Catheter Associated Urinary Tract Infection: Prevalence, Microbiological Profile and Antibiogram at a Tertiary Care Hospital

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Abstract

BACKGROUND

Catheter associated Urinary tract infections (CAUTI) are the most common nosocomial infection. Though urinary tract catheterization is an important aspect of medical care, its inappropriate use may lead to significant morbidity and mortality, increased hospitalization and financial burden. This study was carried out to identify the etiological agents of UTI and its antibiogram among inpatients with indwelling catheters.

METHODS

A total of 136 urine samples were collected over a period of 10 months. Microscopic and macroscopic examinations were performed. Isolation, identification and antimicrobial susceptibility testing was performed by standard microbiological methods. Statistical analysis of data was done by chi-square test.

RESULTS

Out of the 136 patients, 17 (12.5%) developed catheter-associated UTI. Development of significant bacteriuria was not affected by sex, age, urine pH or antibiotic intake however there was significant association between significant pyuria and significant bacteriuria ($p<0.001$). *E coli* accounted for 35.3% followed by *Klebsiella* spp and *Enterococcus* spp. Cotrimoxazole was the most effective amongst antibiotics tested followed by Nitrofurantoin . Gram negative bacteria were least sensitive to Ampicillin.

CONCLUSION

This study suggests urine culture and sensitivity should be done among the catheterized patients on regular basis. Unnecessary urethral catheterization should be avoided to reduce catheter-related complications.

KEY WORDS

Catheter, significant bacteriuria, nosocomial infection, urinary tract infection

INTRODUCTION

Urinary Tract Infection (UTI) is the invasion of tissues by microorganisms, inducing an inflammatory response as well as signs and symptoms[1]. Significant bacteriuria is defined as a urine sample containing more than 10^5 colony forming units/ml of urine (10^8/l) in pure culture using a standard calibrated bacteriological loop.[2] UTI is said nosocomial when it is acquired in any healthcare institution or in a more general fashion, when it is related to patient management.[3] Nosocomial urinary tract infections (NUTI) remain a significant contributor to the over-all prevalence or incidence of nosocomial infections.[4-7] Amongst NUTIs approximately 75% to 80% are associated with urinary catheter[3, 5-7] since15% and 25% of hospitalized patients may receive short-term indwelling urinary catheters.[8, 9]

In many cases, catheters are placed for inappropriate indications, and alarming fact is that healthcare personnels are often unaware that their patients have catheters, leading to prolonged, unnecessary hospital stay which cause huge extra costs.[7-13] The risk of hospitalization, length of hospitalization, and antibiotic therapy are three times higher in catheterized residents than other residents.[14] Further all iatrogenic illness contributes significantly to morbidity and mortality in the hospitalized patients.[13]

Although usually benign, a systemic complication which is gram-negative bacteraemia can develop in many patients,[3,7,8] although, the origin of nosocomial bacteria is endogenous in two thirds of the cases.[1,8] Indwelling catheter offers a conduit to bacterial entry along its external and internal surface and provide a surface on which bacteria can multiply at least partially shielded from the humoral and cellular mechanisms[8,15] and encrustation formed on the inner surface may protect bacteria from antimicrobial agents as well.[3, 7]

The etiological agents of Catheter associated urinary tract infection (CAUTI) are sundry and comprises a huge reservoir often multidrug resistant pathogens.[16-18]The causative pathogen profile varies from region to region but *E. coli* remain the most common causative pathogen.[18] The aim of this study was to compute the prevalence of uropathogens causing nosocomial UTI and their sensitivity pattern at our institution to guide antibiotic choice.

METHODS

The present study was conducted in 136 catheterized inpatients at different wards of Dhulikhel Hospital after obtaining the ethical approval from the Institutional Review Committee, Kathmandu University School of Medical Sciences. Patients in whom an indwelling Foley catheter was inserted for more than 24 hours at different wards of Dhulikhel Hospital were recruited for this study. Patients with positive urine culture before catheterization and less than 2 calendar days of urinary catheterization were not included in the study. Similarly repeated episodes from the same patients were excluded. Demographic information such as age, sex, date of catheterization, clinical diagnosis, underlying medical conditions, history of systemic antibiotic administered were recorded.

