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Urinary Pathogens and their Antimicrobial Sensitivity in Hospitalized Patient

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SUMMARY

Urinary tract infection (UTI) is one of the common nosocomial infection. Out of 26368 patients admitted in Shaikh Zayed Hospital, Lahore, during a period of one year, 2870 patients showed significant bacteriuria (>10^5/ml) giving a urinary infection rate in hospitalised patients of 10.88%. Out of 14596 male patients 1604 (10.99%) and out of 11772 female patients 1266 (10.5%) had significant bacteriuia. The highest prevalence was found in Urology ward where 34.5% of the patients admitted had UTI followed by surgical ward where 22.13% had UTI. The commonest organism isolated was E.coli, seen in 29.7%, followed by Klebsiella, 21.6%. Proteus 15.8%, Staphylococcus 14.4%, Psuedomonas 8.4%, Streptococcus fecalis 7.2%, and Acinetobacter 1.9% and 0.9% others. E.Coli, Klebsiella, Staphylococcus, Streptococcus fecalis and Acinetobacter were more common in females while Proteus and Psuedomonas were more common in male patients. In age group of 11-30 years the prevalence of Staphylococcus was higher in females as compared to other age groups and in females and males of same age group. These organisms showed greater resistance to earlier antibiotics. Ampicillin, Amoxacillin, Co-trimoxazole,Pipemidic acid and Gentamycin. The antibiotics showing good sensitivity (>80%) against different organisms were as follows: Amikacin, 3rd generation cephalosporins and Aztreonam for Pseudomonas, second and third generation quinolones, Amikacin, Aztreonam, and 3rd generation cephalosporins for E.Coli, Klebsiella and Proteus. Cephradine, cofaclor, cefuroxime for Staphylococcus ; ampicillin, cefaclor and cefoperazone against Streptococcus fecalis; cefotaxime, ceftazidime, third generation quinolones and amikacin for acinetobacter showed greater than 80% sensitivity.

Given the present situation with respect to resistance, second and third generation quinolones, third generation cephalosporins and amikacin are recommended in that order for blind therapy of hospital acquired urinary tract infections prior to receiving back the culture sensitivity report.

Urinary tract infections (UTIs) are the most common bacterial infections encountered in the practice of medicine today. These infections affect humans throughout their life span and it is estimated that UTIs account for 5 million office visits yearly in United States[1,2].

During the past 40 years a large number of antimicrobial agents have been available for treatment of UTIs. The advent of these antimicrobial agents have been associated with many claims of superior activity and efficacy. Many of the infections of urinary tract respond readily to treatment with these compounds, but treatment failures occur. Bacterial resistance is a major cause of these failures. This increase in bacterial resistance to the commonly used antimicrobial agents makes the choice difficult for the clinicians.

The purpose of this paper was to find the rate of UTIs in our hospitalized patients, prevalence of different urinary pathogens and their antimicrobial sensitivities so as to help the clinicians to start the empiric therapy for UTIs.

MATERIALS AND METHODS

The study covers a period of 12 months that is from July 1991 to June 1992. Clean catch midstream

or catheterized samples of urine were collected in a sterile container from the patients in whom UTI was suspected clinically or on routine urine analysis (presence of WBCs on microscopic examination of urine sediment). These samples were sent to the laboratory without unnecessary delay. The inoculation was done within two hours of collection by semiquantitative method. A standardized loop that could hold 0.002 ml was used for inoculation. A loopful from each uncentrifuged urine sample was inoculated on to C L E D (Cystein Lactose Electrolyte Deficient) Agar and was incubated at 35-37 ° F for 18-24 hours. The isolated organisms were identified using various biochemical tests such as catalase, oxidase, motility indole urease agar test and triple sugar iron agar test. The number of colonies per milliliter was calculated by counting the number of colonies obtained on the agar plate after incubation and multiplying it with 500. The urine culture was reported to be positive and taken as evidence of urinary infection if the colony count of a single organism was more than 10^5 cfu/ml. Their susceptibility to different antimicrobial agents was determined by the modified disc diffusion method from National Committee for Clinical Laboratory Standards (NCCLS)[3]. To have adequate data only the organisms isolated and antibiotics used on more than ten occasions were included in the final analysis. The information was collected about the patients' age sex and ward from the hospital records.

RESULTS

During the study period a total of 4587 urine samples were collected. Out of these 2870 specimens showed significant bacteriuria. Total number of patients admitted in Sheikh Zayed Hospital during this period was 26368. This gives us a urinary tract infection rate of 10.88% in the hospitalized patients. There were 14596 males and 11772 females. Out of these 1604 males (10.99%) and 1266 females (10.75%) had significant bacteriuria (Fig. 1).

The prevalence of bacteriuria by age is shown in Figure 2. The lowest incidence (4.5%) was found in age group 11-20 years and highest incidence (16.4%) in age group of 41-50 years. Most of the patients (58.2%) belonged to age group 21-60 years and 13.4% were less than one year old.

Different urinary pathogens isolated and their frequency are depicted in Figure 3. E. coli was the most common organism responsible for UTI. It was isolated in 29.7% patients. Next to it were Klebsiella (21.6%), Proteus (15.8%) Staphylococcus (14.4%) Pseudomonas (8.4%), Strept. fecalis (7.2%) and Acinetobacter (1.9%).

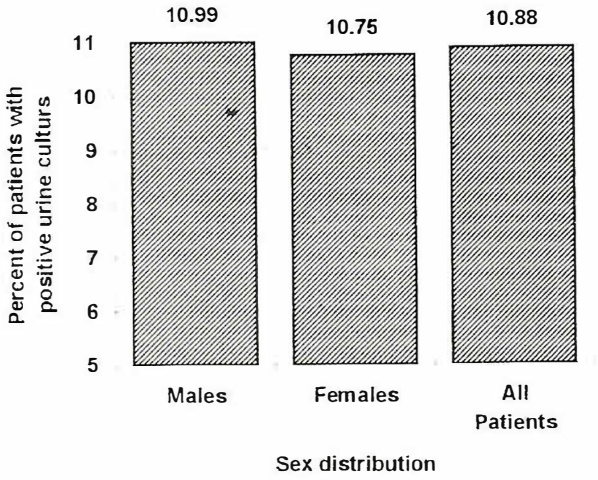

Fig. 1: Rate of urinary tract infections among hospitalized patients.

Distribution of these organisms among males and females is shown in Figure 4. E. coli, Klebsiella, Staphylococci, Acinetobacter and Strept. fecalis were seen more commonly in female patients, while Proteus and Pseudomonas were present more often in males.

