Journal of Cardiovascular Disease Research
ISSN:0975-3583,0976-2833 VOL14,ISSUE05,2023

CATHETER-ASSOCIATED URINARY TRACT INFECTION IN INTENSIVE CARE UNIT PATIENTS AT A TERTIARY CARE HOSPITAL

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Abstract

Background: Catheter-associated urinary tract infections (CAUTIs) are some 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 concerns in catheterized ICU patients. In these cases, Gram-negative bacteria are the most common bacteria. **Aim and objective:** The present study was undertaken to determine the frequency, antibiograms, disease pattern, and risk factors involved in providing an advocacy recommendation to prevent CAUTI. **Material and method**: The present study comprises 100 subjects of both ages and sexes whom clinically confirmed cases of CAUTI, with an age group ranging from 18 to 70 years. The present study provides CAUTI incidence rates in a tertiary care hospital in Index Medical College Hospital and Research Centre, Indore (M.P.)Furthermore, information on the risk factors of common associated CAUTI causative organisms and their antibiogram patterns are also presented. **Result:** CAUTI was reported only in 70 patients. *Klebsiella pneumoniae* (20%) was the predominant isolate, with *Serratia* (3%) and *Providencia* (3%) species being the least common isolates in this study.**Conclusions :** 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 infection (CAUTI); *Klebsiella pneumoniae*, *Proteus mirabilis, Pseudomonas aeruginosa, HAIs*

Introduction

Catheter-associated urinary tract infections (CAUTIs) are the most common hospital acquired infections (HAIs). Prolonged hospitalization, use of invasive devices such as catheters, and irrational use of antimicrobial agents are believed to be the major causes of higher rates of HAIs [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 (CLABSIs) 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]. During hospitalization, indwelling urethral catheters account for about 80% of urinary tract infections [3]. However, catheter placement is not the main reason for the development of UTIs. Catheters may facilitate colonization of the urinary bladder due to poor catheter placement, prolonged catheterization, poor aseptic technique, poor hand hygiene, and poor sepsis of the urethral orifice opening. Hence, catheters are the most common source of infection [5]. For each patient, the test result and frequency of a urinary tract infection can differ significantly, depending on age, comorbidity, and socioeconomic status. Gram-negative bacteria, such as *Escherichia coli*, *Klebsiella* spp., *Proteus mirabilis*, *Pseudomonas aeruginosa*, and *Citrobacter* spp., are the predominant isolates in urinary tract infections. Gram-positive bacteria such as *Staphylococcus aureus* and *Enterococcus species* are the most common [6,7]. On the other hand, secondary hospital-acquired bloodstream infections may occur post catheter-associated urinary tract infections, as 17% of nonsocial bacteria emerges from urinary tract infections, with an associated mortality of 10% [8]. Moreover, asymptomatic bacterial (presence of a significant bacterial count, i.e., >105 CFU/mL in a well-collected urine sample with aseptic precautions from a patient with no signs or symptoms of urinary tract infection) is very common in clinical practice [9]. However, it is associated with a low number of sequel and low morbidity, and in the majority, it is self-limiting except in pregnant women where asymptomatic bacterial should be treated. The most common signs and symptoms of urinary tract infections are fever, flank pain, supra pubic pain, dysphoria, urinary urgency, and hematuria. Long-term hospitalization infer able 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, antibiotics, disease pattern, and risk factors involved and to offer an advocacy recommendation for preventing CAUTIs

MATERIALS AND METHOD

The study was conducted in Index Medical College Hospital and Research Centre, Indore (M.P.) , Department of ICU. Ethical clearances were obtained from the Institutional Ethical Committee and written informed consent was taken from all the cases and controls, before carrying out the study.

Subject Selection

The present study comprises 100 subjects of both ages and sexes whom clinically confirmed cases of CAUTI, with an age group ranging from 18 to 70 years. . The present study provides CAUTI incidence rates in a tertiary care hospital in Index Medical College Hospital and Research Centre, Indore (M.P.) The patients under treatment were also included as cases. Patients with renal failure, Pregnant and other malignancies have been excluded from this study.

Sample Collection

For quantitative microbiological culture, 10 mL of midstream urine sample was collected from the catheter tube using a sterile disposable syringe in a sterile universal container from each patient.

