.29%)	0.200
Age category	≤ 50 years	> 50 years	0.00
Positive, n (%) Negative, n (%)	30 (32.26%) 66(77.78%)	63(67.74%) 21(22.22%)	
Gender	Male	Female	0.02
Positive, n (%) Negative, n (%)	36(38.71%) 60(68.97%)	57(61.29%) 27(31.03%)	
Catheter days stay	≤ Week, n (%)	> Week n (%)	0.03
Positive, n (%) Negative, n (%)	18(19.35%) 39(44.83%)	75(80.65%) 48(55.17%)	
Diabetes	Present	Absent	0.020
Positive, n (%) Negative, n (%)	42(45.16%) 15(17.24%)	51(54.84%) 72(82.76%)	
Urethral swelling around the catheter	Present	Absent	0.00
Positive, n (%) Negative, n (%)	48(51.61%) 12(13.79%)	45(48.39%) 75(86.21%)	

The findings reveal a statistically significant difference in CAUTI incidence by gender (2 (1) = 5.511, P = 0.02), with females having more cases of the infection (n=57, 61.29%) and males having fewer cases (n=36, 38.71%). There was also a statistically significant difference in CAUTI incidence by the length of catheter stays (2 (1) = 4.492, P = 0.034). When compared to patients with short catheter days (n = 18; 19.35%), patients with longer catheter days (n = 75; 80.65%) had more CAUTI cases. Patients under 50 years old had more instances of CAUTI than patients over 50 years old (n = 30 (32.26%), demonstrating statistically significant variations in the incidence of CAUTI by age group (2 (1) = 11.446, P = 0.00). The next two significant risk variables for CAUTI were shown to be diabetes (2 (1) = 5.398, P = 0.020), and urethral edema surrounding the catheter (2 (1) = 9.644, P = 0.00). According to Table [1], the drainage system and length of catheterization were the two most crucial ones.

Table 2. Frequency And Percentage Of Patients According To The Signs And Symptoms Of CAUTI

Characteristics	Yes, n(%)	No, n(%)
Feel pain in the lower abdomen or groin	42(23.33%)	138(76.67%)
Feel fever and chills	60(33.33%)	120(66.67%)
Urinary urgency	72(40%)	108(60%)
Urinary frequency	84(46.67%)	96(53.33%)
Dysuria	66(36.67%)	114(63.33%)
Feel a burning sensation during urination	69(38.33%)	111(61.67%)
Urine looks cloudy and has a strong odour	87(48.33%)	93(51.67%)
Blood in the urine	54(30%)	126(70%)
Deposits in the catheter tube	72(40%)	108(60%)

The results of the urine culture are shown in Table [3]. The urine cultures were all single-microbe cultures. Gram-positive isolated species 24 (25.81%) and Gram-negative isolated species 69 (74.19%) respectively. Escherichia coli was the most frequent organism grown in culture with a prevalence of 27 (29.03%), followed by Klebsiella pneumoniae (18 (19.36%), Pseudomonas aeruginosa (12(12.90%), Enterococcus fecalis (12(12.90%), Staphylococcus aureus (9(9.68%), Enterobacter spp. (6(6.45%), Citrobacter spp.

Table 3. Species Isolated From Bacteremia Attributed To Catheter-acquired Urinary Infection

Variable	Number, n= (93)	%
Gram-negative isolated species		
Escherichia coli	27	29.03%
Klebsiella pneumoniae	18	19.35%
Pseudomonas aeruginosa	12	12.90%

Enterobacter spp	6	6.45%
Citrobacter spp	3	3.23%
Acinetobacter baumannii	3	3.23%
Gram-positive isolated species		
Enterococcus fecalis	12	12.90%
Staphylococcus aureus	9	9.68%
Streptococcus spp	3	3.23%

Tests for antibiotic susceptibility were performed on 93 (51.67%) of the identified bacterium isolates. high resistance in the gathering of gram-negative isolates. All tested antimicrobials were completely ineffective against Acinetobacter baumannii. As demonstrated in Table [4], gram-positive isolates shown severe resistance to AK, CIP, AML 100%, 75%, Staphylococcus aureus, and Enterococcus fecalis, respectively.

