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Article

Catheter-associated Urinary Tract Infection in Intensive Care Unit Patients at a Tertiary Care Hospital, Hail, Kingdom of Saudi Arabia

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Abstract: Catheter-associated urinary tract infection (CAUTI) is one of the most common hospital-acquired infections (HAIs). Prolonged hospitalization, invasive devices such as catheters, and irrational use of antimicrobial agents are believed to be the major causes of high rates of HAIs. Infections such as pyelonephritis, urethritis, cystitis, and prostatitis are the main concern in catheterized ICU patients. In these cases, Gram-negative bacteria are the most common. The present study is undertaken to determine the frequency, antibiograms, disease pattern, and risk factors involved in providing an advocacy recommendation to prevent CAUTI. A total of 1078 patients were admitted to the hospital ICU, out of which healthcare-associated infection was reported in 316 patients. CAUTI was reported only in 70 patients. *Klebsiella pneumoniae* (20%) was the predominant isolate, with *Serratia* (3%) and *Providencia* (3%) species as the least common in this study. The present study provides CAUTI incidence rates in a tertiary care hospital in Hail, Saudi Arabia. Furthermore, information on risk factors of CAUTI common causative organism associated, and their antibiogram patterns are also presented. This study provides vital information that can be used to formulate an effective antibiotic stewardship program that can be implemented throughout the kingdom.

Keywords: Catheter-associated urinary tract infections (CAUTI); Klebsiella pneumoniae; Hospital-acquired infections; Proteus mirabilis; Pseudomonas aeruginosa; antibiogram

1. Introduction

Catheter-associated urinary tract infections (CAUTI) are the most common hospital-acquired infections (HAI). Prolonged hospitalization, use of invasive devices like catheters, and irrational use of antimicrobial agents are believed to be the major causes of a higher rate of HAI [1]. It is estimated that infections in acute care units in hospitals represent more than 30% of annual infections [2]. Central line-associated bloodstream infections (CLABSI) are the most common hospital-acquired infections related to invasive devices [3], followed by catheter-associated urinary tract infections (CAUTIs) and ventilator-associated pneumonia (VAP) [4].

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During hospitalization, indwelling urethral catheter accounts for about 80% of urinary tract infections [3]. For each patient, the test result and frequency of a urinary tract infection can differ significantly, depending on age, comorbidities, and socioeconomic status. Gram-negative bacteria, like *Escherichia coli*, *Klebsiella spp*., *Proteus mirabilis*, *Pseudomonas aeruginosa*, and *Citrobacter spp*., are the predominant isolates in urinary tract infections. While Gram-positive bacteria such as *Staphylococcus aureus* and *Enterococcus species* are the most common [5,6]. On the other hand, secondary hospital-acquired bloodstream infections may occur post-catheter-associated urinary tract infections, as 17% of nosocomial bacteremia emerge from urinary tract infections with an associated mortality of 10% [7]. A long-term hospitalization inferable to device-related infections should be an avoidable situation; moreover, there is an increase in treatment costs and risk of lethality for patients whenever it occurs. The present study was undertaken to determine the frequency, antibiogram, disease pattern, and risk factors involved and to offer an advocacy recommendation for preventing CAUTI.

2. Materials and Methods

Study design, duration, and settings

The present study is a cross-sectional hospital-based study conducted in the division of Microbiology, Department of Pathology, College of Medicine, University of Hail, Hail, Kingdom of Saudi Arabia (KSA) from January 2020 to December 2021. The patient information was obtained from the ICU of King Khalid hospital, Hail, KSA.

Study population

The study included adult patients ≥18 years who were admitted to ICU during the study period with medical conditions including urinary tract infection (UTI) and were catheterized using a Foley catheter. While patients who were admitted with positive urine cultures before catheterization were excluded from the study.

Ethical considerations

This research was performed after obtaining approval from the Ethics Committee, Research Deanship, University of Hail (H-2020-236, letter number 23561/5/42; IRB Registration Number with KACS: H-08-L-074). Before enrolling in this study all the participants were requested to sign informed consent forms. All the study-related information and data were secured by using unique identifying numbers to ensure confidentiality throughout the study.