Prevalence of these organisms in different age groups in all patients, in males and females is presented in Figures 5-7. E. coli (28-33.2%) was isolated most commonly in all age groups. Next to it was Klebsiella (17.7-26.2%) except in age group of 11 to 20 years in which Staphylococcus exceeded Klebsiella (19.4 vs 17.7%) as shown in Fig. 5. Distribution of different urinary pathogens in males in various age groups is presented in Figure 6. E. coli dominated in all age groups except in age group 1-10 years in which Klebsiella, Proteus and Pseudomonas were seen more often than the E. coli. Distribution of various organisms in females in different age groups showed that E. coli was again the most common organism in all age groups except in age group 21-30 in which Klebsiella was slightly more common than E. coli (25.2.5 vs 24.8%). Staphylococcal was equal to E. coli in this age group and only slightly less common than E. coli in age group 11-20 years (26.8% vs 27.2%). Prevalence of Staphylococcus was significantly higher in females in age groups

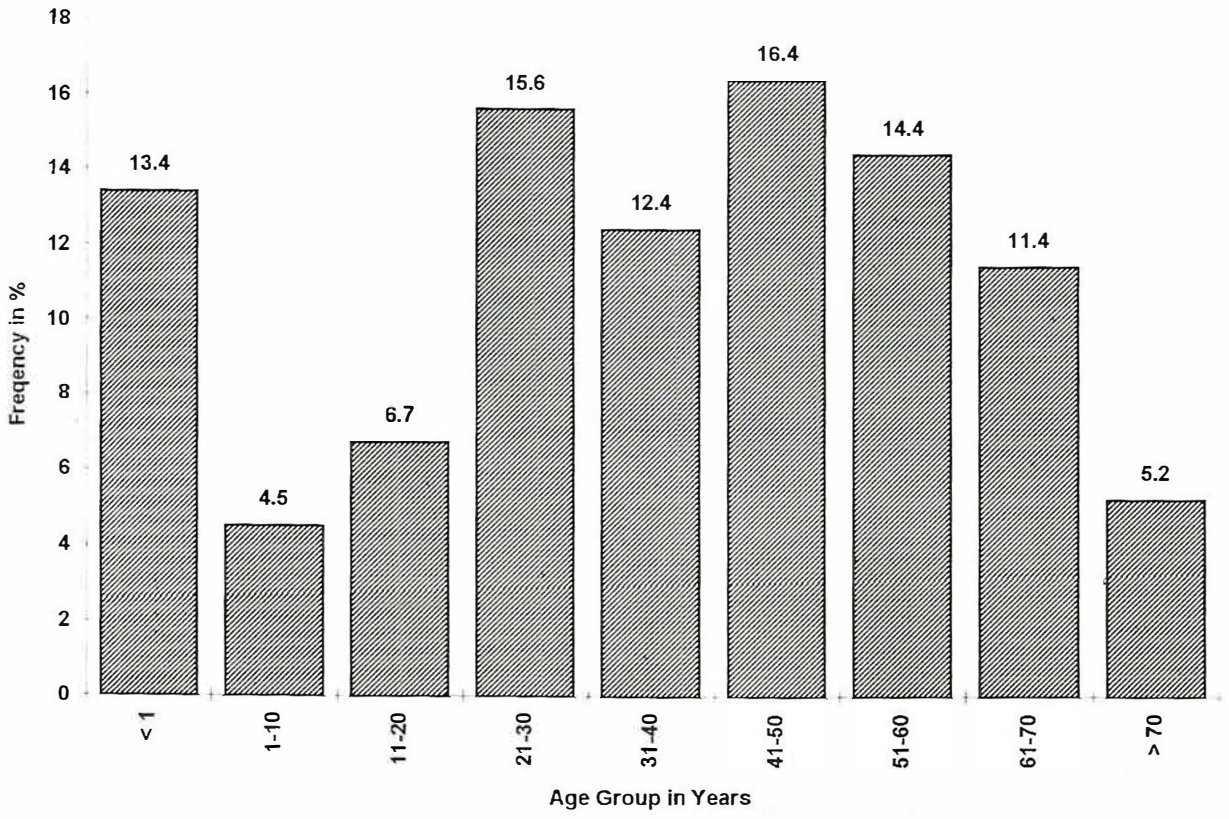

Fig. 2: Prevalence of urinary tract infection in different age groups.

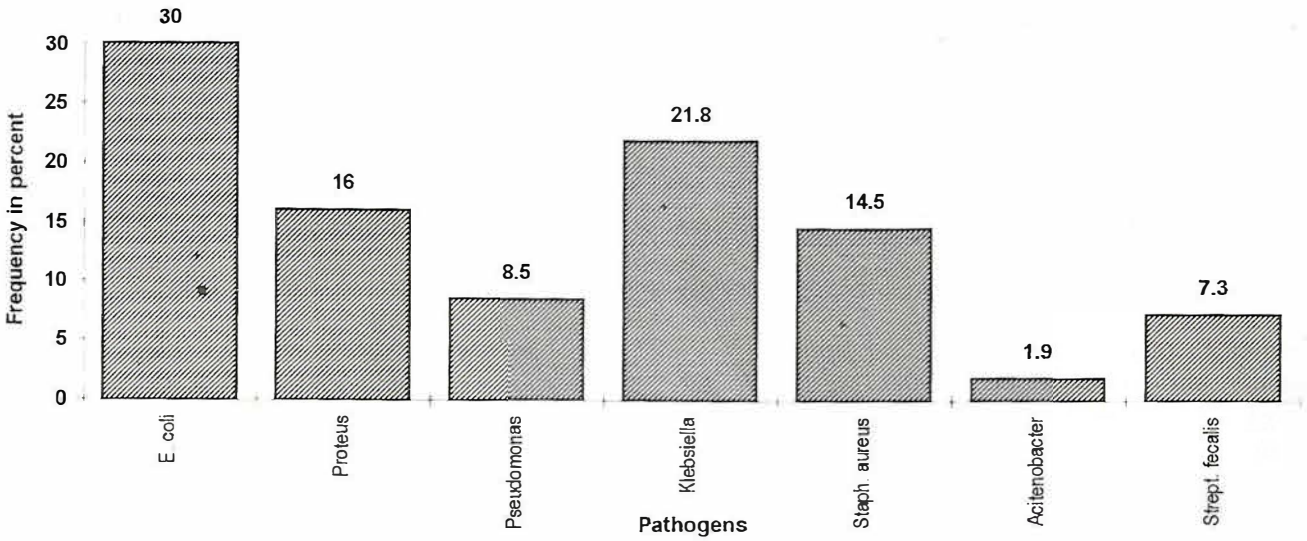

Fig. 3: Frequency of various urinary pathogens isolated.