Urine specimens were obtained aseptically by disinfecting thoroughly with 70% alcohol and aspirating the catheter with a sterile syringe keeping the system closed. Samples were processed immediately in Clinical Microbiology laboratory. After macroscopic examination, urine samples were subjected to wet mount examination and Gram stain. Specimens were inoculated by Standard loop method on CLED and 5% sheep blood agar and incubated at 37^0C for 24-48 hours aerobically and the isolates were identified by standard laboratory procedures.[19] Antimicrobial susceptibility testing was performed by Kirby-Bauer disk diffusion technique according to CLSI guidelines.[20] Samples with mixed growth were excluded from the study.

Culture positivity obtained in more than 2 calendar days of urinary catheterization was considered as Catheter associated bacteriuria.

RESULTS

A total of 17 (12.5%) patients in our study showed significant bacteriuria. Most of the

study population were admitted in ICU (41.9%). Ward wise distribution of patients is depicted in Table 1. 70 (51.47%) of catheterized patients included in our study were female and 66 (48.53%) were male. Significant bacteriuria was reported among 11 (15.71%) female and 6 (9.09%) male patients.

Table 1: Distribution of patients according to wards

Department	Frequency	Percentage (%)
Medical	42	30.9
Surgical	25	18.4
ICU	57	41.9
Orthopedics	12	8.8
Total	**136**	**100**

The overall infection rate was highest among age group of 61-70 years. Age wise distribution of patients and the growth pattern is shown in Table 2. Mean age of our patients was 44.38 ±19.952 (SD). Minimum age being 12 years and maximum 93 years.

Table 2: Growth pattern among the different age groups of catheterized patients

Age Group	Growth	No Growth	Total
11 to 20	0	12	12
21 to 30	3	21	24
31 to 40	4	30	34
41 to 50	3	17	20
51 to 60	1	10	11
61 to 70	4	13	17
71 to 80	1	11	12
81 to 90	1	4	5
91 to 100	0	1	1
Total	**17**	**119**	**136**

Table 3: Reason for Hospitalization

Illness classified according to ICD-10	Frequency and %
Diseases of Gastrointestinal apparatus	38 (27.9)
Injury, poisoning and certain other consequences of external cause	30 (22.1)
Disease of Genitourinary apparatus	20 (14.7)
Disease of Respiratory tract	16 (11.8)
Diseases of Blood and Hematopoietic organs	10 (7.40)
Endocrine, nutritional and metabolic diseases	8 (5.9)
Disease of Musculoskeletal and connective tissue	5 (3.7)
Disease of nervous system	4 (2.9)
Disease of circulatory system	4 (2.9)
Pregnancy, childbirth and puerperium	1(0.7)
Total	**136**

International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10)-WHO Version for; 2016

Table 3 shows that the most common reason for hospitalization amongst our study subjects was due to disease of Gastrointestinal apparatus followed by Injury and organophosphate poisoning.

As shown in Table 4, Acidic urine was found in 124 urine samples and alkaline in remaining 12, however no significant association between urine pH and significant bacteriuria was seen ($p>0.05$). 75.73% (n=103) were under prior antibiotic use, Cephotaxime was commonly used antibiotic but no significant effect was seen with prior antibiotic administration and significant bacteriuria ($p>0.05\%$) as shown in table 5.

Table 4: Growth pattern according to pH of urine

Urine pH	Growth	No Growth	Total
Acidic	15	109	124
Alkaline	2	10	12
Total	**17**	**119**	**136**

p =0.647

Table 5: Growth pattern in patients with prior use of antibiotics

Antibiotics	Growth	No growth	Total
Yes	12	91	103
No	5	28	33
Total	**17**	**119**	**136**

p=0.559

Table 6: Number of pus cells during micro-scopic observation of urine sample

No of pus cells	Frequency	Percentage (%)
0	3	2.2
1 - 5	87	64
6 - 10	32	23.5
11 - 20	7	5.1
21 - 50	6	4.4
>50	1	0.7
Total	**136**	**100**

Table 6 shows the number of pus cells during wet mount. Sample with more than 5 pus cells was considered as significant pyuria. In our study 46 (33.8%) showed significant pyuria. There was significant association between significant pyuria and significant bacteriuria (p<0.001) as shown in table 7.

Table 7: Significant bacteriuria in sample with significant pyuria

Pyuria	Growth	No growth	Total
Significant	12	34	46
Insignifi-cant	5	85	90
Total	**17**	**119**	**136**

Out of 136 urine specimens from study subjects who previously had no significant bacteriuria, 17 bacterial isolates were recovered. Gram positives and Gram negatives contributed to 4(23.53%) and 13(76.47%) respectively. Amongst various pathogens isolated, most common was *E. coli* (35.3%) followed by *Klebsiella* spp and *Enterococcus* spp. 4 (22.53%) of the isolates were Gram positives. The spectrums of isolated bacteria are shown in figure 1.