Study tools and data and sample collection

Patient information, including demographics (age, sex), clinical data, type and cause of admission, risk factors, comorbidities, causes of urinary catheterization, antibiogram, and outcome of CAUTI management, was collected from the medical record files. No personally identifiable information was retrieved.

For quantitative microbiological culture, 10ml of midstream urine sample was collected from the catheter tube using a sterile disposable syringe in a sterile universal container from each patient. While collecting the urine sample, all mandatory aseptic precautions were taken as the site of aspiration in the catheter tube was primarily cleaned using 70% ethanol. The catheter tube was clamped proximally to the urethral or suprapubic opening to collect freshly voided urine. Freshly collected samples were then sent to the microbiology department in a cold storage transfer container without delay.

Urine culture and microscopic examination

Direct wet mount of uncentrifuged urine samples was done to determine pyuria and bacteriuria under a high-power field. Urine samples were then directly inoculated on a BD Cysteine-lactose-electrolyte-deficient (CLED) agar plate using a standard dimension disposable plastic inoculating loop with an internal diameter of 3.26 mm. The dish was then incubated at 37^{o} C for 16-18 hrs in an incubator. The number of the colonies was counted using a microprocessor colony counter, and this number was used to calculate the number of viable bacteria per ml of urine. Thus, if 0.001 ml of urine yields 100 colonies,

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the count per ml will be 105, or just indicative of significant bacteriuria. Hence, with significant growth, ≥105 CFU/ml, isolates were identified as possible species levels by the conventional method using a standard biochemical media (catalase, oxidase Invitrogen Amplex Red, slide coagulase Thermo Scientific Oxoid, Indole Kovac's reagent, Methyl red CH-METHRED, Citrate utilization test, Christensen's urease agar HIMEDIA M1125-500G, TSI agar CHEMsolute, Bile esculin HIMEDIA M972A-500G) as per the requirements for both Gram-negative and Gram-positive bacteria as reported in earlier studies [8,9]. Further, it was confirmed by the BD Phoenix M50 system (BD Diagnostic Systems, Oxford, UK) with antibiotic susceptibility pattern according to the manufacturer's recommendations.

Preliminary identification was made by the conventional method. In contrast, the automated method was based on chromogenic and fluorogenic reactions, and the AST was based on turbidimetry and redox reactions to determine each antibiotic's minimal inhibitory concentration (MIC) as per CLSI guidelines 2020 [10].

3. Results

A total of 1078 patients were admitted to the hospital's intensive care unit, of which HAI was reported in 316 patients. Among these, CAUTI was reported only in 70 patients. Table 1 shows patients' demographics reported with CAUTI. The most common age group seen with CAUTI infection was 70-80 years (n=21, 30%), followed by 60-70 years (n=16, 23%), 50-60 years (n=12, 17%) with least in 30-40 years (n=2, 3%). Significantly, more male patients had CAUTI compared to female patients, with a ratio of 1.12 (37/33). Under BMI distribution, 28 patients were overweight (40%), while 12 were obese (17%).

Table 1. Age and gender-specific frequency of CAUTI in the study participants.

Age group (years)	Number of Patients	Percentage (%)
20-30	5	7
30-40	2	3
40-50	5	7
50-60	12	17
60-70	16	23
70-80	21	30
80-90	9	13
Sex		
Male	37	53
Female	33	47
BMI		
Underweight	11	16
Normal weight	19	27
Overweight	28	40
Obese	12	17

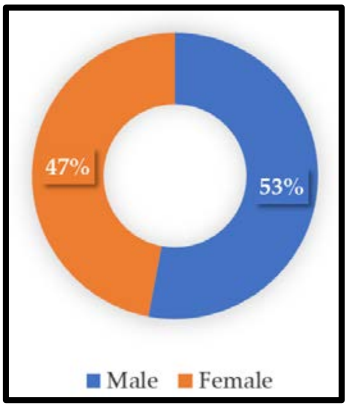

Figure 1. Gender-specific distribution of patients with CAUTI in the study participants.