11-20 and 21-30 than in other age groups in females (Fig. 7) and when compared with males of same age group (Fig. 6). Infection with Staphylococcus was more common in females with age between 1 to 30 years. In infants less than 1 year of age and patients older than 70 Staphylococcal infection was more

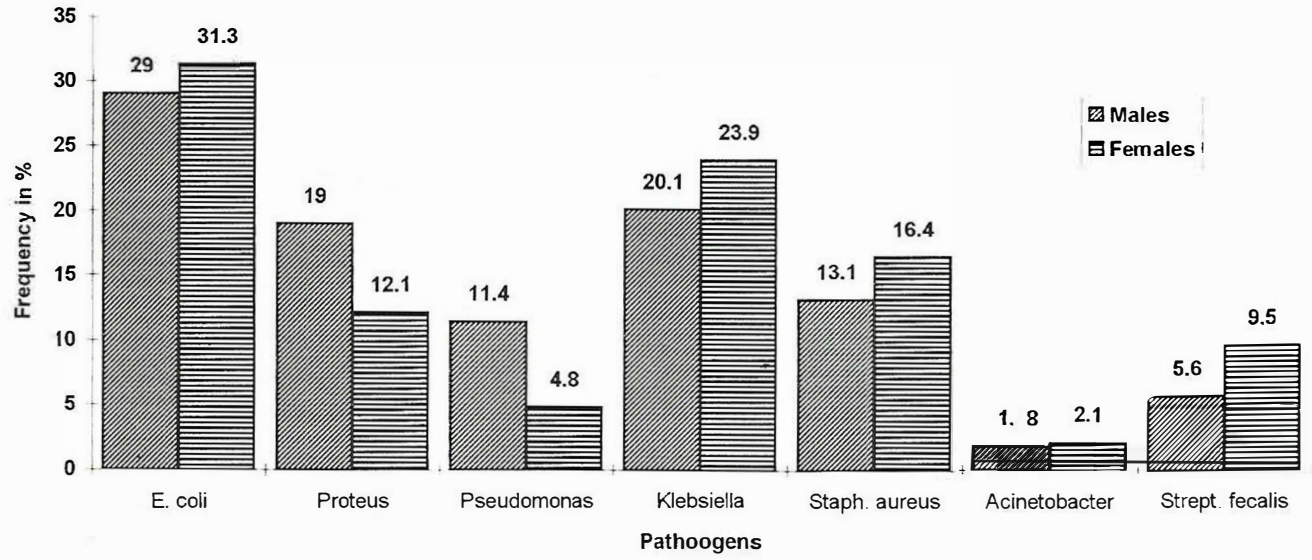

Fig. 4: Distribution of different urinary pathogens among males and females.

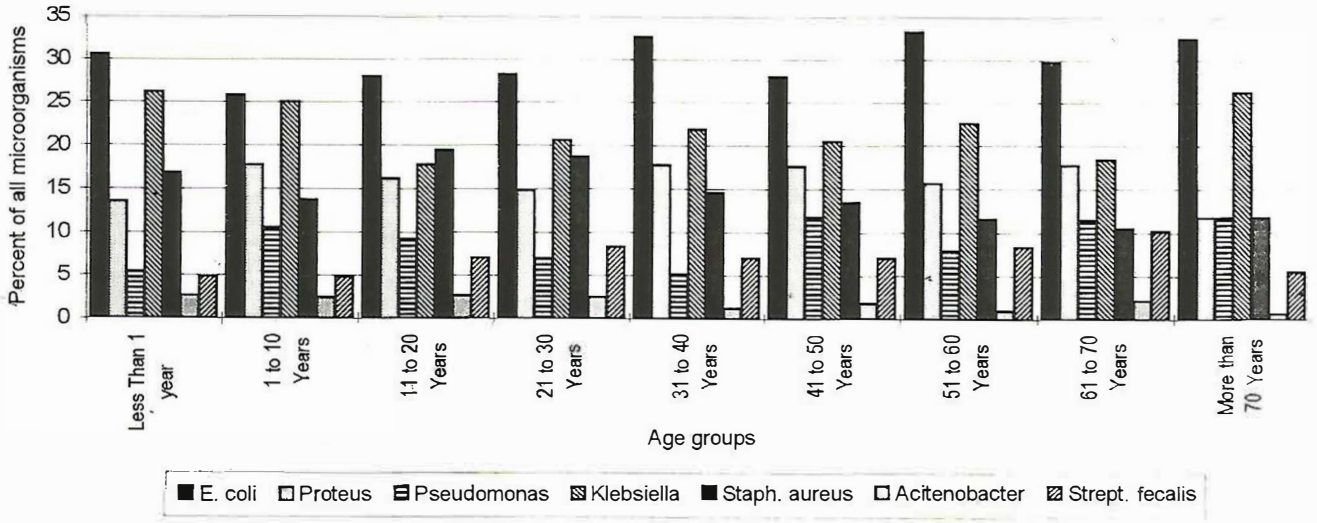

Fig. 5: Distribution of various organisms among different age groups in all patients.

common in males. In age group less than one year patients both males and females were affected almost equally with E coli. Proteus was more common in males in all age groups except in age group 41-50. Pseudomonas infection was more common in males in all age groups except in patients older than 70.

The number of patients with urinary infection was highest in urology ward followed by surgical ward as shown in Figure 8. UTI was found in 34.5% of patients admitted in urology and 22.13% of patients admitted in surgical ward.

Sensitivity of these pathogens to various antibiotics were also studied. More than 60% of E. coli, Proteus, Pseudomonas, Klebsiella and Acinetobacter were resistant to older antibiotics like ampicillin, amoxycillin, cotrimoxazole and carbenicillin (Figs. 9, 10). Cotrimoxazole has lowest sensitivity against these organisms (10.37-32.73%). E. coli and Klebsiella showed 62.7 to 65.7% sensitivity against cephradine and cefaclor, 47.7 to 56.7% against cephalexin. Proteus and Pseudomonas were more sensitive to cefaclor than cephalexin or cephradine (53.66 to 59.2% vs 21.8 to 54.9%). Staphylococci and

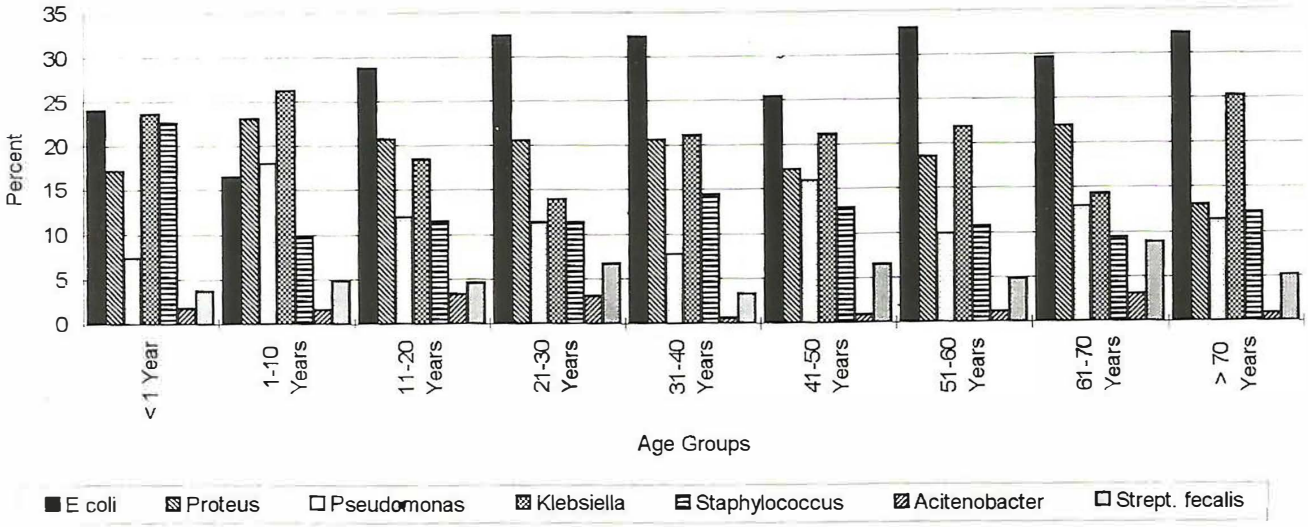

Fig. 6: Distribution of different urinary pathogens among males.