Sample Analysis

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

Statistics Analysis

Occurrence of symptomatic CAUTI was taken as primary outcome. Various personal (age, gender, etc) and clinical parameters (type of disease, steroid use, etc) of the patients were considered as explanatory factors. Descriptive analysis of all the explanatory and outcome parameters was presented as frequencies and percentages. The association between explanatory and outcome variables was analyzed by calculating odds ratios and their 95% confidence intervals. Statistical significance of this association was analyzed using chi square test. Microsoft excel and IBM SPSS version 21 were used for analysis.

RESULTS:

In this study, total of 100 patients were enrolled and included in the final analysis.

Table : Incidence of symptomatic CAUTI

Total Number of cases with Symptomatic CAUTI	28 (28%)
Total Duration of catheterisation (days)	1040
Symptomatic CAUTI rate per 1000 catheter days	28/1040*1000=26.92

The incidence rate of CAUTI per 1000 catheter days was calculated as 26.92 cases in the study population.

Table : Descriptive analysis of age-wise distribution in study group (N=100)

Age Groups	Frequency	Percent
18 to 30 yrs	33	33.0
31 to 40 yrs	24	24.0
41 to 50 yrs	18	18.0
51 to 60 yrs	11	11.0

61 to 70 yrs	10	10.0
71 to 80 yrs	4	4.0

The age distribution of the participants showed, maximum proportion (33%) of subjects belonging to 18 to 30 years. The proportion of subjects with age between 31 to40 years, 41 to 50 yrs, 51 to 60 years, 61 to 70 yrs and 71 to 80 yrs was 24%, 18%, 11% 10 and 4% respectively.

Fig : Pie chart of age groups distribution in study group (N=100)

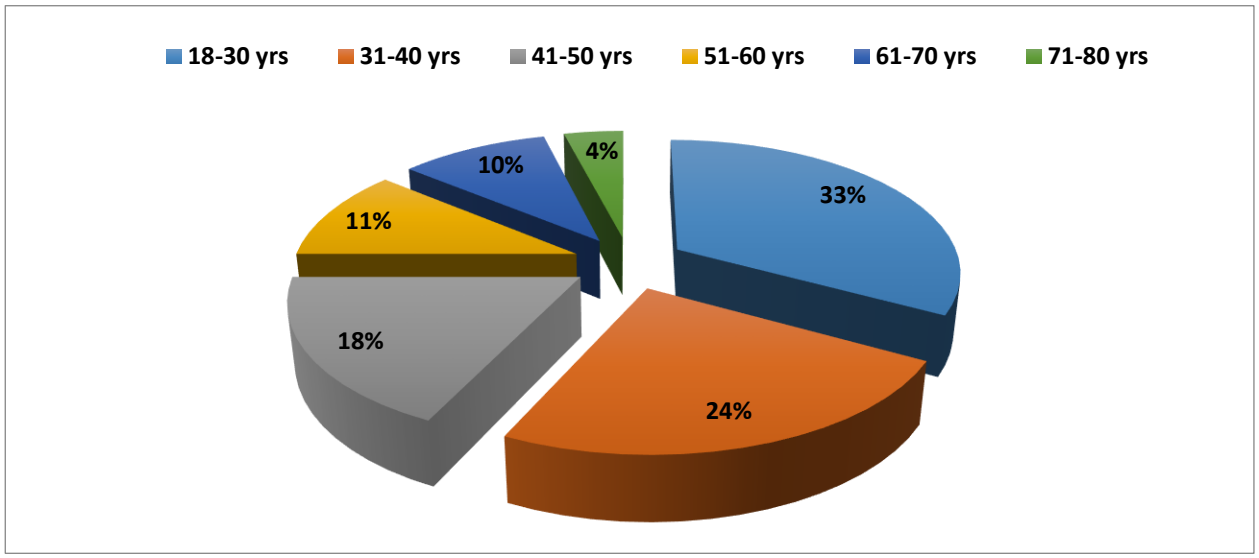
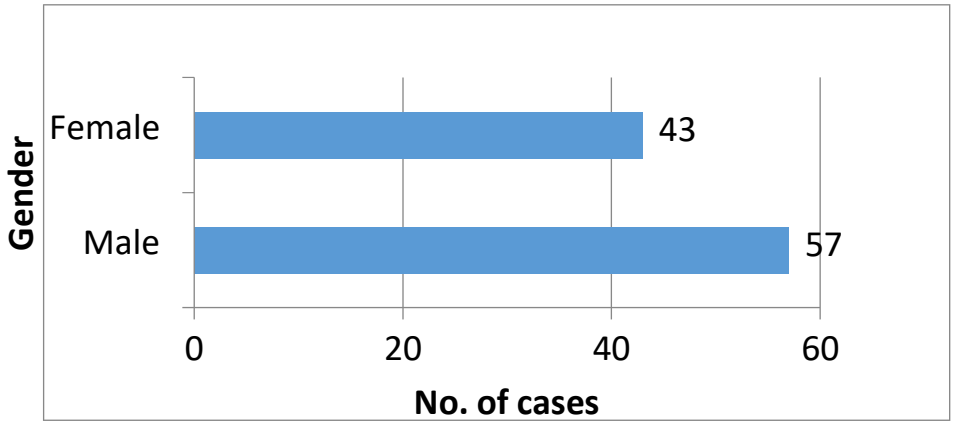