Table 2 depicts that most patients had urethral catheterization 51 (73%) with few suprapubic catheterizations 19 (27%). 16Fr catheter size is the most common (n=42, 60%), with the least common size 18Fr (17%). The majority of the patients with long-term indwelling urethral catheterization (IUC) had a significantly higher prevalence of CAUTI 37 (53%) than those with short-term IUC 13 (13%). Significantly, the patients with long-term IUC had benign prostatic hypertrophy (BPH) 37 (53%) than patients with short-term IUC. The major number with IUC had no other comorbidities (n=42, 60%).

Table 2. Clinical characteristics of patients with CAUTI in the study participants.

Patient characteristics	Type of catheter (N=70)	Percentage (%)	p-value
Urethral type	51	73	<0.05
Supra-pubic type	19	27	
Cather size (French size) Fr			
14Fr	16	23	<0.05
16Fr	42	60	
18Fr	12	17	
Duration of indwelling urethral catheterization (days)			
0-14	13	18.5	<0.05
15-30	20	28.5	
>31	37	53	
Implication for catheterization			
Urine retention	2	3	<0.05
Urethral stricture	9	13	
Benign prostatic hyperplasia	37	53	
Urinary incontinence	20	27	
Others	2	3	
Comorbidity factors			
With comorbidity	28	40	>0.05
Without comorbidity	42	60	

Table 3 represents the symptoms persisted by the study group, where fever is the most common symptom (n=23, 33%), followed by flank pain (n=14, 20%), urinary urgency (n=9, 13%), and suprapubic pain (n=8, 11%) with haematuria (n=3, 4%) as the least recorded symptom.

Table 3. Rate and frequencies of CAUTI patients with clinical symptoms.

Symptoms	Number of patients (N=70)	Percentage (%)
Only Fever	23	33
Flank pain	14	20
Suprapubic pain	8	11
Fever; suprapubic pain	6	9
Dysuria	7	10
Urinary urgency	9	13
Haematuria	3	4
Confusion	0	0

Table 4 shows the month-wise distribution of bacterial isolates from CAUTI in ICU patients. The months were categorized into two seasons: Summer (March to August) and Winter (September to February). Figure 2 shows that more cases of CAUTI were seen during winter (n=37, 53%) than in summer (n=33, 47%).

Table 4. Month-wise distribution of bacterial isolates from CAUTI patients.

Month	Isolate number (n)	Percentage (%)
January	2	3
February	5	7
March	5	7
April	7	10
May	2	3
June	7	10
July	7	10
August	5	7
September	14	20
October	9	13
November	2	3
December	5	7
Total	**70**	**100**

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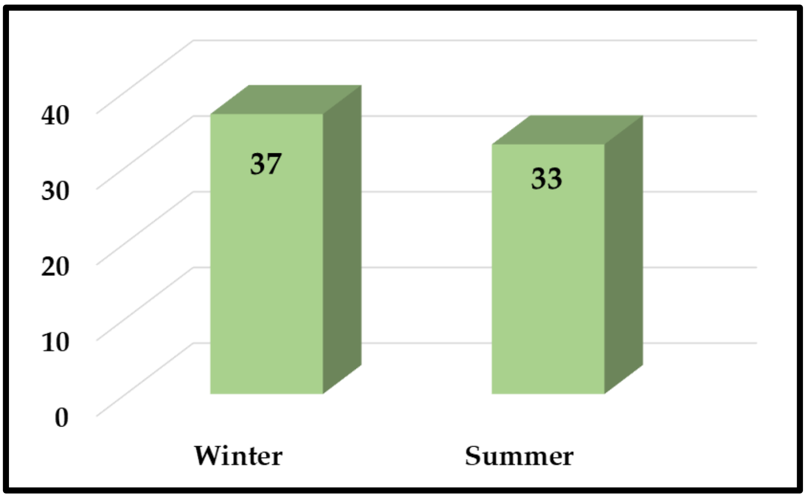

Figure 2. Number of uropathogens from CAUTI patients during summer and winter.