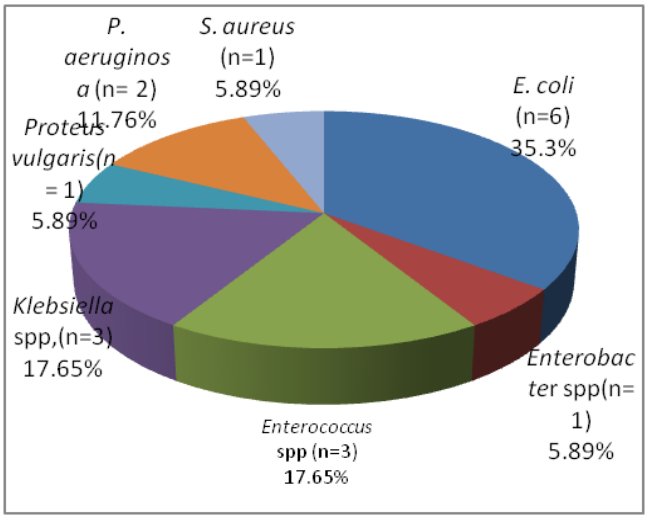

Fig 1: Frequency of bacteria isolated from urine sample

Table 8 shows sensitivity of isolated bacteria to commonly used antibiotics. Amongst different antibiotics discs applied for isolated bacteria, Cotrimoxazole was found to be most efficient antibiotic against all bacterial isolates as none showed resistance. However, most of the Gram negative bacteria showed resistance to Ampicillin. Both of the Gram positives were however sensitive to Ampicillin, Imipenem, Gentamicin and Vancomycin.

Table 8: Sensitivity pattern of bacterial isolates to different antibiotics

Antibiotics	*E. coli (n=6)*	*Entero-bacter* spp (n=1)	*Enterococ-cus* spp (n=3)	*Klebsiella spp (n=3)*	*Proteus vulgaris (n=1)*	*Pseudomo-nas aerugi-nosa (n=2)*	*S. aureus (n=1)*
Nitrofurantoin	6(100%)	0	2(66.6%)	1(33.3%)	1(100%)	1(50%)	1(100%)
Gentamicin	6(100%)	1(100%)	2(66.6%)	3(100%)	1(100%)	2(100%)	1(100%)
Ampicillin	0 (0%)	0 (0%)	3(100%)	0 (0%)	0(0%)	0(0%)	1(100%)
Cotrimoxazole	6(100%)	1 (100%)	3(100%)	3(100%)	1(100%)	2(100%)	1(100%)
Amikacin	6(100%)	0 (0%)	1(33.33%)	NA	NA	NA	NA
Imipenem	NA	1 (100%)	3(100%)	NA	NA	NA	1(100%)
Cefazolin	4 (66.6%)	NA	NA	0(0%)	NA	NA	NA
Nalidixic acid	5 (83.3%)	1 (100%)	NA	3(100%)	1(100%)	1 (50%)	NA
Vancomycin	NA	NA	3(100%)	NA	NA	NA	1(100%)
Ciprofloxacin	NA	1(100%)	1(33.33%)	-	1(100%)	2(100%)	1(100%)

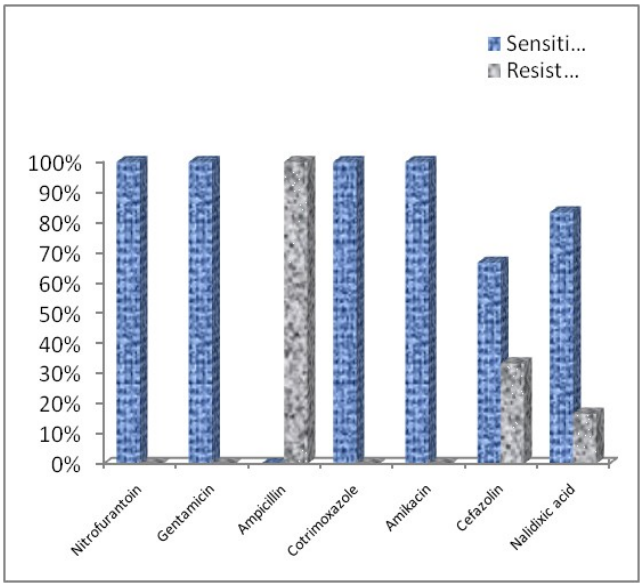

Fig 2: Sensitivity pattern of most commonly isolated bacteria *E. coli*

E coli didn't show any resistance against Nitrofurantoin, aminoglycosides and Gentamicin, however showed decreasing sensitivity to Nalidixic acid and Cefazoline and it is important to note its 100% resistance towards Ampicillin