Table: Descriptive analysis of gender distribution in study group (N=100)

Gender	Frequency	Percent
Male	57	57.0
Female	43	43.0

Males constituted 57% and females contributed 43% of study subjects.

Fig: Bar chart of gender distribution in study group (N=100)



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ISSN:0975-3583,0976-2833 VOL14,ISSUE05,2023

Table: Descriptive analysis of CAUTI parameters in study group (N=100)

Parameter	Frequency	Percent
I. Symptomatic CAUTI		
Yes	28	28.0
No	72	72.0
II. Day of development of Symptomatic CAUTI (N=28)		
10	5	17.85
14	21	75.0
21	2	7.14

A total of 28 (28%) of subjects developed symptomatic CAUTI during the hospital stay. Out of symptomatic CAUTI, majority 21 (75%) developed it on 14th day, followed by 5(17.85%), who developed on day 10. Remaining 2(7.14%) subjects developed CAUTIon 21st day.

Table: Descriptive analysis of Organism isolated in study group (N=42)

Organism Isolated	Frequency	Percent
Candida Species	6	14.28
Gram negative bacilli		
Enterobacteriaceae	14	33.34
Non-fermenters	13	30.95
Gram positive organisms	9	21.43
Total	42	100.0

Majority of the organisms isolated belonged to Enterobacteriaceae (33.34%) and non- fermenters (30.95%). Candida species (14.28%) and Gram positive organisms (21.43%) contributed to the remaining portion of the organisms.

Fig: Pie chart organism isolated distribution in study group (N=42)