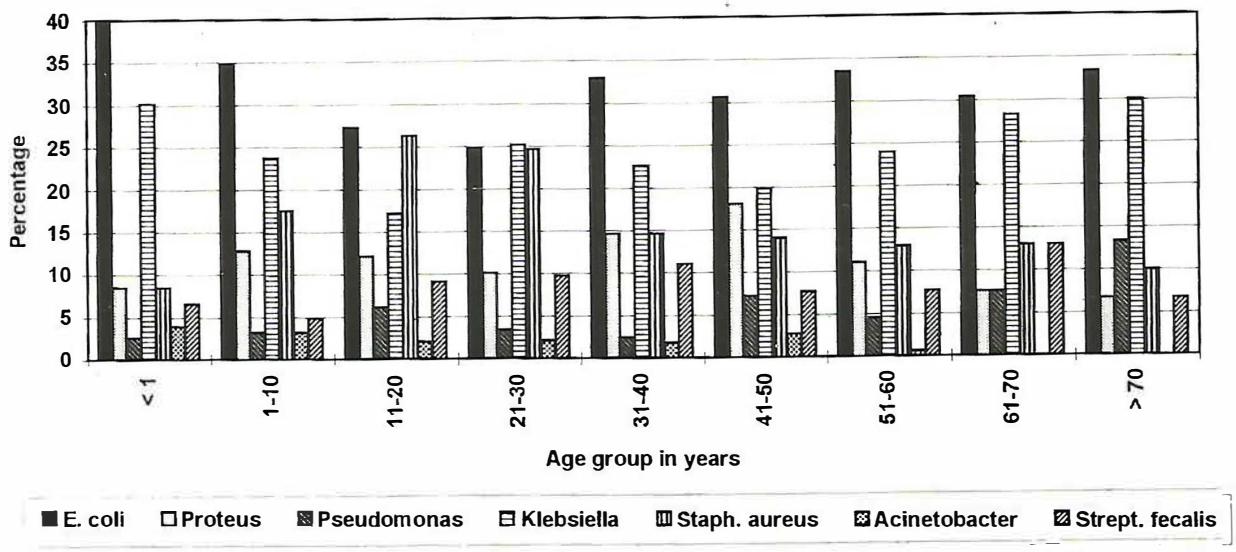

Fig. 7: Distribution of various urinary pathogens among females in different age groups.

Strept. fecalis had 85.2 and 86.6% against cefaclor, 85.3 and 70% against cephradine, 52.4 to 63.1 and 84.2 to 85.4% against ampicillin and amoxycillin. Among the newer cephalosporins ceftazidime and cefoperazone had almost similar results i.e. sensitivity about 80% against E. coli, 78% against Klebsiella and greater than 90% against Pseudomonas. Ceftazidime showed better sensitivity than cefoperazone for Proteus (90% vs 82%). Cefotaxime was sensitive to 80% isolates of E. coli, 84% of Proteus, 88% of Klebsiella and 70% of Pseudomonas. Except for ceftazidime and cephalexin other cephalosporins like cephradine, cefaclor, cefuroxime cefoperazone, and cefotaxime had over 80% sensitivity against Staphylococcus. Ceftazidime and cefotaxime were more effective against Acinetobacter (sensitivity > 88%) while cefoperazone showed better sensitivity (sensitivity 90%) against Strept. fecalis than the other cephalosporins tested (Fig. 11).

Out of aminoglycosides amikacin had 90% or more sensitivity against E. coli, Proteus, Pseudomonas, Klebsiella, Acinetobacter and Staphylococcus. Tobramycin was next to it against all these organisms (sensitivity 68 to 87%) but

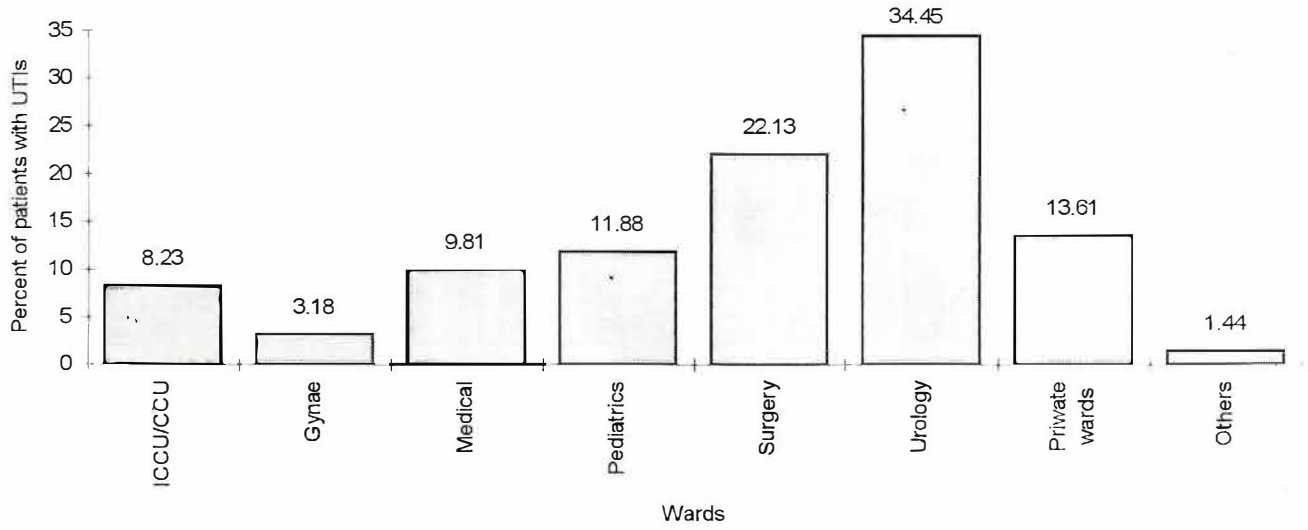

Fig. 8: Percent of patients with urinary tract infections in different wards.