In this study, the most common bacterial species found associated with CAUTI was *Klebsiella pneumoniae* (n=15, 21%), followed by *Proteus mirabilis* (n=12, 17%), *Pseudomonas aeruginosa* and *Enterococcus faecalis* (n=9, 13%) each respectively (Table 5). We found two uncommon bacterial isolates in our setting: *Serratia* [*S. marcescens* (n=5, 7%), *S. macalane* (n=2, 3%), and *S. plymuthica* (n=2, 3%)], and *Providencia stuartii* (n=2, 3%).

Table 5. Rate of bacterial species identified from CAUTI patients

Bacteria	CAUTI	Percentage (%)
Acinetobacter baumannii	5	7
Escherichia coli	7	10
Enterococcus faecalis	9	13
Klebsiella oxytoca	2	3
Klebsiella pneumoniae	15	21
Proteus mirabilis	12	17
Providencia stuartii	2	3
Pseudomonas aeruginosa	9	13
Serratia macalane	2	3
Serratia marcescens	5	7
Serratia plymuthica	2	3
Total	**70**	**100**

The antimicrobial susceptibility pattern of *Klebsiella pneumoniae* (Table 6) showed high sensitivity towards amikacin (100%), followed by colistin, gentamicin, and imipenem (86.7%). In contrast, cefepime, levofloxacin, meropenem, piperacillin/tazobactam, and sulfamethoxazole/Trimethoprim were only 66.7% sensitive. 53.3% sensitivity was seen with ciprofloxacin, ceftazidime, teicoplanin, and amoxiclav. High resistance of *Klebsiella pneumoniae* was observed for ceftriaxone, mupirocin, TEG, and tigecycline (80%) followed by nitrofurantoin, aztreonam, cefuroxime, and cephalothin (66.7%). In our setting, empirical therapy was based on epidemiological data, antibiograms, and hospital guidelines where broad-spectrum antibiotics were avoided in the first line of antimicrobial treatment. For *Klebsiella pneumoniae*-like bacterium, amoxiclav and nitrofurantoin were

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prescribed as the first line of therapy. In our study, nitrofurantoin was prescribed as the first choice of drug for uropathogens, but we reported high resistance to it (66.7%). We further found less susceptibility against ciprofloxacin for *K. pneumoniae* (46.7%), which might be because ciprofloxacin is one of the most widely administered antibiotics in our setting.

Table 6. Antibiogram pattern of *Klebsiella pneumoniae*, the predominant isolate recovered from CAUTI patients

Antibiotics	Sensitive n=15	Sensitive %	Resistant n=15	Resistant %
Amikacin (30 µg)	15	100	-	-
Cefepime (30 µg)	10	66.7	5	33.4
Colistin (10 µg)	13	86.7	2	13.4
Gentamicin (10 µg)	13	86.7	2	13.4
Ciprofloxacin (5 µg)	8	53.4	7	46.7
Levofloxacin (5 µg)	10	66.7	5	33.4
Meropenem (10 µg)	10	66.7	5	33.4
Ceftazidime (30 µg)	8	53.4	7	46.7
Ceftriaxone (30 µg)	3	20	12	80
Imipenem (10 µg)	13	86.7	2	13.4
Piperacillin/tazobactam (100 µg/10 µg	10	66.7	5	33.4
Teicoplanin (30 µg)	8	53.4	7	46.7
Cefoxitin (30 µg)	13	86.7	2	13.4
Nitrofurantoin (300 µg)	5	33.4	10	66.7
Ertapenem (10 µg)	13	86.7	2	13.4
Aztreonam (30 µg)	5	33.4	10	66.7
Amoxiclav (20-10 µg)	8	53.4	7	46.7
Sulfamethoxazole/Trimethoprim (1.25/23.75 µg)	10	66.7	5	33.4
Mupirocin (200 µg)	3	20	12	80
Cefuroxime (30 µg)	5	33.4	10	66.7
Cephalothin (30 µg)	5	33.4	10	66.7
TEG	3	20	12	80
Tigecycline (15 µg)	3	20	12	80