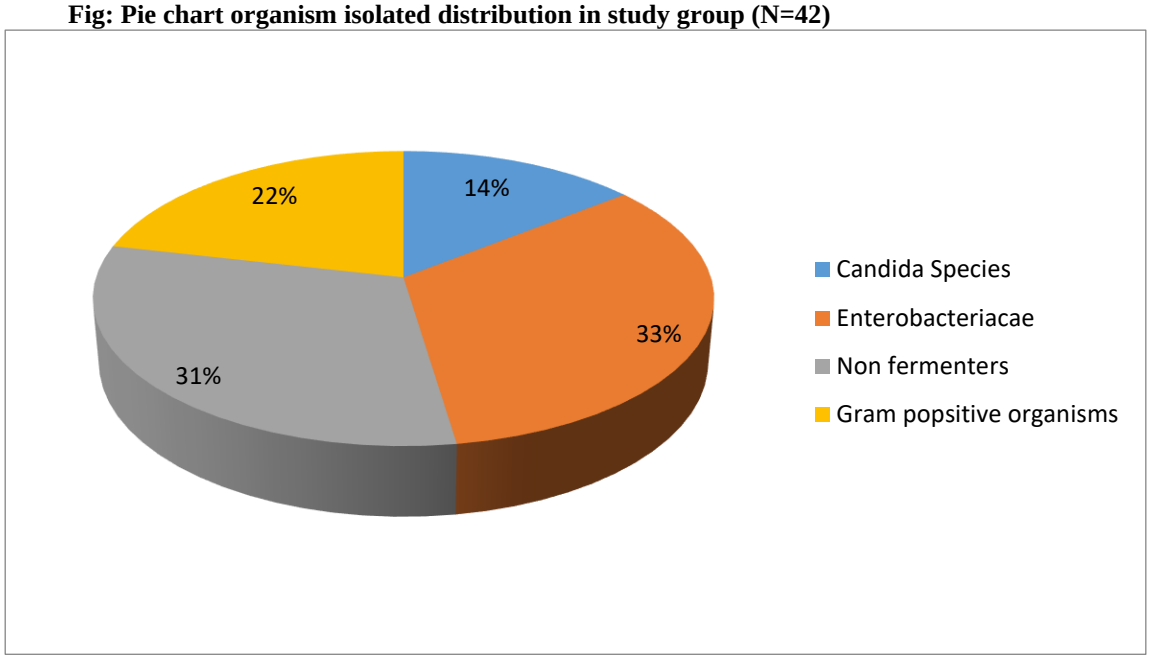


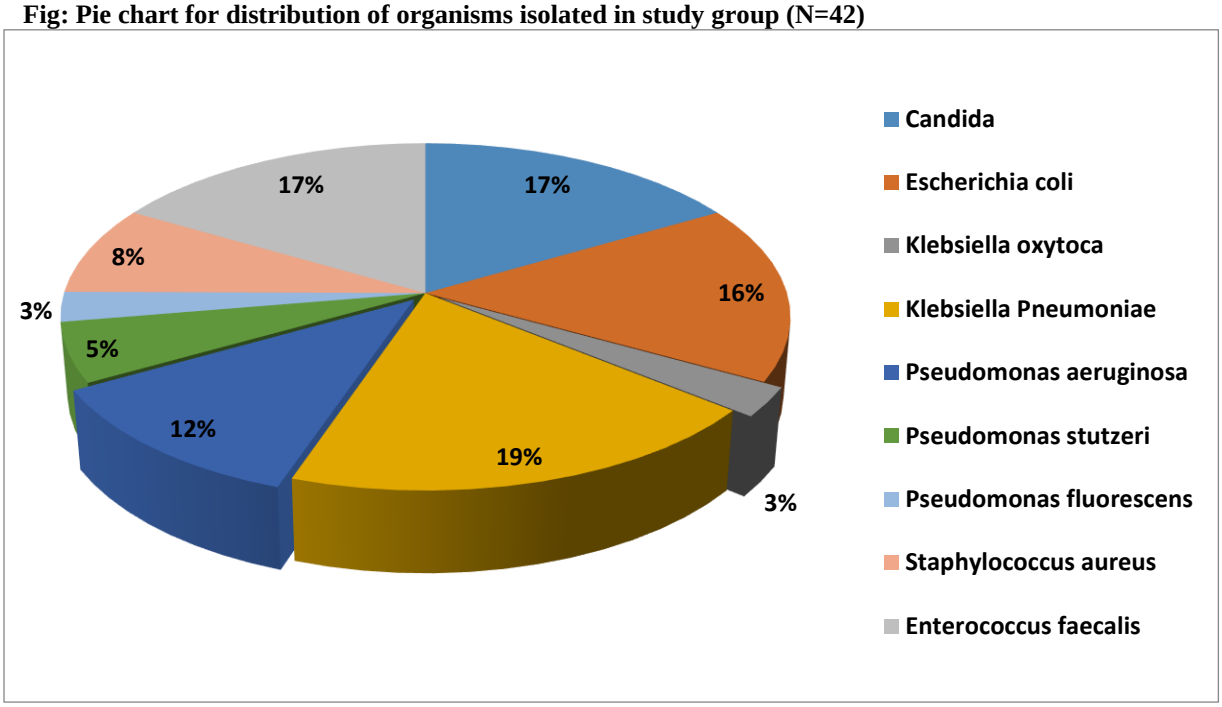
Table: Descriptive analysis of Organism isolated in study group (N=42)

Organism Isolated	**Frequency**	**Percent**
Candida species	**6**	**14.28**
Enterobacteriaceae		
Escherichia coli	6	14.2
Klebsiella oxytoca	1	2.38
Klebsiella pneumoniae	7	16.67
Non-fermenters		
Pseudomonas aeruginosa	10	23.80
Pseudomonas stutzeri	2	4.76
Pseudomonas fluorescens	1	2.38
Gram Positive organisms		
Staphylococcus aureus	3	7.14
Enterococcus faecalis	6	14.28
Total	42	100.0

