

Etiologies of the urinary tract infections in a Yemeni City

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ABSTRACT

Objective: To determine the causative agents of urinary tract infection in Yemeni patients in Sana'a city, and to determine the antibiotic susceptibilities of these agents in vitro.

Methods: Consecutive mid-stream urine specimens were submitted to our laboratory by 4029 patients in Sana'a city from 1990 to the end of 1999. The specimens were cultured and the isolates were identified using standard microbiological techniques. The antibiotic susceptibilities of the isolates were also determined (*in vitro*).

Results: The number of patients with urinary tract infection who yielded positive cultures from their mid stream urine specimens was 685 out of 4029 patients (17%). The ratio of female-to-male patients was 462:223 (2.07:1). The causative agents were mainly members of the family *Enterobacteriaceae*, 579 out of the 685 isolates (84.5%). *Escherichia coli* was the main pathogen, 357 isolates out of all the isolates (52%) followed by *Klebsiella pneumoniae*, 143 isolates (21%) and *Proteus* species, 56 isolates (8%). The other pathogens (*Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Enterobacter aerogenes*, *Staphylococcus saprophyticus*, *Corynebacterium urealyticum* and *Enterococcus faecalis*) constituted 129 out of the 685 isolates (19%). There was a shift in the types of the causative agents of urinary tract

infection between the first and 2nd halves of the study period. The isolation of *Escherichia coli* decreased from 60% in the first half to 42% in the 2nd. Whereas *Klebsiella pneumoniae* increased from 16% in the first half to 27% in the 2nd, *Proteus species* from 8% to 9%, *Staphylococcus aureus* from 5% to 7%, *Pseudomonas aeruginosa* from 3% to 7%, *Enterobacter aerogenes* from 3% to 3.5%, *Staphylococcus saprophyticus* from 2% to 3% and *Corynebacterium urealyticum* from 1% to 2%. Ninety percent of all the urinary pathogens were sensitive to ciprofloxacin, 75% to nitrofurantoin, 57% to gentamicin, 46% to cefaclor, 46% to nalidixic acid, 39% to doxycycline, 37% to co-trimoxazole and 20% to ampiclox.

Conclusion: The types of urinary tract pathogens and their antibiotic susceptibilities in addition to the rate of isolation from male and female patients are reported. It is recommended that ciprofloxacin and nitrofurantoin or both are used in the blind treatment of urinary tract infection while awaiting the culture and sensitivity results. It is also recommended to continuously monitor the pattern of urinary pathogens from the community to guide the blind treatment of patients in the future.

Keywords: Urinary tract infection, causative organisms, antibiotic susceptibilities.

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Urinary tract infection (UTI) is among the most common bacterial infections that lead patients to seek medical care. The exact prevalence of UTI is age and sex dependent.¹ Although UTI is a major

problem for the community at large, there is lack of reports about the causative agents of UTI's and their treatment, at least during the last 10 years in the Republic of Yemen. The aim of this study was to

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look at the etiologies of UTIs, and their susceptibilities, in Yemeni patients in Sana'a City during the last 10 years.

Methods. Four thousand and twenty nine consecutive freshly voided mid-stream urine (MSU) specimens were submitted from the community during the period 1990 to the end of 1999. The MSU specimens were submitted by patients attending 2 primary care clinics. The patients were either suspected of suffering from symptoms of UTI (urethritis, cystitis or pyelonephritis or both) or following treatment of UTI. All MSU specimens were submitted for culture upon medical request from the caring clinicians. Standard microbiological techniques were used in the culture of all MSU specimens and in the identification of the isolates with modification. One µl of MSU samples were inoculated, using standard loops, onto blood agar (BA) plates containing 6% blood and cysteine lactose electrolyte deficient (CLED) plates. The plates were incubated in air for 24 to 48 hours at 37°C.² The plates were read at the end of the incubation period and the isolates were identified using standard biochemical tests. Antibiotic sensitivity testing was performed using the disc diffusion method on 85 mm Mueller-Hinton agar (Oxoid) plates with agar depth of 4 mm. The bacterial suspension that was prepared for antibiotic sensitivity testing on Mueller-Hinton agar was adjusted to the recommended turbidities for all species.³

Results. The MSU specimens were submitted by 4029 patients, 2055 females and 1974 males. The criteria for considering a culture as having a "significant growth" is the growth of more than 100 colony forming units of pure growth/1ml MSU inoculum on the plates. This corresponds with more than 10⁵ colony-forming units per 1 milliliter MSU.² Significant growth of pure culture of organisms was obtained from 685 out of 4029 patients (17%). Within these 685 patients, UTI was significantly higher among the females, 462 (67%), than in the males, 223 (33%), (P-value <0.001). Urinary tract infection cultures with significant growth were diagnosed among 462 out of 2055 female subjects (22%) compared to 223 out of 1974 male subjects (11%), [Odds Ratio = 2.28, P-value <0.001, 95% Cumulative Index = 1.91 to 2.72].