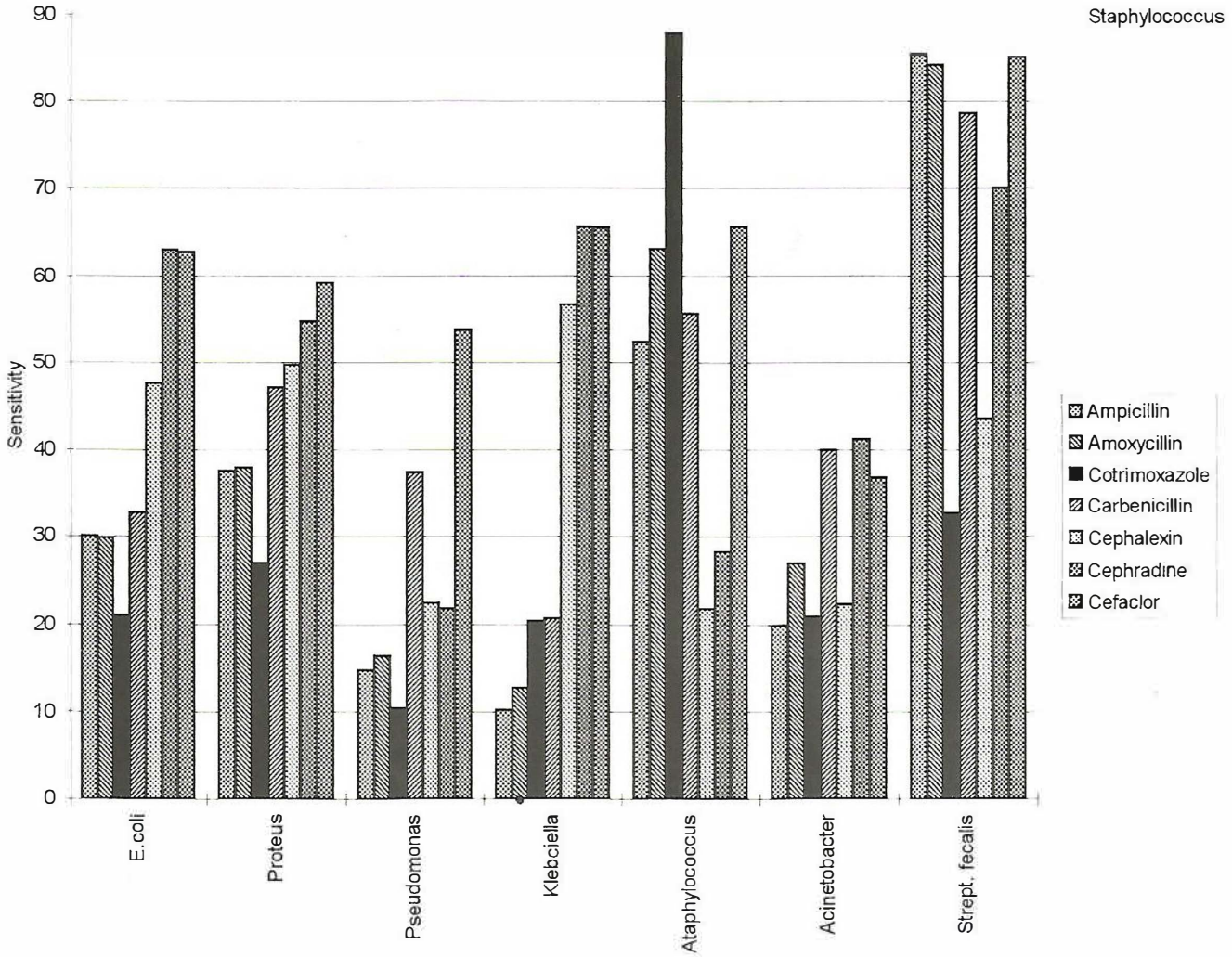

Fig. 9: Sensitivity of different urinary pathogens too earlier antibiotics.

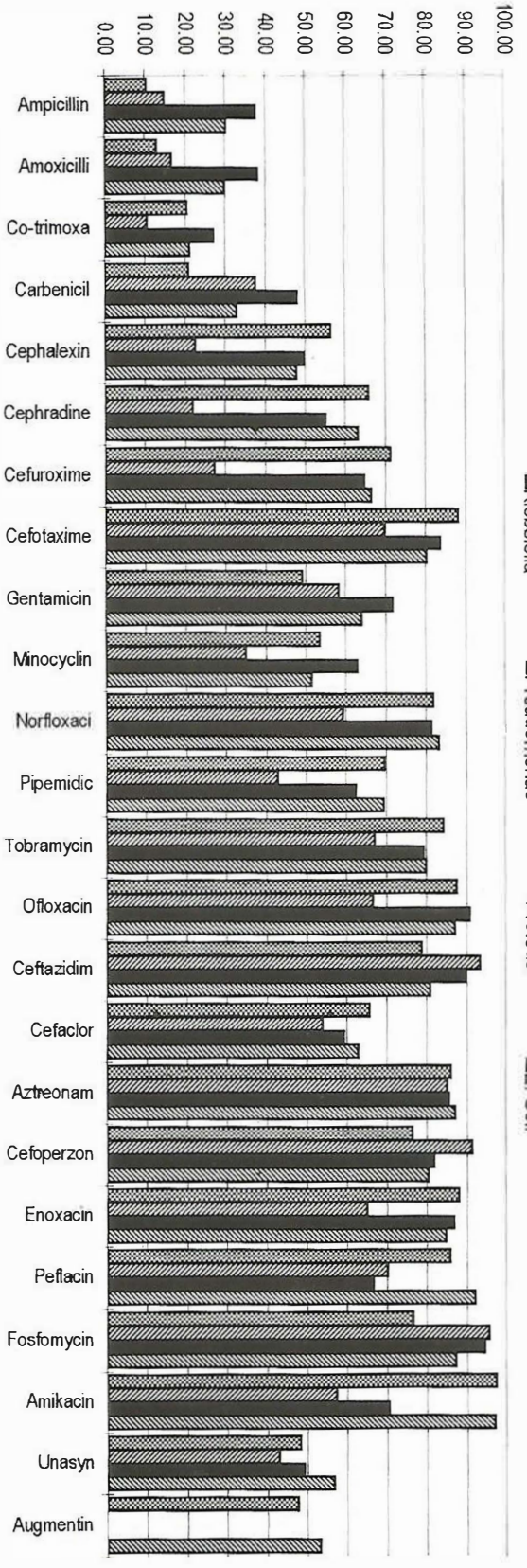

Fig. 10: Sensitivity of commonly isolated urinary pathogens to different antibiotics.

showed better sensitivity than amikacin against Strept fecalis (75% vs 52%). There was greater resistance of all these organisms except Strept. fecalis to gentamicin (sensitivity 38 to 75%). For Strept. fecalis sensitivity pattern was similar (sensitivity 52%) to amikacin (Fig. 12).

Out of quinolones pefloxacin ofloxacin and enoxacin had almost equal sensitivities about 80% or higher against E. coli, Proteus, Klebsiella, Staphylococcus, Acinetobacter and Strept. fecalis. But 30 to 40% strains of Pseudomonas were resistant to these antibiotics. Norfloxacin showed slightly less sensitivity compared to third generation quinolones. All the common organisms isolated in this study showed greater resistance to pipemidic acid (Fig. 13). More than 85% of E. coli, Proteus, Klebsiella and Pseudomonas were sensitive to aztreonam (Fig. 14).