Susceptibility pattern against *Proteus mirabilis* was also investigated (Table 7). It was highly sensitive to nitrofurantoin and cefoxitin (100%), followed by amikacin, piperacillin/tazobactam, ertapenem (83.3%), amoxiclav (58.3%), and meropenem (50%). High resistance of *Proteus mirabilis* was also observed for cefepime, colistin, levofloxacin, sulfamethoxazole/trimethoprim, daptomycin, linezolid, tetracycline, vancomycin, erythromycin, and TZP (83.3%), followed by mupirocin (58.3%). *Pseudomonas aeruginosa* was highly sensitive to amikacin, cefepime, colistin, ciprofloxacin, and ceftazidime (100%), followed by gentamicin, imipenem (77.8%), levofloxacin and meropenem (55.6%; Table 7). It was highly resistant against piperacillin/tazobactam, teicoplanin, cefoxitin, aztreonam, sulfamethoxazole/trimethoprim, TZP (77.8%), and imipenem (66.7%). *Enterococcus faecalis* was highly sensitive to daptomycin (100%), followed by vancomycin, ampicillin, moxifloxacin (77.8%), nitrofurantoin, amoxiclav, sulfamethoxazole/trimethoprim and linezolid

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(66.7%), whereas ciprofloxacin was only (55.6%) sensitive. This bacterium is highly resistant to ceftazidime, teicoplanin, and fusidic acid (77.8%; Table 7).

Table 7. Antibiogram pattern of remaining bacterial isolates from CAUTI patients

Antibiotics	***S. marcescens* (n=5)**	***E. coli* (n=7)**	***E. faecalis* (n=9)**	***P. mirabilis* (n=12)**	***P. aeruginosa* (n=9)**
Amikacin (30 µg)	5	7	-	10	9
Cefepime (30 µg)	5	5	-	2	9
Colistin (10 µg)	3	7	-	2	9
Gentamycin (10 µg)	5	7	-	-	7
Ciprofloxacin (5 µg)	3	5	5	-	9
Levofloxacin (5 µg)	5	5	-	2	5
Meropenem (10 µg)	5	7	-	6	5
Ceftazidime (30 µg)	5	5	2	-	9
Ceftriaxone (30 µg)	3	-	-	-	3
Imipenem (10 µg)	3	7	-	-	7
Piperacillin/Tazobactam (100 µg/10 µg)	5	-	-	10	2
Teicoplanin (30 µg)	-	5	2	-	2
Cefoxitin (30 µg)	2	7	-	12	2
Nitrofurantoin (300 µg)	-	2	6	12	-
Ertapenem (10 µg)	3	7	-	10	-
Aztreonam (30 µg)	5	2	-	-	2
Amoxiclav (20-10 µg)	-	2	6	7	-
Sulfamethox/Trimethoprim (1.25/23.75 µg)	5	5	6	2	2
Daptomycin	-	-	9	2	-
Linezolid (30 µg)	-	-	6	2	-
Mupirocin (200 µg)	-	-	-	5	-
Tetracycline (30 µg)	-	-	5	2	-
Vancomycin (30 µg)	-	-	7	2	-
Erythromycin (15 µg)	-	-	-	2	-
Ampicillin (10 µg)	2	-	7	-	-
Moxifloxacin (5 µg)	-	-	7	-	-
Taxobactam/Pipril (TZP)	-	-	-	2	2
Fusidic acid (10 µg)	-	-	2	-	-
Cefotaxime (30 µg)	3	-	-	-	-

Table 7 cont.

ANTIBIOTICS	*P. stuartii (n=2)*	*A. baumannii (n=5)*	*K. oxytoca (n=2)*	*S. macalane (n=2)*	*S. plymathica (n=2)*
Amikacin (30 µg)	2	5	-	2	-
Cefepime (30 µg)	2	-	-	2	-
Colistin (10 µg)	-	3	2	2	-
Gentamicin (10 µg)	-	3	2	2	-
Ciprofloxacin (5 µg)	-	3	-	2	-
Levofloxacin (5 µg)	-	-	-	2	-
Meropenem (10 µg)	-	-	-	2	-
Ceftazidime (30 µg)	2	-	-	2	-
Ceftriaxone (30 µg)	-	-	-	-	-
Imipenem (10 µg)	-	-	-	-	2
Pipiracillin/Tazobactum (100 µg/10 µg)	-	-	-	2	2
Teicoplanin (30 µg)	-	-	-	-	-
Cefoxitin (30 µg)	2	-	-	-	2
Nitrofurantoin (300 µg)	-	-	-	-	-
Ertapenem (10 µg)	2	-	-	2	2
Aztreonam (30 µg)	2	-	-	-	-
Amoxil/Clav 20/10 µg)	-	-	-	2	-
Sulfamethoxazole/Trimethoprim (1.25/23.75 µg)	2	-	-	-	2
Cefuroxime (30 µg)	2	-	-	-	-