The causative agents. The species that were isolated from the positive cultures are shown in Table 1. None of the specimens yielded polymicrobial cultures. With regard to the types of the isolates from UTI cases during the years from 1990 to 1999 it was found that there was a shift in the types of the causative agents isolated during the first and 2nd halves of this decade, as shown in Table 2.

Table 1 - The causative agents of urinary tract infections and their isolation from infected male and female patients.

| Species | Number of infected patients | | Number of isolates (% of total isolates) |
|-------------------------------------|-----------------------------|------------|--|
| | Males | Females | |
| <i>Escherichia coli</i> | 90 | 267 | 357 (52) |
| <i>Klebsiella pneumoniae</i> | 47 | 96 | 143 (21) |
| <i>Proteus species</i> | 20 | 36 | 56 (8) |
| <i>Staphylococcus aureus</i> | 10 | 29 | 39 (6) |
| <i>Pseudomonas aeruginosa</i> | 31 | 5 | 36 (5) |
| <i>Enterobacter aerogenes</i> | 16 | 7 | 23 (3) |
| <i>Staphylococcus saprophyticus</i> | 3 | 14 | 17 (3) |
| <i>Corynebacterium urealyticum</i> | 5 | 3 | 8 (1) |
| <i>Enterococcus faecalis</i> | 1 | 5 | 6 (1) |
| Total | 223 | 462 | 685 (100) |

Antibiotic sensitivities. The rates of susceptibility for all organisms, *in vitro*, were ciprofloxacin, 90%; nitrofurantoin, 75%; gentamicin, 57%; cefaclor, 46%; nalidixic acid, 46%; doxycycline, 39%; cotrimoxazole, 37% and ampiclox, 20% (Table 3).

Table 2 - Comparison between the percentage isolation of the causative agents of urinary tract infection in the first and 2nd halves of the 1990s.

| Organism | Percentage isolation of organisms from 1990 to mid 1995 | Percentage isolation of organisms from mid 1995 to 1999 |
|-------------------------------------|---|---|
| <i>Escherichia coli</i> | 60 | 42 |
| <i>Klebsiella pneumoniae</i> | 16 | 27 |
| <i>Proteus species</i> | 8 | 9 |
| <i>Staphylococcus aureus</i> | 5 | 7 |
| <i>Pseudomonas aeruginosa</i> | 3 | 7 |
| <i>Enterobacter aerogenes</i> | 3 | 4 |
| <i>Staphylococcus saprophyticus</i> | 2 | 3 |
| <i>Corynebacterium urealyticum</i> | 1 | 2 |
| <i>Enterococcus faecalis</i> | 1 | 1 |

Table 3 - The number (and percentage) of the urinary tract isolates' sensitivities towards the different antibiotics.

| Bacterial species | Total number of each isolate | Cipro | Nitro | Gent | Cef | Nal. Acid | Doxy | Co-Tri | Amp |
|-------------------------------------|------------------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| <i>Escherichia coli</i> | 357 | 332/357 (93%) | 300/357 (84%) | 17/357 (48%) | 186/357 (52%) | 114/357 (32%) | 125/357 (35%) | 111/357 (31%) | 61/357 (17%) |
| <i>Klebsiella pneumoniae</i> | 143 | 125/143 (87%) | 113/143 (79%) | 106/143 (74%) | 46/143 (32%) | 113/143 (79%) | 77/143 (54%) | 76/143 (53%) | 20/143 (14%) |
| <i>Proteus species</i> | 56 | 49/56 (87.5%) | 28/56 (50%) | 25/56 (45%) | 28/56 (50%) | 28/56 (50%) | 15/56 (27%) | 22/56 (39%) | 10/56 (18%) |
| <i>Staphylococcus aureus</i> | 39 | 35/39 (90%) | 20/39 (51%) | 37/39 (95%) | 33/39 (85%) | 20/39 (51%) | 34/39 (87%) | 16/39 (41%) | 29/39 (74%) |
| <i>Pseudomonas aeruginosa</i> | 36 | 26/36 (72%) | 18/36 (50%) | 15/36 (42%) | 0/36 (0%) | 9/36 (25%) | 0/36 (0%) | 0/36 (0%) | 0/36 (0%) |
| <i>Enterobacter aerogenes</i> | 23 | 22/23 (96%) | 22/23 (96%) | 17/23 (74%) | 12/23 (52%) | 15/23 (65%) | 6/23 (26%) | 15/23 (65%) | 2/23 (9%) |
| <i>Staphylococcus saprophyticus</i> | 17 | 16/17 (94%) | 15/17 (88%) | 16/17 (94%) | 8/17 (47%) | 15/17 (88%) | 9/17 (53%) | 13/17 (76.5%) | 7/17 (41%) |
| <i>Corynebacterium urealyticum</i> | 8 | 6/8 (75%) | 0/8 (0%) | 4/8 (50%) | 4/8 (50%) | 0/8 (0%) | 2/8 (25%) | 2/8 (25%) | 4/8 (50%) |
| <i>Enterococcus faecalis</i> | 6 | 4/6 (67%) | 0/6 (0%) | 0/6 (0%) | 0/6 (0%) | 2/6 (33%) | 1/6 (17%) | 1/6 (17%) | 4/6 (67%) |
| Total | 685 | 615/685 (90%) | 516/685 (75%) | 391/685 (57%) | 317/685 (46%) | 316/685 (46%) | 269/685 (39%) | 256/685 (37%) | 137/685 (20%) |