DISCUSSION

Urinary tract infection is the most common nosocomial infection. It has been reported that 35-40% of nosocomial infections are of urinary origin[4,5]. Jarvis et al. reported an average urinary tract infection rate of 13.1 cases /1000 hospital discharges[6]. There were estimated 900,000 cases of UTI in 1976, with an incidence rate of 2.39 cases per 100 acute hospital admissions[7,8]. In other reports 2.5.-6% of admissions in various hospitals were found to have hospital acquired urinary tract infection[5,9,11]. In this study we found UTI rate of 10.88 per 100 hospital admissions. There was no significant difference between prevalence of UTIs in males (10.99%) and females (10.75%). This is in contrast to community acquired infections which are more common in females. High UTI rate in hospitalized patients is mostly due to presence of indwelling catheters, instrumentation of urinary tract, patients admitted with anatomical problems of urinary tract and is also linked with altered host factors like age sex, and debilitating diseases Seventy to ninety percent of cases of nosocomial UTIs are associated with instrumentation of the urinary tract[13-15]. Less than 1% of noncatheterized patients acquire bacteriuria during their hospitalization[9]. Between 15 and 25% of patients in acute care hospitals may have catheter in place sometimes during their stay in hospital[10]. Bacteriuria develops in 10 to 30% of these catheterized patients[9-12]. The

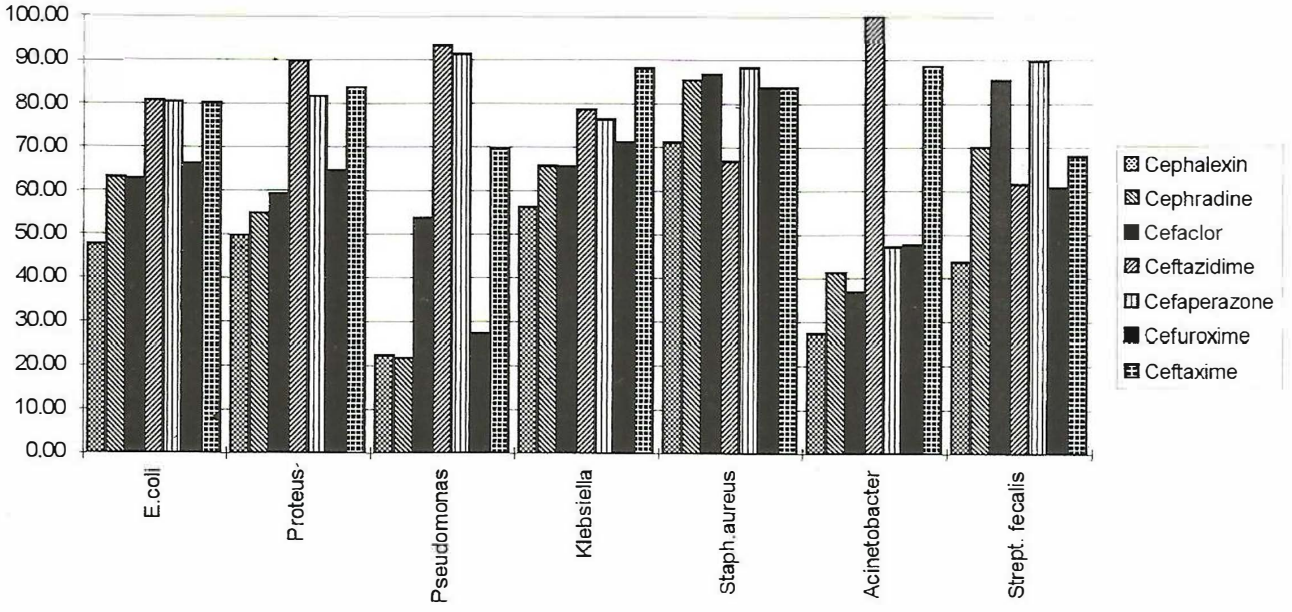

Fig. 11: Sensitivity of different urinary pathogens to cephalosporins.

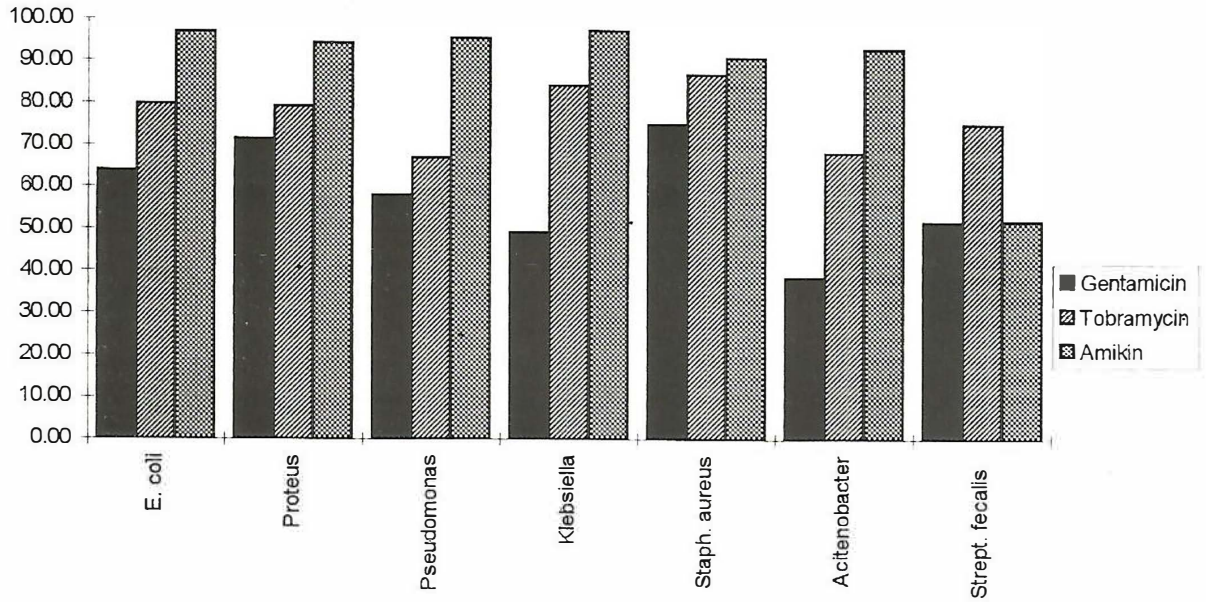

Fig. 12: Sensitivity of different urinary pathogens aminoglycosides.

incidence reported is approximately 5-7% for each day of catheterization[16]. High rate of UTI in our patients was most likely due to these factors. Significant number of patients belonged to urology and surgical wards where bacteriuria was found to be in 34.45% and 22.13% of the patients admitted to these wards respectively. In medical wards 9.81% and in paediatric ward 11.88% of the patients admitted had bacteriuria. Efforts must be done to reduce the frequency and duration of catheterization to decrease the incidence of infection besides aseptic insertion of catheter and careful maintenance of