4. Discussion

Urinary tract infection is one of the most common clinical conditions in human medicine, which affects a wide range of the population of discrete groups irrespective of age and gender. Long-term UTIs may result in developing chronic diseases. It also dramatically affects the socioeconomic lives of infected individuals, contributing largely to the increased intake of antibiotics. Community-acquired and healthcare-associated urinary tract infections should be considered a serious public health issue and an economic burden. The etiological agents of UTI show diversity, especially in hospital settings, where prolonged catheterization and immunosuppressive drugs are used.

In this study, 1078 patients admitted to the ICU were examined, out of which HAI was reported in 316 (29.3%) patients. CAUTI was reported only in 70 (22%) patients. Our result was comparable with the prevalence rate of other studies like H Bizuayehu et al. (21%) and Vinoth et al. (20%) [11,12]. Irrational use of antibiotics, gender, extremes of age, length of ICU stay, use of immunosuppressive drugs, and indwelling urethral catheterization have been considered risk factors for the increased case of CAUTI in ICU patients. In our study, higher cases of CAUTI were found to be associated with extreme age group patients 37 (52.8%, 37/70) who are between 60-80 years of age. Several studies suggest CAUTI cases increase with advancing age [13-15]. In our research, more male patients were recorded with CAUTI than females with a ratio of 1.12 (37/33], similar to the findings of other authors (1.89, 144/76), (1.67, 102/61) [12,16]. In our study, women's gender was not a risk factor for CAUTI. In contrast, other studies concluded that females had a stronger predisposition to CAUTI [17-19]. Possibly, this result can be explained by a lower number of female patients in our study. In the present study, most patients were presented only with a fever (n=23, 33%), and there was a positive association between the fever and CAUTI. Fever is particularly a common symptom among critically ill patients, and evaluation for CAUTI should be done if fever is present in catheterized patients [7].

Significantly, the patients with a long duration of ICU were older than those with a short period; as in older men, there is an underlying physiological change in the prostate gland (due to benign prostatic hyperplasia) as is seen in this study (n=37, 53%), which subjected them to develop UTI. Numerous studies reported the more prolonged the catheter remains indwelling inside the urethra, the higher the rate of bacteria colonizing the urinary bag and ascending in the drainage tubing towards the bladder, resulting in CAUTI [20,21]. Using the Society for Healthcare Epidemiology of America/Infectious Diseases recommendation, Abdul Muttalib DA et al., 2013, a Saudi Arabian study, concluded that removing the catheter as soon as possible reduced CAUTI [22]. According to a study by Tasseau et al., the risk of CAUTI rose from 19% to 50% when catheterization duration increased from 5 to 14 days. They also reported that each day of catheterization increased the risk of CAUTI development by 5%, depending on the frequent species and its antibiogram. Virtually all patients were found colonized by day 30 in a separate report [23], which was found to be a result of the urinary catheter and disruption of host defense mechanisms, as microbes were able to attach and eventually form biofilms [24-26].

Regarding the catheter size, a significant number of patients used 16Fr size in our study. It is recommended that a smaller size catheter provide better drainage with a 5ml balloon inflated with 10cc sterile water to ensure balloon symmetry for better clearance of the urinary bladder. Irreparable destruction caused to the urethra and bladder neck by using large-size catheters sometimes causes bladder spasms. It also causes hindrance in drainage of the peri-urethral gland, which can enhance the risk of infection [27]. The prevalence of CAUTI in this study was higher in comparison to other studies by Podkovik S et al. (8.5%) and Getliffe K et al. (4.76%) [28,29].