Cipro = Ciprofloxacin, Nitro = Nitrofrantoin, Gent = Gentamicin, Cef = Cefaclor, Nal. Acid = Nalidixic Acid, Doxy = Doxycycline, Co-Tri = Co-Trimoxazole, Amp = Ampiclox

Discussion. The causative agents of UTI in patients in Sana'a City were determined in this study (Table 1). The rate of isolation of the urinary tract pathogens was in general agreement with others.⁴ However, the most predominant urinary tract pathogen in both sexes in this investigation was *E. coli*. This was in concordance in part with another study which reported *E. coli* and *S. saprophyticus* as the 2 most common urinary tract pathogens in women. However, *S. saprophyticus* rated 7th (among the pathogens in this study) in terms of percentage isolation.⁵ Trend analysis of the type of species in both halves of the decade has shown that *E. coli* was the most predominant cause of UTI followed by *K. pneumoniae* during both halves of the decade. However, there was a shift in the percentage isolation of UTI agents, which included *E. coli*, *K. pneumoniae*, *Proteus* species, *S. aureus*, and *P. aeruginosa*, in both halves of the decade. For example, there was a regression in the percentage isolation of *E. coli* with respect to *K. pneumoniae* which increased in terms of percentage isolation during the 2nd half of the decade, but still rating 2nd. Whether this shift was coincidental or caused by some factors remains to be determined. One reason may be the effect of some predisposing factors such as the source of the infecting agent whether

endogenous or acquired. Another reason may be that the patients were not all residents of Sana'a City but some were from outside Sana'a but seeking medical treatment there. Microbiological shift in the etiologies of UTI was also reported in the literature. There was a decline in the rate of isolation of *K. pneumoniae* and *Proteus* species in a 10-year study.⁶ In another study there was a reduced isolation of Gram-negative bacilli and a significant increase of Gram-positive cocci in a 20-year study of urinary pathogens in the city of Florence, Italy.⁷ The number of female patients with UTI was more than the males (Table 1). This may be due to the factors that predispose women to UTI more than men. These include key host and bacterial factors. The host factors include the colonization of the vaginal and periurethral mucosa with the infecting uropathogen.⁸ The bacterial factors comprise the type I fimbriae, which are present in all *E. coli* strains and probably have a role in promoting initial colonization.⁹ The majority of the urinary pathogens (90%) were sensitive to ciprofloxacin *in vitro* followed by nitrofurantoin (75%). The other antibiotics were invariably poorly effective against all the isolates in this study. However, the assessment of the efficacy of antibiotic treatment in patients with UTI in this work, following the culture

and sensitivity of their urinary pathogens, was difficult. This is a limitation in our study and could be attributed to the failure of the patients, in most cases, to submit post-treatment MSU specimens to determine the microbiological cure rate.

There are at least 2 reasons for the emergence of multi-resistance, of the urinary pathogens in Sana'a City, to some of the antibiotics used in this study, namely, ampiclox, co-trimoxazole, doxycycline, nalidixic acid and cefaclor. Firstly, this may be due in part to the blind treatment with antibiotics of UTIs, in some cases, without the culture of MSU specimens and the determination of the antibiotic sensitivities of the isolates. Secondly, the abuse of antibiotics (i.e. the availability of antibiotics, over the counter, without prescription) as a result of the lack of prescription-only-policy of antibiotics in Sana'a City and the country in general. It can be concluded from this study that *E.coli* and *K.pneumoniae* were the main pathogens isolated over the decade of study and that the majority of pathogens were sensitive in vitro to ciprofloxacin or nitrofurantoin or both. We recommend that ciprofloxacin or nitrofurantoin, or both, are used in the empirical treatment of UTIs, following the submission of MSU specimens for culture, while awaiting the culture and sensitivity results in view of the high prevalence of UTI in Yemen associated with urinary schistosomiasis and nephrolithiasis. It is also recommended to monitor continuously the pattern of urinary pathogens, from the community at large, and their respective antibiotic resistance patterns to guide the empirical treatment of patients in the future.

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