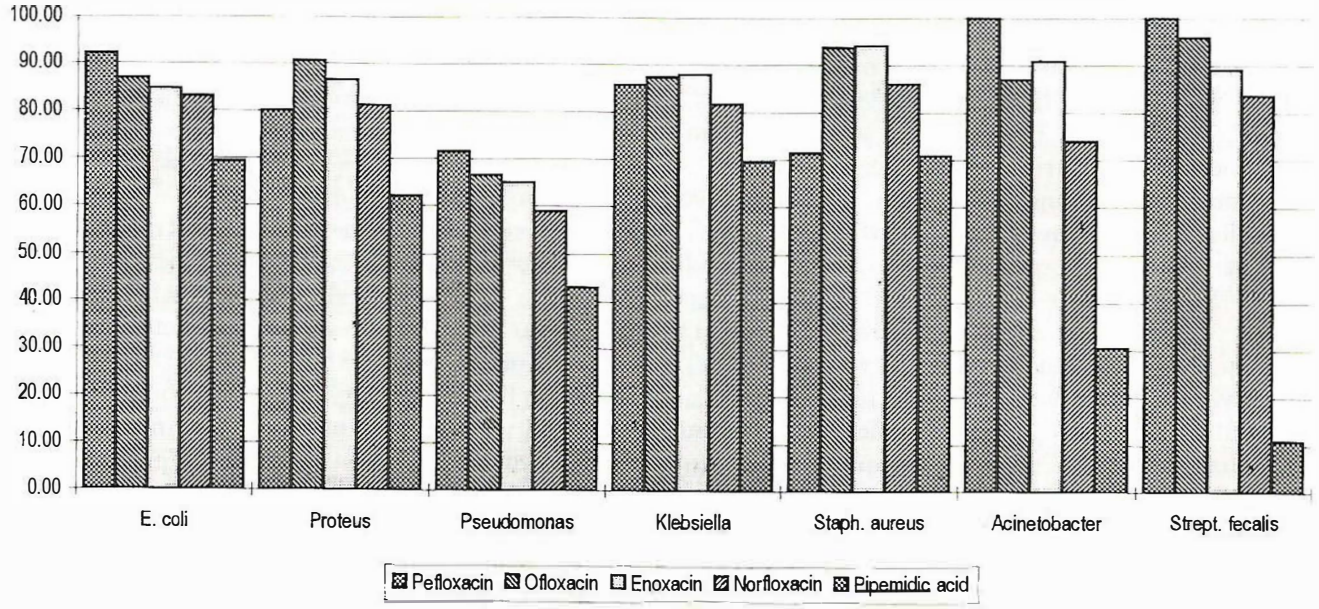

Fig. 13: Sensitivity of various urinary pathogens to different quinolones.

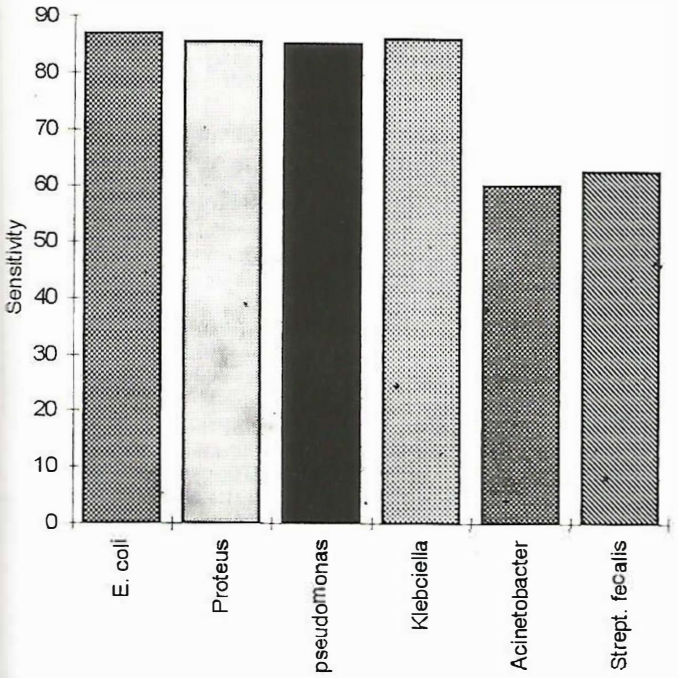

Fig. 14: Sensitivity of various organisms to Aztreonam.

drainage system. Prophylactic, systemic, or tropical antimicrobial agents and modifications of the catheter drainage system designed to reduce the contamination were expensive and have not been shown to be efficacious for the majority of patents[16].

Most common organism responsible for UTIs is E coli. Rubin reported E. coli in 89.2%, Proteus in 3.2% Klebsiella in 2.4% and Pseudomonas in 0.4% in outpatients. But in case of hospitalized patients E. coil was responsible for UTI in 52.7%, Proteus for 12.7%, Klebsiella for 9.3% and Pseudomonas for 6.0%[17]. According to Neu E. coli is most common cause of uncomplicated UTI (79%) followed by Staphylococcus (11%) with Klebsiella, Proteus, Enterococci and other species each accounting for 2% of the remainder[18]. In another report of 1276 male patients with UTI E. coli (35%), Proteus (13.4%), Streptococcus (12.6%), Pseudomonas (10.8%), Klebsiella (9%) and Staphylococcus (9.0%) were the causative organisms[19]. As Naber and colleagues showed, E. coli accounted for only 34% of infections. Enterococci were involved in 14% and Staphylococcus epidermidis in 8.7% of these infections[20]. Slack also found E. coli (58.3%) as most common urinary pathogen followed by Proteus (13.3%), Klebsiella (11.0%), Streptococcus (8%), Staphylococcus (3.6%) and Pseudomonas (3.2%)[21]. E. coli accounted for 85% community acquired and 50% UTIs in hospitalized patients in a report by Sobel[22].

E. coli was also the most common urinary pathogen (in 29%) in a study by Carton et al followed by Proteus (13%), Enterobacter in (12%), Serratia (7%), Pseudomonas (6.5%) and Klebsiella (6.6%)[12]. Our study also showed that the most common etiologic agent was E. coli and there is more shift to non- E. coli pathogens in hospitalized patients. The prevalence of other urinary pathogens is different. We found second most common organism as Klebsiella (21.6%). These were followed by Proteus (15.8.0%), Staphylococcus (14.5%), Pseudomonas (8.5%), Strept fecalis (7.3%) and Acinetobacter (1.9%). Indwelling catheters, cross infection, instrumentation of urinary tract and resistant bowel and environmental flora, reduced host resistance contribute to this altered microbiology in hospitalized patients. Community acquired UTIs are commonly seen in newborns, prepubertal girls, young boys sexually active young women elderly males and females[18]. There was no difference between males (10.99%) and females (10.75%) as far as frequency is concerned, in this study. But the spectrum of organisms isolated was different in males and females. Proteus and Pseudomonas were seen more often in males, while E. coli, Klebsiella, Staphylococcus, Strept. fecalis and Acinetobacter were more common in females. Females with age in second and third decades were affected significantly more with staphylococcus compared to males of same age group. Staphylococcus has been reported as an important cause of UTI in young women by others also[18,20,23].

