Antibacterial Resistance Trend in Urinary Tract Infections and their Control at a Tertiary Care Hospital in the Saurashtra Region of Gujarat, India

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Urinary tract infections are a major infection burden globally and antimicrobial resistance can lead to treatment failures as well as upsurge cost of healthcare. The study was aimed to know the common pathogens responsible for urinary tract infection, their antibiotic resistance pattern, and bundle care effectiveness. A total 2352 urine samples were studied from the year 2013 to 2017. Urine culture and antibiotic sensitivity testing were carried out. Care bundle compliance for catheter-associated urinary tract infections (CAUTI) was observed during the starting year (2013) and end year (2017). A 46.3% of samples were found positive for the presence of significant bacteriuria. *Escherichia coli* was the commonest isolate followed by *Pseudomonas aeruginosa* and *Klebsiella pneumoniae*. All antibiotics were found more or less resistant against various organisms, most trusted antibiotics against UTI, Nitrofurantoin was found 20.8% (CI = 18.0-23.8) resistant overall. Out of all *E. coli* isolated,86.0% were possible extended-spectrum beta-lactamase (ESBL) producers, 18.3% were carbapenem-resistant, 20.7% were amikacin resistant and 0.7% were colistin-resistant. The number of CAUTIand CAUTI rates per 1000 catheter days decreased where, p = 0.0482 and p = 0.0783 respectively.CAUTI bundle shows no significant difference;p = 0.8475.Non-bias compliance surveys and continuous monitoring with quality care can limit nosocomial infections.

Keywords: Antibiotic resistance; Bundle care approach; Urinary isolates; Urinary tract infection.

Urinary tract infections (UTIs) are very common and diagnosed with the help of urine culture technique[1,2]. It is always advisable to correlate clinical symptoms with the results of the test. Organisms like *Escherichia coli* are the most frequently isolated organism in uncomplicated and complicated UTIs. However, it creates ambiguity towards choosing correct empirical treatment[3]. Antimicrobial resistance in nosocomial UTIs, especially catheter-associated

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urinary tract infections poses grave concerns for antimicrobial effectiveness in treating[4,5]. It is necessary to measure and compare the antimicrobial resistance in hospitals regularly because the effects of antimicrobial resistance are mainly felt in healthcare facilities[6].

Urinary catheters are used in critical patients, especially those who are unable to move from their bed or unable to empty the bladder naturally due to some clinical conditions. The catheter remains attached for a long period, which leads to catheter-associated urinary tract infection (CAUTI) because of the catheter act as a reservoir for multidrug-resistant organisms and responsible for hospital-acquired infections. Such infections are prevented by implementing a bundle of care[7,8]. CAUTI bundle care is an evidence-based guideline to assess the need, proper handling, and earliest removal of catheters to alleviate the risk in the patient[9].

The study aimed to summarize the most common pathogens of UTIs and their antimicrobial susceptibility patterns, so this may be helpful while preparing the local empirical treatment regimens. The study also aims to evaluate the effectiveness of CAUTI bundle care as it checks whether it succors to reduce CAUTI by minimizing the number of days of catheterization or not.

MATERIALS AND METHODS

Urine culture and antibiotic sensitivity

Urine samples received from the inpatient department as well as the outpatient department were processed as per the standard operating procedure followed by the hospital[10]. Samples were streaked on sheep blood agar and MacConkey's agar with a calibrated nichrome wire loop and incubated for 24 h at 35°C. After 24 h, if any microbial growth found, it was carried for identification procedure. If no growth observed, then re-incubated and observed for microbial growth after a total of 48 h from the first incubation. Identification of organism and antibiogram was carried out by using automated system MicroScanautoSCAN (Siemens, Germany; Beckman Coulter, U.S.A.).

Bundle care compliance

Infection control program surveillance regarding urinary tract infections was carried out with the help of a trained infection control nurse.

Bundle care assessment and data about that were collected from the daily registers. Starting year (2013) and end year (2017) survey was taken in the account for CAUTI bundle care compliance to observe the difference.