ISSN:0975-3583,0976-2833

VOL14,ISSUE05,2023

Fig: Pie chart for distribution of organisms isolated in study group (N=42)



Pseudomonas aeruginosa was the most common isolate (30.95%) followed by Klebsiella pneumoniae (16.67%), Enterococcus faecalis (14.28%), Escherichia coli (14.2%) and Candida spp. (14.28%). Other isolates were Pseudomonas stutzeri (4.76%), Klebsiella oxytoca (2.38%), Pseudomonas fluorescence (2.38%). and Staphylococcus aureus (7.14%).Catheter associated urinary tract infection is the commonest device associated nosocomial infection. A total of 100 patients admitted in medical ICU were enrolled in the study and followed up for the development of CAUTI. In this study, only symptomatic cases were included under CAUTI.

The rate of device associated infections shows variation in India. According to a study conducted by Angshuman Jana et al (2015) [10], the incidence was 31.85%. Another study by Neha Garg et al (2015) [11] found the incidence to be 20%. A study by Priya Datta et al (2014) [12] found the CAUTI rate as 10.75% and 9.08/1000 catheter days by Pooja et al (2014) [13] as 32.14%, by Kamat et al (2009) [14] as 33.6%, C.M.Poudel et al (2008) [15] as 54% and Al Jebouri et al (2006) [16] as 28.1 %. Habibi et al (2008) [17] conducted a study in AIIMS, Delhi and reported CAUTI as 24% of nosocomial UTIs, the rate being 11.3/1000 catheter days. Study conducted in ICUs of four Mexican public hospitals reported CAUTI as 21.79% [18]**.** A survey conducted to determine the DAIs in the ICUs of 8 different developing countries reported that CAUTI comprised 29% of all DAIs (19,20). Due to these wide variations in the incidence, it is important for a hospital to generate its own data for the implementation on proper infection control programmes.

In this study, out of 100 patients, 28 patients were diagnosed to develop symptomatic CAUTI during their course of hospitalisation. Therefore, the incidence was 28% and the CAUTI rate was calculated as 26.92 per 1000 catheter days.

The age distribution of the study subjects showed maximum proportion (33%) of the patients belonged to 18-30 years. Males constituted 57% and females 43% of the study subjects. In majority of the patients (87%), total catheter days were in the range of 8-14 days. The indication of catheterisation was found to be valid in all patients. Among 28 patients who developed symptomatic CAUTI, 21 developed in day 14.A number of risk factors implicated with the development of symptomatic CAUTI were studied .The p value and Odd's ratio were calculated by Chi square test to find the statistical significance ($p<0.05$) and the strength of association of these risk factors. Age $\geq$ 50 years showed increased development of CAUTI, the risk being 1.200 times. The incidence was also higher among females (34.88%) than males (13.0%). However, in this study age and gender showed no statistical significance. Similar results were seen in studies conducted by Priya et al [21], Meric et al [22] and Agrawal et al [23].

Duration of catheterisation and length of hospital stay constitute an important risk factor and

ISSN:0975-3583,0976-2833

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has been cited in studies by Priya Datta et al [24] and Angshuman Jana et al [25]. In this study, maximum patients (87%) belonged to the category of duration of catheterisation for 8 to 14 days. Among patients catheterised for 14 days, 75% developed CAUTI and among 2 patients catheterised till 21 days, 100% developed the infection. Duration of catheterisation 10 ≥days was found to be statistically significant as among 45 patients who had catheter for 10 ≥days, 62.23% developed CAUTI. This is due to the fact that the longer a patient stays in the ICU and catheterised, more are the chances that he will get colonised with multidrug resistant organisms present in theenvironmental niche.

In this study, the predominant isolates were Gram negative bacilli comprising 64.28% of the isolates among which Enterobacteriaceae were 33.34% and non-fermenters 30.95%. This finding was similar to other studies where in GNB constituted the common isolate: Neha Garg et al (80%) [26], Priya Datta et al (72.61%) [27] and C.M.Poudel et al(66.67%) [28].