Table 4. Prevalence And Antimicrobial Resistance Of Bacterial Agents Isolated From CAUTI

Anti-biotic	E. coli n = 27	K. pneumoniae n=18	P. aeruginosa n = 12	Entero-bacter spp n = 6	Citro-bacter spp n = 3	A. bau-mannii n = 3	S aureus n = 9	E. fecalis n=12
E (15 µg)	19(70.37 %)	6(33.33%)	3 (25%)	0	0	3(100 %)	3(33.33 %)	6(50 %)
AK (30 µg)	18(66.67 %)	6(33.33%)	3 (25%)	0	0	3(100 %)	9(100 %)	3(25 %)
AM (10 µg)	19(70.37 %)	6(33.33%)	6 (50%)	3 (50%)	3(100 %)	3(100 %)	3(33.33 %)	3(25 %)
CL (30 µg)	9(33.33 %)	3(16.67%)	6 (50%)	3 (50%)	3(100 %)	3(100 %)	3(33.33 %)	6(50 %)
GM (10 µg)	6(22.22 %)	3(16.67%)	3 (25%)	3 (50%)	3(100 %)	3(100 %)	9(100 %)	3(25 %)
CIP (5µg)	19(70.37 %)	6(33.33%)	0	3 (50%)	0	3(100 %)	9(100 %)	9(75 %)
CRO (30 µg)	9(33.33 %)	6(33.33%)	3 (25%)	0	3(100 %)	3(100 %)	3(33.33 %)	6(50 %)
AML (25 µg)	9(33.33 %)	6(33.33%)	6 (50%)	3 (50%)	3(100 %)	3(100 %)	9(100 %)	9(75 %)
F(300 µg)	15(55.56 %)	15(83.33%)	6 (50%)	3 (50%)	3(100 %)	3(100 %)	6(66.67 %)	3(25 %)
TE (30 µg)	12(44.44 %)	6(33.33%)	6 (50%)	3 (50%)	3(100 %)	3(100 %)	3(33.33 %)	3(25 %)

Erythromycin [E, 15 µg]; Amikacin [AK, 30g]; [CRO 30 µg]; Ampicillin [AM, 10g]; Cephalexin [CL, 30g]; Gentamycin [GM10 µg]; Ciprofloxacin [CIP, 5 µg]); Ceftriaxone Amoxicillin, (AML, 25 µg); Nitrofurantoin [F,300 µg]; Tetracycline [TE,30 µg].

DISCUSSION

Most urological patients regularly use indwelling urinary catheters. The advantages of the catheters must be balanced against any possible drawbacks, as with any medical breakthrough. CAUTI is the most typical adverse effect. Certain risk factors that were significantly linked to CAUTI have been identified in prior research [22]. In our investigation, five variables were independently related with a higher incidence of catheter-associated UTIs. Age (p-value 0.00), since catheterized individuals over 50 had a higher risk of acquiring CAUTI due to lowered immunity in their bodies [12, 23]. Gender (p-value 0.02) showed that females had a considerably higher risk. because females have shorter urethras and theirs is closer to the perineum, which increases the risk. The length of the catheterization was shown to be a highly important risk factor (p-value: 0.03). It was also shown that a prolonged catheterization period is linked to a higher risk of rising intra- or extraluminal infections. The length of catheterization was the most significant risk factor for CAUTI in a research done in an Indian hospital by Leelakrishna (P-value 0.0001) [22]. In a research by [24] that is comparable to ours, diabetics were repeatedly shown to be related with an elevated incidence of CAUTI (P-value 0.02). The perineum of diabetics has an increased microbial population, and diabetic urine also provides a favourable environment for microbial development.