Mostly two events were observed in bundle care: 1) Insertion of the catheter, and 2) Maintenance of catheter. Insertion care included the following points: hand hygiene must be performed before starting the insertion procedure, gloves must be worn before handling the catheter, the catheter must be secured in a comfortable position. Maintenance care included following points: catheter care or perineal care must be carried out in each shift, bladder wash must be given as per the treating doctor's recommendations, urobag must be emptied when it gets 2/3rd full, or 8 h and also before transporting the patient, all junctions and connections in the tubing must be kept closed or not, urobag musts kept below the level of the urinary bladder, drainage bag, and tubing must not touch the floor, before collection of the urine sample, collection site must be disinfected with 70% alcohol swab, the patient must be educated regarding the care of catheter.

Data analysis

Software WHONET-2019 (developed by WHO Collaborating Centre for the surveillance of antimicrobial resistance), EpiInfo (version 7.2.3.1), and SPSS were used for antibiotic resistance trends and statistical analysis, respectively.

RESULTS

Urinary isolates and their antibiogram

In this study, 2352 urine samples were tested for culture and sensitivity, out of which 46.3% of urine samples showed significant bacteriuria (colony-forming unit > 100000 per mL). Distribution according to gender shows 3.6% more significant bacteriuria in the case of females than male, statistically, fisher exact one-tailed p-value is < 0.05 which states that the rise is significant (Table 1).

A total of 1088 isolates were recovered from the urine sample. Out of total isolates, 57 (5.2%) were Gram-positive organisms, 61 (5.6%) were *Candida* sp. and 970 (89.2%) were Gram-negative organisms. *Escherichia coli* (541, 49.7%) was isolated most frequently followed

by *Ps. aeruginosa* (193, 17.7%), *Klebsiella pneumoniae* (190, 17.5%), *Candida albicans* (32, 2.9%), *Enterococcus faecalis* (26, 2.4%), *Candida tropicalis* (25, 2.3%), *Enterococcus faecium*(24, 2.2%). The current study had excluded *Candida* sp. as well as organisms that were less frequently isolated (<2%) in this study. Out of all *E. coli* (54,

100%) isolated, 86.0% were possible extended-spectrum beta-lactamase (ESBL) producers, 18.3% were carbapenem-resistant, 20.7% were amikacin resistant and 0.7% were colistin-resistant.

Out of all *Ps. aeruginosa* (193, 100%) isolated, 1.6% resistant to colistin, 76.7% to tobramycin, 81.9% to ciprofloxacin, 74.6% to cefepime, 64.8% to piperacillin/tazobactam, 68.1% to meropenem, and 65.7% to aztreonam. Out of all *K. pneumoniae* total (190, 100%) isolated, 88.4% were possible ESBL producers, 64.7% were carbapenem-resistant, 55.8% were amikacin resistant and 1.6% were colistin-resistant.Out of all *E. faecalis* (26, 100%), 7.7% were resistant to penicillin whereas, in the case of *E. faecium* (24, 100%), 8.3% were resistant to linezolid. Overall
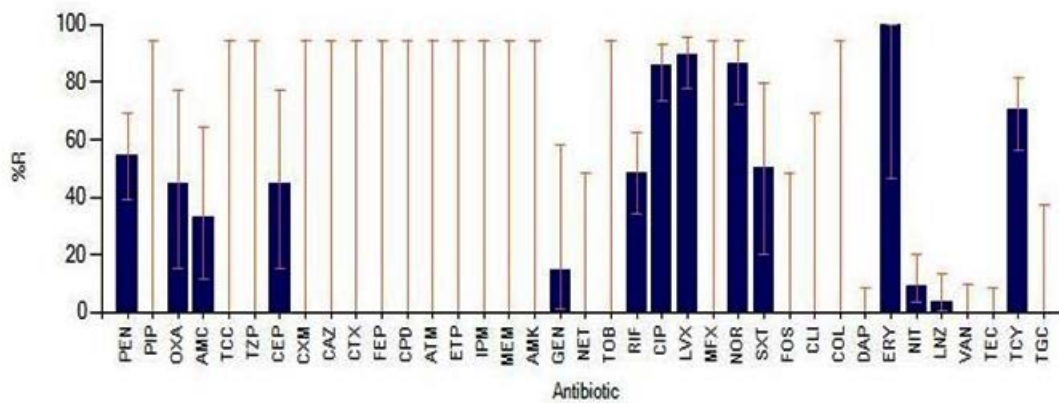
Table 1. Gender wise distribution of occurrence of UTI