Generally hospital based studies show a higher percentage of resistant strains because of frequent use of antibiotics, selection of 'difficult' cases with abnormalities of urinary tract, catheterization, and cross infection within units of hospital. General practice surveys have shown an increase resistance of various bacteria to different antibiotics. Our in vitro work shows in case of nosocomial UTIs generally a higher microbial resistance pattern in E. coli, Proteus, Pseudomonas Klebsiella and Acinetobacter to the earlier antibiotics ampicillin, amoxycillin, co-trimoxazole and carbenicillin pipemidic acid gentamicin. For hospital acquired UTI due to E. coli, Proteus, and Klebsiella, third generation cephalosporins, second and third generation quinolones, aztreonam and amikacin showed higher sensitivity pattern (> 80%). E. coli against fosfomycin and Klebsiella against tobramycin also showed greater than 80% sensitivity. Effective drugs against Pseudomonas were third generation cephalosporins and amikacin. Staphylococcus showed sensitivity >80% for cloxacillin, first and second generation cephalosporins, second and third generation quinolones, fosfomycin, sultamicillin (unasyn) clavulanate-amoxycillin and amikacin. More than 80% isolates of Acinetobacter were sensitive to third generation cephalosporins, third generation quinolones and amikacin. For Strept. fecalis ampicillin, amoxycillin cefaclor and second third generation quinolones showed greater than 80% sensitivity. Resistance to earlier antibiotics has been shown by others also[24,25].

Complicated urinary tract infections may be associated with significant morbidity and mortality. Clinical condition often require the immediate administration of antibiotics. Given the present situation with respect to resistance, the use of antibiotics with a sensitivity of less than 50% does not appear to make good sense. Prior to receiving culture sensitivity report, second generation quinolone norfloxacin, third generation quinolones, third generation cephalosporins and amikacin are recommended in that order.

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REFERENCES

1. **Hooton TM.** *Epidemiology, definition, and terminology in urinary tract infections.* In: **Neu HC, Williams JD, eds.** New trends in urinary tract infections. Basel: Karger, 1988; 1-8.
2. **Cypress BK.** *Patients' reason for visiting physicians*: National Ambulatory Medical Care Survey. United States. 1977-1978 In Vital and Health Statistics. Data from the National Health Survey, Series 13 (56) (DHHS) Publication No 82-1717). Hatstsville, MD National Center for Health Statistics, 1981.
3. **Thonsberry C, Sherris JC.** *Laboratory tests in chemotherapy.* In **Lennette EH, Balows A, Henslerw J, Shadow YHJ, eds.** Manual of Clinical Microbiology. 4th ed Washington DC. American Society of for Microbiology 1985.
4. **Edwards PR, Ewing WH.** Identification of Enterobacteriaceae, 3rd ed. Minneapolis; Burgess Publishing Co. 1972; **3:** 7-47.
5. **Turk M, Stamm W.** Nosocomial infection of urinary tract. *Am J Med 19?;* **70**: 651-4.
6. **Jarvis WR, White JW, Munn VP, et al.** Nosocomial infection surveillance, 1983. *MMWR; 1983;* **33(2SS)**: 9SS.

7. **Haley RW, Culver DH, White JW, et al.** The efficacy of infection surveillance and control programs in preventing nosocomial infections in US hospitals. *Am J Epidemiol 1985;* **121**: 182-205.
8. **Haley RW, Culver DH, White JW, et al.** The nationwide nosocomial infection rate: A new need for vital statistics *Am J Epidemiol 1985;* **121**: 159-167.
9. **Harley R, Hooten TM, Culver DH, et al.** Nosocomial infections U.S hospitals, 1975-1976: Estimated frequency by selected characteristics of patients. *Am J Med 1981;* **70**: 947-59.
10. **Garibaldi RA, Burke JP, Dickman ML, et al.** Factors predisposing to bacteriuria during indwelling urethral catheterization. *N ENG J Med 1974;* **291:** 215.
11. **Hooten TM, Culver DH, et al.** Nosocomial infections U.S hospitals, 1976-1976: Estimated frequency by selected characteristics of patients. *Am J Med 1981;* **70:** 947-59.
12. **Carton JA, Gomez Moro MB, Gonzalez - Lopez B, Maradona JA, de-Diego I, Carcaba V, Arribas JM.** Nosocomically acquired infection of the urinary tract. *Enferm Infec Microbiol Clin 1989;* **7**: 408-14.
13. **Carson CC.** Nosocomial urinary tract infections. *Surg Clin North Am 1988;* **68:** 1147-55.
14. **Givens CD, Wenzel RP.** Catheter associated urinary tract infections in surgical patients: A controlled study on excess morbidity and costs. *J Urol 1980;* **124:** 646-8.
15. **Krieger JN, Kaiser DL, Wenzel RP.** Nosocomial urinary tract infections: Secular trends, treatment and economics in a university hospital. *J Urol 1983;* **130**: 102-6.
16. **Sachaeffer AJ.** Catheter associated bacteriuria. *Urol Clin North Am. 1986;* **13:** 735-47.
17. **Rubin HR, Tolkoff-Rubin NE, Cotran RS.** *Urinary tract infection, pyelonephritis and reflux nephropathy.* In **Brenner BM, Rector FC (eds)** The Kidney. WB Saunders Co Philadelphia 1991 : 1370
18. **Neu HC.** Urinary tract infections. *Am J Med 1992;* **92 (suppl 4A):** 63S-70S
19. **Larson EH, Gasser TC, Madson PO.** Antibacterial prophylaxis in urologic surgery. *Urol Clin North Am 1986;* **13:** 591-604.
20. **Naber KG, Bauernfeind A, Deillein G, Wittenberger R.** *Urinary tract in elderly urological patients.* In **Neu HC, Williams JD, eds.** New trends in urinary tract infections. Basel; Karger, 1988: 48-61.
21. **Slack R.** Review of bacterial resistance - a challenge to the treatment of urinary infection. *J Antimicrobial Chemotherapy 1984;* **13**: 1-7.
22. **Sobel JD.** Bacterial etiologic agents in the pathogenesis of urinary tract infection. *Med Clin North Am 1991;* **75:** 253-73.
23. **Hovelius B, Mardh P.** Staphylococcus saprophyticus as a common cause of urinary tract infection. *Review Infect Dis 1984;* **4:** 328-37.
24. **Dornbusch K, Toivanen P.** Effect of trimethoprim or trimethoprim/sulphamethoxazole usage on submergence of trimethoprim resistance in urinary tract pathogens. *Scand J Infect Dis 1981;* **13**: 203-10.
25. **Rubinstein E, Mark Z, Karen G, Alkan M, Berger S.** Comparative activity of ofloxacin with reference to bacterial strains isolated in in-patients and out-patients. *Infection 1986;* **14**: S20-5.

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