Although further research is needed, altered host immunity in diabetics may also be important. Urethral enlargement close to the catheter (P = 0.00). In our study, the prevalence of CAUTI was 51.67%, which is close to research by Benson Musinguzi et al., who found a CAUTI prevalence of 51.4%. The incidence of CAUTI was 51.67%, indicating a significant risk of getting hospital-acquired CAUTI in patients at the University Teaching Hospital who have indwelling urinary catheters. Numerous studies [25] concur with this study. [26] [12] [23]. that the most typical hospital-acquired illness among hospitalised patients is CAUTI. Poor cleanliness procedures while handling catheters may be to blame for the increased prevalence of CAUTI at University Teaching Hospital [27].

According to the current study, Australia had a CAUTI incidence of 0.9% as opposed to 51.67%. This result illustrates how important good cleanliness is in preventing CAUTI. According to the study's findings, patients with long-lasting urethral catheters have higher incidences of CAUTI. This is consistent with earlier discoveries.[26]. The likelihood of having CAUTI increases with the amount of time the catheter is left in place. From day 5 onward, the risk of developing catheter-associated bacteriuria increases by 5% per day, reaching 100% when the urethral catheter is left in place for four weeks [22]. Due to decreased immunity, the frequency was particularly high in older individuals [26].

In our investigation, five variables were independently related with a higher incidence of catheter-associated UTIs. The following variables were discovered to be major risk factors: age, length of catheterization, diabetes, and urethral edoema surrounding the catheter. The prevalence of Gram-negative bacilli, particularly E. coli and K. pneumoniae, is consistent with a research conducted in Benin that identified gram-negative bacilli as the primary cause of CAUTI that develops in hospitals [27]. This could be the result of enteric bacteria colonising the perineum after entering the urinary system after catheterization [28].

In order to colonise and survive in the urinary system, gram-negative bacteria that cause CAUTI have a number of virulence characteristics linked to motility, adhesion, immunological evasion, biofilm formation, and nutrition acquisition [29]. Staphylococcus aureus, E. fecalis in this study, and S. aureus, a fact that can be related to the presence of lipoteic acid in the cell wall, seldom cause UTI. This makes it easier for the bacteria to stick to the mucosal epithelium and prevents it from being washed out during urine [30].

In 51.67% of utilised urinary catheters, a single bacterial strain grew to its maximum size. Antibiotic resistance is a global issue that is becoming worse. E. coli had the highest level of antibiotic resistance in this research Table [5]. Additionally, every bacteria isolate exhibited resistance to the common antibiotics prescribed to treat UTIs. Because of this, doctors find it challenging to provide a wide range of medicines to CAUTI patients who are catheterized.

Amoxycillin was discovered to be the most resistant drug in all the isolated pathogens, Enterococcus fecalis and Staphylococcus aureus. All Gram-negative isolates were sensitive to Imipenem and Gentamicin more than the isolates that were sensitive to Amikacin the isolates were sensitive to ciprofloxacin and Gatifloxacin. Ciprofloxacin, Amikacin, Gatifloxacin, and Ceftriaxone are effective against E. coli, P. aeruginosa, E. fecalis, and S. aureus, and Gatifloxacin has the highest antibiotic sensitivity. Cefixime-resistant E. faecalis Table [3].

CONCLUSION

The critical device-associated healthcare-acquired illness known as CAUTI. A higher incidence of symptomatic urinary tract infection and bacteremia is linked to the use of an indwelling urethral catheter. Government Villupuram Medical College has a high incidence of CAUTI (51.67%) among patients with indwelling urinary catheters, and it is mostly brought on by E. coli and K. pneumoniae. Antibiotics that are often used do not work on certain bacteria. In order to avoid CAUTIs, it is important to utilise culture and sensitivity testing before prescribing antibiotics.

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