Gender	Total samples	Total positive	% positivity
Male	1224	545	44.5
Female	1128	543	48.1
Total	2352	1088	46.3
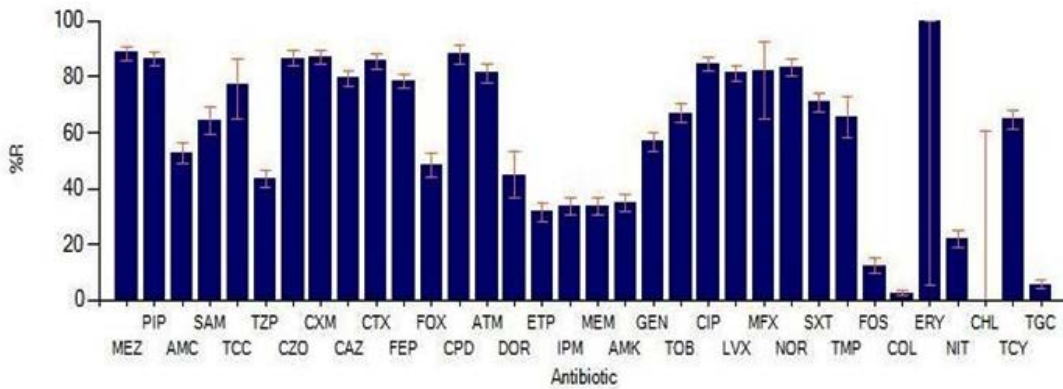
Legends: I = R% 95% Confidence Interval, ■ = % Resistance

Fig. 1. Resistance pattern of Gram-negative isolates with their 95% R% confidence interval (C.I.)

Legends: I = R% 95% Confidence Interval, ■ = % Resistance

Fig. 2. Resistance pattern of Gram-positive isolates with their 95% R% confidence interval (C.I.)

Table 2. Antibiotics which shows decline in resistance

Antibiotic	Baseline R% (R%95% C.I.)	End line R% (R%95% C.I.)
Gram negative isolates		
Colistin	6.0 (3.4-10.1)	0.0 (0.0-3.2)
Tigecycline	13.1 (9.1-18.4)	0.0 (0.3-6.3)
Nitrofurantoin	24.3 (18.4-31.2)	20.7 (14.0-29.4)
Gram positive isolates		
Vancomycin	0.0 (0-43.9)	0.0 (0-37.1)
Teicoplanin	0.0 (0-48.3)	(0-34.5)
Daptomycin	0 (0-48.3)	0 (0-34.5)

resistance pattern of Gram-negative and Gram-positive isolates with their 95% R% confidence interval (C.I.) (Figures 1 and 2).

Bundle care compliance

Catheterised patients during the starting and end year survey were 4686 and 3859 respectively. An unpaired t-test shows a significant difference in the number of catheterized patients in starting and in end-year conditions; t=5.821, p =0.0001. Catheter-associated urinary tract infections were 37 and 19 for starting and end year respectively. An unpaired t-test shows a significant reduction in CAUTI patients in end year as compared to the starting year where t=2.092, p = 0.0482. Urinary catheter days were 18744 and 16107 for starting and end year respectively. An unpaired t-test shows a significant reduction in the urinary catheter days in the end year as compared to the starting year, where t=3.890, p = 0.0008. CAUTI rate per 1000 catheter days were 2.0 and 1.1 for starting and end year respectively. An unpaired t-test showed no significant difference where t=1.846, p = 0.0783. CAUTI bundle care compliance was 92.6% and 93.0% for starting and end year respectively. CAUTI bundle compliance showed no significant rise in end-year which was demonstrated by an unpaired t-test where t=0.1946, p = 0.8475.