DISCUSSION

Mean age of our study group is 44.38 which reflects the age of hospitalized population at our institution. The significant bacteriuria in the present study was 12.5% which was lower than the isolation rates in previous studies done in patients with indwelling urethral catheters where the incidence was 42.2% and 24.72% respectively [7, 17] and higher than in the study done by other investigator where approximately 7% of patients developed UTI.[21] The low rate of growth positivity might be due to inclusion of patients under treatment. Like several previous studies, significant bacteriuria was high in female patients than in male.[4,10,17,22,28] This can be easily attributed to short urethra in female [22] and is directly related to bladder catheterization.[10]

A direct relationship between significant pyuria and significant bacteriuria was observed in this study which was similar to the study by Alavaren et al and Dongol et al.[7,32] However some authors have advocated that there is no relationship between the level of pyuria and infection in patients with indwelling catheters, since the presence of catheter invariably induces pyuria without presence of infection, so pyuria should not be used as sole criterion to obtain a urine culture in a patient with a catheter, which seemed very convincing.[33]

In our study >75% were under antibiotic use for treatment of various medical conditions which agreed with the statement by Warren et al that in general hospital about 80% of patients are administered systemic antibiotics. Previous antibiotic intake was likewise not found to be posing a risk for bacteriuria in this study which can be correlated with the previous data where no direct evidence to consider antibiotic intake as a risk factor for occurrence of bacteriuria was found.[17] On the other hand, many authors have stated that intake of antibiotics would lead to colonization of unusual pathogen in the urinary tract and would increase acquisition of antibiotic-resistant uropathogens though it is effective for the first several days.[6,8,17]

Consistent with the results of numerous studies in Nepal and around the world,[4,6,7,11,17,21,23-25] this study also revealed that Gram negative bacteria accounted as a major contributor of bacterial isolates(76%) from urine sample.

In most of the studies done in UTI till today, the most common organism isolated is *E. coli*.[26] However there is a reduction in the frequency of *E. coli* (although it remains the usual cause) in patients with indwelling catheters.[10] Similar finding was seen in our study where the most common isolate was *E. coli* (35.3%) followed by *Klebsiella* and *Enterococcus*. This observation seems to agree with several other studies where the most common isolate was *E .coli* and its isolation rate ranged from 22% to 40.47%.[4,6,23,24,27,28] Similar profile of bacterial isolates were also seen in those studies.

As contrasted to our result, *E. coli* was one of the least isolated pathogen in the previous study done by Duszyńska et al and *Enterococcu*s was the most common.[21] Some investigators isolated *K. pneumoniae* as the principle pathogen (32.4%)[11], whereas some isolated *Pseudomonas aeruginosa* (37.5%)[29] and *Citrobacter* (26.3%).[17] *Candida* and *Citrobacter* were also isolated in several previous investigations [17,21,23,24] but were not isolated in our study. Yeasts may be isolated particularly when antibiotics are in use and are increasing in incidence.[8] The similarity and differences in spectrum of infecting organisms varies with different environmental condition, patient population, host factors, prior antimicrobial exposure, and the organisms unique to each facility.[30,31]

Regarding susceptibility, it was pragmatic that all Gram negatives isolates were resistant to Ampicillin, which was in concordance with findings of previous investigators who showed Gram negatives were either resistant or least sensitive to it.[4,6,18,24,27,29] It may be because older antibiotics like Ampicillin are showing resistance due to their increased consumption. However *Pseudomonas* spp showed best sensitivity to Ampicillin in study done by Dias et al which disagreed to our finding.[4]

However, sensitivity pattern was different in Gram positives and negatives. In our study all Gram positives including *Enterococcus* spp were sensitive to Ampicillin which agreed with Dias et al and Hanumantha et al.[4,17] Similarly, all of the recovered Gram positives displayed sensitivity towards Vancomycin which was in agreement with study done by Bagchi et al.[24] In our study, most of the isolated pathogens showed best sensitivity towards Cotrimoxazole but the isolates of previous investigators showed high degree of resistance towards it.[4,6,29]