The organisms causing CAUTI vary from one geographical area to another and there is changing trend over a period of time. A prospective study conducted by Tullu MS et al (1998) [29] found the commonest organism was *Escherichia coli*. Wazait et al (2003) [30] although reported similar result, noticed a declining trend over the period time. *Enterococcus spp.* was isolated as the second commonest organism. Another study by Taiwo et al (2006) [31] revealed multiresistant *Klebsiella spp.* as the commonest isolate followed by *Pseudomonas spp., Escherichia coli, Staphylococcus aureus,* Proteus mirabilis and coagulase negative staphylococci. A study by Priya Datta et al (2014) [21] found *Pseudomonas aeruginosa* (31.0%) as the commonest isolate followed by *Klebsiella pneumoniae* (16.67%), *Enterococcus spp*.(14.28%) and *Escherichia coli* (14.2%), *Candida spp*.(14.28%), *Acinetobacter spp* (9.5%) and *Morganella morganii* (1.1%). Study by Neha Garg et al (2015) [32] found *Escherichia coli* as the commonest isolate(40%) followed by *Citrobacter koseri* (20%), *Staphylococcus aureus* (15%), *Klebsiella oxytoca* (10%), *Acinetobacter spp* (5%). *Pseudomonas aeruginosa* (5%) and *Enterococcus faecalis* (5%). According to a study by Angshuman Jana et al (2015) [33], the main pathogen belonged to Enterobacteriaceae among which *Escherichia coli* was 19.4%. Other organisms included *Pseudomonas spp.* 19.4% followed by *Klebsiella spp*. (16.6%), *Staphylococcus* and *Candida spp*.(11%) each.

Other authors also reported Gram-negative bacteria as the most common etiological agents of CAUTI. However, 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* [34–35]. Moreover, another study conducted by Shiva et al. reported that 69.2% of CAUTIs had a bacterial origin, and 30% were due to pathogenic yeast [36]. Although *Candida* is not on the CDC's list of pathogens that cause CAUTI, a high proportion of *Candidia* cannot be ignored. Resistance to antimicrobial agents has been reported since the beginning of their use and is an emerging global concern. In our study, all Gram-negative isolates showed great variation in sensitivity patterns. *Klebsiella pneumoniae* showed extreme resistance toward ceftriaxone, tigecycline, and TEG (80%), whereas 66.7% of the 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 [37,38]. Against aminoglycosides, we noted that most of the *K. pneumoniae* bacteria were far more susceptible to amikacin (100%) than to gentamicin (86.7%).

Conclusions

The present study provided CAUTI incidence rates in Index Medical College Hospital and Research Centre, Indore (M.P.). A similar situation may exist in other government hospitals in Saudi Arabia. Furthermore, information on the risk factors of common associated CAUTI causative organisms and their antibiogram patterns were 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.

Reference

1. Al-Tawfifiq, J.A.; Tambyah, P.A. Healthcare associated infections (HAI) perspectives. *J. Infect. Public Health* **2014**, *7*, 339–344.
2. Klevens, R.M.; Edwards, J.R.; Richards, C.L., Jr.; Horan, T.C.; Gaynes, R.P.; Pollock, D.A.; Cardo, D.M. Estimating health care-associated infections and deaths in U.S. hospitals, 2002. *Public Health Rep.* **2007**, *122*, 160–166.