Emphasis on the reduction of usage of higher antibiotics like colistin, nitrofurantoin, and vancomycin showed a reduction in resistance during the end line. Table 2 shows the difference between the starting year and end year survey upon such antibiotics.

DISCUSSION

This study proffers the details about the bacterial and fungal isolates responsible for UTIs as well as also gives antibiotic resistance patterns for bacterial isolates. It also proffers the cognizance about the importance of the selection of antibiotics in the UTI treatment. Effectiveness of the infection control program with the aspect of bundle care compliance can be well understood.

The current study shows the highest culture positivity i.e. 46.3%; whereas Pondei *et al*[11] showed 37.38% and Aboderin *et al*[12] showed 35.8%. This study complies with Patel *et al*.[13] and Demir *et al*[14] study that showed the prevalence of UTI is more in females than males. *E. coli* remains the most common organism which was upheld by other studies too[13,15-22], whereas Aboderin *et al*[12] found *Klebsiella* spp. as a major isolate. The distribution of bacteria is different in different parts of the world and studying the influencing factors that cause this infection in unassociated geographical regions, indicates their dissipation[23].

The present study shows that *E. coli* was less resistant to nitrofurantoin, amoxicillin/clavulanic acid, tetracycline, gentamicin except for ciprofloxacin as compared to the study of Aboderin *et al*[12]. This shows the importance of local analysis of antibiotics. *E. coli* showed resistance to ampicillin, ampicillin/sulbactam, cefuroxime, levofloxacin, meropenem, nitrofurantoin, tobramycin, cefazolin in Patel *et al* study[13] which is quite lower than the current study except for Nitrofurantoin. Similar results were seen in *K. pneumoniae* and *Ps. aeruginosa* except for nitrofurantoin for *K. pneumoniae,* where resistant pattern remains similar. Antibiotics advised under empirical treatment by a government body are also showing a certain level of resistance in different studies[24]. Misuse of antibiotics leads to increasing resistance which becomes a matter of attention. General practitioners should consider about the microbiological profile and the antibiotic sensitivity pattern during management to avoid misuse of antibiotics[25].

It has been estimated that due to symptomatic urinary tract infections, 7 million people take treatment at emergency units and 100,000 people seek for hospitalizations yearly. UTI has become the most frequent hospital-

acquired infection, and responsible for as many as 35% of hospital-acquired infections. It is the second most common cause responsible for bacteremia in hospitalized patients[20]. In the present study, it was found that CAUTI decreased in end year (p = 0.0482) with CAUTI rate per 1000 catheter days (p = 0.0783) which suggests that though the number of infections significantly decreased infection rate change remains statistically insignificant. In Taiwan, the CAUTI rate decreased by 22.7% after the successful implementation of UTI bundle care[26]. However, a study conducted in the US shows no change in catheter-days in the end year as compared to the starting year (p = 0.90)[27]. Agodi *et al.*[28] show 4.2 CAUTI rate per 100 catheter days (the year 2006-2007) to 3.7 CAUTI rates per 100 catheter days (the year 2010-2011) with relative risk 1.13 and CI = 0.71-1.78 which was statistically significant.

CAUTI bundle care compliance was 92.6% and 93.0% for starting and end year respectively (p =0.8475) which suggests that difference was statistically insignificant. Upon implementation of CAUTI bundle care in the hospital, a decline in nosocomial infection was observed in many of the studies. Effective bundle implementation requires the dedication of nursing staff and with continuous monitoring[29-32].

CONCLUSION

Urinary tract infections are the most common and some times life-threatening infections. Catheter-associated UTIs are also emerging and most of them are hospital-acquired. It was observed that antibiotic resistance has been reported for all known antibiotics and to confine prevention of infection is the convenient way. Effective implementation of bundled care approach can alleviate the burden of CA-UTI in the hospitals and implementation of antibiotic policy can save higher antibiotics as an option for an emergency. *The in-vivo* and *in-vitro* difference in antibiotic resistance should be studied. Continuous monitoring of resistance patterns and monitoring of the infection control program is inevitable.

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