Varying degree of sensitivity was shown towards Gentamicin in study by Dias et al[4], high degree of resistance was shown in study done by Moue et al[18] but isolates of our study showed high susceptibility to it which was good. The isolates (both Gram positive and Gram negative) showed a high level of resistance to Nalidixic acid in a study done by Nwankwo et al which was in contrast to our study where most of the Gram negatives were sensitive to it.[29]

As it can be perceived, in a hospital environment, the map of etiological agents and antibiotic susceptibility pattern are changing over years and varies according to hospital under analysis.[11]

Because patients who have symptoms will certainly be prescribed antibiotics,

asymptomatic patients having such epidemiological characteristics should get more attention from medical team.[11] Hence universally two catheter hygiene principles are recommended. One to keep catheter system closed and second is to remove catheter before bacteriuria develops.[8] Furthermore, authors would like to recommend that causative pathogens of nosocomial infection and their resistance patterns should be investigated on regular basis according to the different wards.

CONCLUSION

Urinary catheter is an essential part of modern medical care. Unfortunately, when used inappropriately or when left in place for too long, it is a hazard to the very patients that it is designed to protect. This study was hence conducted to determine the incidence of bacteriuria, its onset after insertion. It is hoped that the results of this study will serve as a basis for the formulation of guidelines for prevention of catheter-related UTI. It is widely accepted that the risk for CAUTI is proportional to the number of days a catheter remains indwelling. Therefore, reduction of indwelling catheter days is a cornerstone of any CAUTI prevention program.

CONFLICT OF INTEREST

None declared

REFERENCES

1. Botto H et al. Nosocomial urinary tract infections (NUTI) in adult patients: Consensus conference 2002, short text. *Médecine et maladies infectieuses* 2003; 33: 218s–222s
2. Cheesebrough M. Examination of urine. In: Cheesebrough Monica, editors. District Laboratory Practice in tropical countries. Part 2. *Cambridge University Press* 2006: 105–114.
3. Stamm WE. Catheter-associated urinary tract infections: Epidemiology, pathogenesis and prevention. *Am J Med* 1991; 91(Suppl3B):65-71
4. Dias Neto JA, Silva LDM, Martins ACP, Tiraboschi RB, Domingos ALA, Suaid HJ, Tucci Jr S, Cologna AJ. Prevalence and bacterial susceptibility of hospital acquired urinary tract infection. *Acta Cirúrgica Brasileira* 2003; 18(5):36-38
5. Centers for Disease Control and Prevention. The direct medical costs of healthcare associated infections in U. S. hospital and the benefits of prevention. 2009.Retrieved from http://www.cdc.gov/ncidod/dhqp/pdf/Scott_CostPaper.pdf
6. Savas L, Guvel S, Onlen Y, Savas N, Duran N. Nosocomial Urinary Tract Infections: Micro-organisms, Antibiotic Sensitivities and Risk Factors. *West Indian Med J* 2006; 55 (3): 188-193
7. Alavaren HF, Lim JA, Velmonte MA, Mendoza MT, M.D. Urinary Tract Infection in Patients with Indwelling Catheter. *Phil J Microbiol Infect Dis* 1993; 22(2):65-74
8. Warren JW. Catheter-associated urinary tract infections. *Int J Antimicrob Agents*. 2001; 17(4):299-303
9. Jacobsen SM, Stickler DJ, Mobley HLT, Shirtliff ME. Complicated Catheter-Associated Urinary Tract Infections Due to *Escherichia coli* and *Proteus mirabilis*. *Clinical microbiology reviews*. 2008;21 (1):26–59
10. de Siqueira e Silva MF, de Sena FCR, Agostinho F, Almeida Medeiros KK, Miguel CB, et al. Urinary tract infection related to hospitalized patients:A Review. *Arch Urol Res* 2017; 1(1): 001-004
11. Negromote GR, Nascimento JS, Brigido JV, Carvalho AM, Farias RL. Study of variables involved in hospital-acquired urinary tract infections at a university hospital. *Rev Soc Bras Clin Med* 2015; 13 (2):90-93
12. Johansen TE, Cek M, Naber K, Stratchounski L, Svendsen MV , Tenke P. Prevalence of Hospital Acquired Urinary Tract Infections in Urology Departments. *European urology* 2007;51:1100–1112
13. Jain P, Parada JP, David A, Smith LG. Overuse of the Indwelling Urinary Tract Catheter in Hospitalized Medical Patients.*Arch Intern Med*. 1995;155:1425-1429
14. Kunin CM, Douthitt S, Dancing J, Anderson J, Moeschberger M. The association between the use of urinary catheters and morbidity and mortality among elderly patients in nursing homes. *Am J Epidemiol* 1992; 135(3):291-301
15. Dickinson GM, Bisno A L. Infections Associated with Indwelling Devices: Concepts of Pathogenesis; Infections Associated with Intravascular Devices. *Antimicrobial agents and chemotherapy*. 1989; 33 (5):597-601
16. Tambyah PA. Catheter associated urinary tract infection is rarely symptomatic. *Arch Intern Med* 2000;160:678-682
17. Hanumantha S, Pilli HK. Catheter associated urinary tract infection(CAUTI)– Incidence and microbiological profile in a tertiary care hospital in Andhra Pradesh. *Indian J Microbiol Res 2016;3 (4):454-457*
18. Moue A, Aktaruzzaman S, Ferdous N, Karim RM, Khalil MMR, Das AK. A. Prevalence of urinary tract infection in both outpatient department and in patient department at a medical college setting of Bangladesh. *Int J Biosci* 2015; 7(5):146-152
19. Collee JG, Fraser AG, Marmion BP, Simmons A. Mackie and McCartney practical Medical