ISSN:0975-3583,0976-2833

VOL14,ISSUE05,2023

3. Obaid, N.A. Preventive Measures and Management of Catheter-Associated Urinary Tract Infection in Adult Intensive Care Units in Saudi Arabia. *J. Epidemiol. Glob. Health* **2021**, *11*, 164–168.
4. Rosenthal, V.D. Device-Associated Nosocomial Infections in 55 Intensive Care Units of 8 Developing Countries. *Ann. Intern. Med.* **2006**, *145*, 582–591.
5. Storme, O.; Tiran Saucedo, J.; Garcia-Mora, A.; Dehesa-Davila, M.; Naber, K.G. Risk factors and predisposing conditions for urinary tract infection. *Ther. Adv. Urol.* **2019**, *11*, 1756287218814382.
6. Guneysel, O.; Onur, O.; Erdede, M.; Denizbasi, A. Trimethoprim/sulfamethoxazole resistance in urinary tract infections. *J. Emerg. Med.* **2009**, *36*, 338–341.
7. Bagchi, I.; Jaitly, N.K.; Thombare, V. Microbiological evaluation of catheter associated urinary tract infection in a tertiary care hospital. *People's J. Sci. Res.* **2015**, *8*, 23–29.
8. Zahran, F. Catheter Associated Urinary Tract Infection (Cauti) in Medical Ward, and Icu Kfhh during Year 2017. *Int. J. Adv. Res.* **2018**, *6*, 997–1011.
9. Dalen, D.M.; Zvonar, R.K.; Jessamine, P.G. An evaluation of the management of asymptomatic catheter-associated bacteriuria and candiduria at The Ottawa Hospital. *Can. J. Infect. Dis. Med Microbiol.* **2005**, *16*, 166–170.
10. Rodriguez-Tudela JL, Arendrup MC, Barchiesi F, Bille J, Chryssanthou E, Cuenca-Estrella M, Dannaoui E, Denning DW, Donnelly JP, Dromer F, Fegeler W. EUCAST Definitive Document EDef 7.1: method for the determination of broth dilution MICs of antifungal agents for fermentative yeasts: Subcommittee on Antifungal Susceptibility Testing (AFST) of the ESCMID European Committee for Antimicrobial Susceptibility Testing (EUCAST)∗. Clinical Microbiology and Infection. 2008 Apr 1;14(4):398-405.
11. Rojas FD, Sosa MD, Fernandez MS, Cattana ME, Cordoba SB, Giusiano GE. Antifungal susceptibility of Malassezia furfur, Malassezia sympodialis, and Malassezia globosa to azole drugs and amphotericin B evaluated using a broth microdilution method. Sabouraudia. 2014 Jun 25;52(6):641-6.
12. angshuman jana, nk pal, arijit majumdar, jayeeta mitra, anirban jana, soumali biswas, babita bag device-associated infection rates and median length of acquiring device-associated infection in an intensive therapeutic unit of an indian hospital : journal of medicine in the tropics:year : 2015 | volume : 17 | issue : 2 | page : 97-102.
13. Neha garg, indu shukla, meher rizvi, syed moied ahmed,abida khatoon and fatima khan : microbiological profile and antibiotic sensitivity pattern of bacterial isolates causing urinary tract infection in intensive care unit patients in a tertiary care hospital in aligarh region, india : *int.j.curr.microbiol.app.sci*(2015) special issue-1: 163-172
14. Priya datta, hena rani, rajni chauhan, satinder gombar, and jagdish chander.Health-care-associated infections: risk factors and epidemiology from an intensive care unit in northern india. *Indian j anaesth. 2014 jan-feb; 58(1): 30–35.*
15. Pooja patel, garala,r.n. 2014. Bacteriological profile and antibiotic susceptibility pattern (antibiogram) of urinary tract infections in paediatric patients. *J. Res. Med. Dent. Sci.*, 2(1).
16. Kamat u s, ferreira a, amonkar d, motghare d d, kulkarni m s. Epidemiology of hospital acquired urinary tract infections in a medical college hospital in goa. *Indian j urol 2009; 25:76–80.*
17. Poudel CM, Baniya G, Pokhrel BM. Indwelling catheter associated urinary tract infection. Journal of Institute of Medicine Nepal. 2008;30(3):3-7.
18. Al-jebouri, o.a.h. 2006. The relationship between urinary caliculi types and urinary tract infections among patients in tikrit district. M. Sc. Thesis, college ofmedicine, tikrit university, tikrit.
19. Habibi et al habibi s, wig n, agarwal s, sharma sk, lodha r, pandey rm, et al.Epidemiology of nosocomial infections in medicine intensive care unit at a tertiary care hospital in northern india. Trop doct. 2008;38:233–5.
20. Ramirez Barba Ej[1], Rosenthal Vd, Higuera F, Oropeza Ms, Hernández Ht, López Ms, Lona El, Duarte P, Ruiz J, Hernandez Rr, Chavez A, Cerrato Ip,Ramirez Ge, Safdar N. Device-associated nosocomial infection rates in intensive care units in four mexican public hospitals : Amj infect control. 2006,may;34(4):244-7.
21. Datta P, Rani H, Chauhan R, Gombar S, Chander J. Health-care-associated infections: Risk factors and epidemiology from an intensive care unit in Northern India. Indian journal of anaesthesia. 2014 Jan;58(1):30.
22. Agarwal r, gupta d, ray p, aggarwal an, jindal sk. Epidemiology, risk factors and outcome of nosocomial infections in a respiratory intensive care unit in north india. J infect. 2006;53:98–105.