In this study, 100% (70/70) of CAUTIs were due to bacterial aetiologies. Of 70 bacterial isolates, 61 (87%) were gram-negative bacteria and 9 (13%) were gram-positive bacteria. Among the gram-negative bacterial isolates, *Klebsiella pneumoniae* was the predominant isolate (n=15, 21%), followed by *Proteus mirabilis* (n=12, 17%), *Pseudomonas aeruginosa* (n=9, 13%), and *E. coli* (n=7, 10%), with *Serratia* and *Providencia* species as the least common (3%). Of the gram-positive bacteria, *Enterococcus feacalis* (n=9, 13%) was the only isolate reported in this study. Other authors also reported Gram-negative bacteria as the most common etiological agents of CAUTI. But the predominant bacterial isolate reported in our study was contradictory to many other studies that reported *E. coli* as the most common isolate, followed by *Klebsiella pneumoniae* [30-32]. Moreover, another study conducted by Shiva et al. reported that 69.2% of CAUTIs were due to bacterial origin, and 30% were due to pathogenic yeast [16]. Since *Candida* is not on the CDC's list of pathogens that cause CAUTI, a high proportion of *Candidia* cannot be ignored.

The resistance to antimicrobial agents has been reported since its use and is an emerging global worrisome. In our study, all gram-negative isolates show great variation in sensitivity patterns. The *Klebsiella pneumoniae* bacteria shows extreme resistance toward ceftri-

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axone, tigecycline, and TEG (80%), whereas 66.7% of isolates were resistant to nitrofurantoin, aztreonam, cefuroxime, and cephalothin. Moreover, it showed high sensitivity against amikacin (100%), gentamicin (86.7%), and imipenem (86.7%). These patterns are in agreement with the reports of other authors [27,33]. Against aminoglycosides, we noted that most of the K. pneumoniae were far more susceptible to amikacin (100%) than to gentamicin (86.7%).

For *Proteus mirabilis*, absolute susceptibility against nitrofurantoin cefoxitin was reported with high resistance against sulfamethoxazole/trimethoprim, levofloxacin, linezolid, tetracycline, vancomycin, and TZP (83.3%). The third most common isolate of the study, *Pseudomonas aeruginosa*, was highly sensitive toward colistin, amikacin, and ciprofloxacin (100%). This result is in line with another similar study by Alzahrani et al., who reported 100% sensitivity for colistin but with a descending sensitivity for amikacin (70%) and ciprofloxacin (60%) [27]. Ciprofloxacin is a medication that is widely used to treat UTIs. In our setting, we tested this antibiotic against 52 isolates and found that 35 (67%) were sensitive, while only 17 (32.6%) were resistant. This finding suggests that we can consider ciprofloxacin in the first-line treatment of UTI patients.

Multidrug resistance as one of the life-threatening incidences has been increasing significantly globally (34) and is more frequent in healthcare-associated infections than community-acquired infections. In Gram-negative bacteria, extremely high MDR is being reported. The most concerning part of this study was that high counts of Gram-negative bacteria developed MDR strains at varying frequencies. The wide distribution of bacteria from the Enterobacteriaceae family in our study area with easy exchange of plasmids encoding for ESBL and other resistance codons that code for resistance to other classes of antibiotics contributed to the emergence of MDR prevalence in the present study. **5.**

5. Conclusions

The present study provides CAUTI incidence rates in King Khaled Hospital in Hail, Saudi Arabia. A similar situation may exist in other government hospitals in Saudi Arabia. Furthermore, information on risk factors of CAUTI common causative organism associated, and their antibiogram patterns are also presented. This study has significant clinical implications for patient treatment. It provides vital information that can be used to formulate an effective antibiotic stewardship program that can be implemented throughout the kingdom.

6. Patents

This section is not mandatory but may be added if there are patents resulting from the work reported in this manuscript.

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Informed Consent Statement: patients were informed about the research, and informed consent was taken from them.

Data Availability Statement: The original and raw data used and reported in this study is available with the first author and corresponding author.

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