Microbiology. 14th ed *London Churchill Livingstone press* 2007;131-50
20. Clinical and Laboratory Standards Institute (CLSI). Performance standards for antimicrobial susceptibility testing, 23rd informational supplement M100-S23. Wayne, PA,USA :CLSI. 2013; 33 (1)
21. DuszyńskaW, Rosenthal VD, Szczęsny A, Woźnica E, Ulfik K, Ostrowska E, Litwin A, Kubler A. Urinary tract infections in intensive care unit patients— a single-centre, 3-year observational study according to the INICC project. *Anaesthesiology Intensive Therapy* 2016;48(1): 1–6
22. Sharma A, Shrestha S, Upadhyay S, Rijal P. Clinical and Bacteriological profile of urinary tract infection in children at Nepal Medical College Teaching Hospital. *Nepal Med Coll J* 2011; 13(1): 24-26
23. Vinoth M, Prabagaravarthanan R, Bhaskar M. Prevalence of microorganisms causing catheter associated urinary tract infections (CAUTI) among catheterised patients admitted in a tertiary care hospital. *Int J Res Med Sci* 2017;5(6):2367-2372
24. Bagchi I, Jaitly NK, ThombareVR. Microbiological Evaluation of Catheter Associated Urinary Tract Infection in a Tertiary Care Hospital. *People's Journal of Scientific Research* 2015; 8 (2):23-29
25. Pradhan B, Pradhan SB. Prevalence of Urinary Tract Infection and Antibiotic Susceptibility Pattern to Urinary Pathogens in Kathmandu Medical College and Teaching Hospital , Duwakot. *Birat Journal of Health Sciences* 2017; 2 (1) 2 :134-137
26. Shah LJ, Vaghela GM, Mahida H. Urinary tract infection: Bacteriological profile and its antibiotic susceptibility in Western India. *National Journal of Medical Research*. 2015; 5(1): 71-74
27. Poudel CM, Baniya G, Pokhrel BM. Indwelling catheter associated urinary tract infection. *Journal of Institute of Medicine* 2008; 30:3 2-7
28. Tasbakan MI, Durusoy R, Pullukcu H, Sipahi OR, Ulusoy S. Hospital acquired urinary tract infection point prevalence in Turkey: Differences in risk factors among patient groups. *Annals of clinical microbiology and antimicrobials*. 2013; 12:31
29. Nwankwo I U,Godwin C T. Evaluation of the Antibacterial Susceptibility Patterns in Patients with Indwelling Urinary Catheters in Federal Medical Centre, Umuahia, Abia State. *IOSR Journal of Pharmacy and Biological Sciences* 2014; 9(3):19-22
30. Nicolle LE. Catheter-Related urinary tract infection. *Drugs Aging* 2005;22(8):627-639
31. Rajput MS, Chavan NS, Parashar S, Jain SM. Bacteriological Profile of Urinary Tract Infection in Female Patient Attending Tertiary Care Hospital, Indore, India. *Int.J.Curr.Microbiol.App.Sci* 2014; 3 (7): 847-852
32. Dongol A, Joshi DM , Gautam A. Detection of Pyuria versus Bacteriuria in Suspected Patients of Urinary Tract Infection. *Nepal Journal of Science and Technology* 2014; 15(1):129-132
33. Tambyah PA, Maki DG. The relationship between pyuria and infection in patients with indwelling urinary catheters: a prospective study of 761 patients. *Arch Intern Med* 2000; 160 (5):673-677.