ISSN:0975-3583,0976-2833

VOL14,ISSUE05,2023

23. Meric m, willke a, caglayan c, toker k. Intensive care unit- acquired infections: incidence, risk factors and associated mortality in a turkish university hospital.Jpn j infect dis. 2005;58:297–302.
24. Datta P, Rani H, Chauhan R, Gombar S, Chander J. Health-care-associated infections: Risk factors and epidemiology from an intensive care unit in Northern India. Indian journal of anaesthesia. 2014 Jan;58(1):30.
25. Jana A, Pal NK, Majumdar A, Mitra J, Jana A, Biswas S, Bag B. Device-associated infection rates and median length of acquiring device-associated infection in an intensive therapeutic unit of an Indian hospital. Journal of Medicine in the Tropics. 2015 Jul 1;17(2):97.
26. Neha garg, indu shukla, meher rizvi, syed moied ahmed,abida khatoon and fatima khan : microbiological profile and antibiotic sensitivity pattern of bacterial isolates causing urinary tract infection in intensive care unit patients in a tertiary care hospital in aligarh region, india : *int.j.curr.microbiol.app.sci*(2015) special issue-1: 163-172
27. Priya datta, hena rani, rajni chauhan, satinder gombar, and jagdish chander.Health-care-associated infections: risk factors and epidemiology from an intensive care unit in northern india. *Indian j anaesth. 2014 jan-feb; 58(1): 30–35.*
28. Poudel CM, Baniya G, Pokhrel BM. Indwelling catheter associated urinary tract infection. Journal of Institute of Medicine Nepal. 2008;30(3):3-7.
29. Tullu ms, deshmukh ct, baveja sm. Bacterial profile and antimicrobial susceptibility pattern in catheter related nosocomial infections. J postgrad med 1998;44:7-13.
30. Wazait HD, Patel HR, Veer V, Kelsey M, Van Der Meulen JH, Miller RA, Emberton M. Catheter-associated urinary tract infections: prevalence of uropathogens and pattern of antimicrobial resistance in a UK hospital (1996–2001). BJU international. 2003 Jun;91(9):806-9.
31. Taiwo SS, Aderounmu AO. Catheter associated urinary tract infection: aetiologic agents and antimicrobial susceptibility pattern in Ladoke Akintola University Teaching Hospital, Osogbo, Nigeria. African Journal of Biomedical Research. 2006;9(3).
32. Neha garg, indu shukla, meher rizvi, syed moied ahmed,abida khatoon and fatima khan : microbiological profile and antibiotic sensitivity pattern of bacterial isolates causing urinary tract infection in intensive care unit patients in a tertiary care hospital in aligarh region, india : *int.j.curr.microbiol.app.sci*(2015) special issue-1: 163-172
33. Jana A, Pal NK, Majumdar A, Mitra J, Jana A, Biswas S, Bag B. Device-associated infection rates and median length of acquiring device-associated infection in an intensive therapeutic unit of an Indian hospital. Journal of Medicine in the Tropics. 2015 Jul 1;17(2):97.
34. Alzahrani, M.A.; Ali, M.S.; Anwar, S. Bacteria Causing Urinary Tract Infections and Its Antibiotic Susceptibility Pattern at Tertiary Hospital in Al-Baha Region, Saudi Arabia: A Retrospective Study. *J. Pharm. Bioallied Sci.* **2020**, *12*, 449–456.
35. Behzadi, P.; Behzadi, E.; Yazdanbod, H.; Aghapour, R.; Akbari Cheshmeh, M.; Salehian Omran, D. A survey on urinary tract infections associated with the three most common uropathogenic bacteria. *Maedica* **2010**, *5*, 111–115.
36. Verma, S.; Naik, S.; Deepak, T. Etiology and risk factors of catheter associated urinary tract infections in ICU patients. *Int. J. Med. Microbiol. Trop. Dis.* **2017**, *3*, 65–70.
37. Emr, K.; Ryan, R. Best practice for indwelling catheter in the home setting. *Home Healthc. Now* **2004**, *22*, 820–828.
38. El-Kersh, T.; Marie, M.; Al-Sheikh, Y.; Al-Kahtani, S. Prevalence and risk factors of community-acquired urinary tract infections due to ESBL-producing Gram negative bacteria in an Armed Forces Hospital in Sothern Saudi Arabia. *Glob. Adv. Res. J. Med. Med. Sci.* **2015**, *4*, 321–330