**ABSTRACT**

**Background and objective:** Urinary tract infections (UTIs) are the most common minor complication after operations, mostly due to bladder catheterization that used routinely during operations. This investigation seeks to determine prevalence rate, bacterial features, antibiotic sensitivity and risk factors for urinary tract infection in postoperative patients in tertiary hospitals in Sana’a, Yemen.

**Methods:** This prospective analysis included 390 patients undergoing surgery between 2017 and 2018 at Al-Thawra Hospital. The study includes 258 male and 132 female between the ages 5 to 80 years. Clinical and demographic data and factors affecting UTIs were collected in the standard questionnaire, and the sample was obtained after catheter removal; or, in patients with a clinical indication of continuous catheterization, a sample was obtained after the replacement of a new catheter. The samples were cultured, examined for significant possible bacterial pathogens, isolated and identified by standard laboratory techniques, and microbial sensitivity testing was carried out by disc diffusion method. The operative characteristics associated with postoperative UTI were also analysis.

**Results:** Postoperative UTI (POUTI) occurred in 144/390 (37%), and the predominant post-operative uropathogen was *Escherichia coli* (34%), followed by *Pseudomonas aeruginosa* (27%) and *Staphylococcus coagulase* negative (16.7%). In Gram-negative bacteria, high resistance to ampicillin (95%), nalidixic acid (63%), ceftriaxone (68%) and cotrimoxazole (55%) was recorded, while high sensitivity to amikacin (98%) and ciprofloxacin (93%), cefotaxime (87%), gentamicin (87%) and imipenem (98%). In Gram-positive bacteria, high resistance to penicillin (90%), erythromycin (85%), and amoxicillin (78%) was recorded, while high sensitivity to aztreonam (94%), augmentin (83%), ciprofloxacin (93%), cefotaxime (86%), gentamicin (85%), Rifampicin (100%) and vancomycin (97%). The following characteristics are independently associated with postoperative UTI: female sex (OR 2.1, 95% CI 1.3–3.2), Rubber PTFE catheter (OR 4.7, 95% CI 1.99–11.4), longer duration of catheterization >10 days (OR 4.4, 95% CI 2.3–8.3), overweight (OR 1.7, 95% CI 1.1–2.9), and emergency surgery (OR 1.9, 95% CI 1.2–3.0).

**Conclusions:** POUTI remains an important problem in our hospitals and what complicates the situation is that all the causative microorganisms are MDR with few treatment options; and several risk factors were independently associated with POUTI.

**Keywords:** antibiotics, Catheter associated Urinary tract infections, drug resistance, post operative UTI, POUTI, Sana’a City, Yemen.

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**INTRODUCTION**

Urinary tract infection is the fourth most important cause of healthcare-related infection with around 70% - 80% attributable to improper use of indwelling urinary catheters. Catheter UTI (CAUTI) is connected with escalated morbidity and mortality and extended the length of hospital stay. Indwelling bladder catheterization is a recognized risk factor for developing UTIs. There is no commonly recognized guideline concerning catheterization in the...
perioperative setting, to date, with surgeon preferred mainly bladder management. Practice catheterization has been used in various surgical centers with the purpose of avoiding postoperative urinary retention, something that patients undergo during operation are recognized to be at increased risk, and that itself is associated with UTIs. UTIs account for between 13-15% of all health care-related diseases worldwide, leading to long hospital stays, increased health care expenditures, and an increased mortality rate. Postoperative UTIs are estimated at 30.26%. POUTIs are described as the most common minor systemic complications after operations, which exceeding pneumonia, deep venous thrombosis, and renal insufficiency. Also, POUTIs have been linked to considerable unfavorable events such as implant failure, periprostatic infection, and subsequent revision procedures, consequential in extended and costly hospital stays. This investigation seeks to determine prevalence rate, bacterial profile, antibiotic sensitivity and specific risk factors for UTI in post operative patients in tertiary hospitals in Sana’a, Yemen.

SUBJECTS AND METHODS
The study design was an active prospective follow-up study. All patients undergoing surgery between 2017 and 2018 at Al-Thawra Hospital, who agree to participate in the study, were targeted. During the study time period, 390 patients who underwent surgery with indwelling urinary catheters were included in the study. They are 258 male and 132 female, between the ages of 5 and 80 years old. Clinical and demographic data, factors affecting urinary tract infection and operational characteristics data as a type of surgery (elective surgery, emergency surgery, etc.), types of catheters, duration of catheter, etc. for each post-operative patient were collected. After that, a urine sample was obtained (midstream) after the catheter was removed; or, in patients with a clinical indication of continuous catheterization, a sample was obtained after the obtaining of a new catheter. After that the samples were cultured in blood agar and MacConkey agar aerobically; cultures were then examined for significant possible bacterial pathogens of UTIs. Possible bacterial pathogens were isolated and identified by standard laboratory techniques, and microbiological sensitivity testing was carried out by disc diffusion method as described by Clinical and Laboratory Standards Institute (CLSI). The antibiotics employed in this study were: Aztreonam, Amoxicillin, Amikacin, Augmentin, Ampicillin, Ciprofloxacin, Clarithromycin, Cotrimoxazole, Ceftriaxone, Cefixime, Ceftazidime, Cefotaxime, Cefepime, Gentamicin, Imipenem, Nalidixic acid, Nitrofurantoin, Norfloxacin, Penicillin, Erythromycin, Rifampicin and Vancomycin (Oxide, USA). Inhibition zone was measured after 24 h of incubation at 37°C. The experiments of each antibiotic were performed in triplicate. The results were interpreted according to Clinical and Laboratory Standards Institute (CLSI) methodology.

Data analysis
The data were statistically analyzed by a software version for statistical significance (Epi Info version 6, CDC, Atlanta, USA). First rates were calculated, then from two-by-two tables, the independence odds ratios were calculated and P-value was determined using the uncorrected chi square test. Fisher’s exact test was used for the small expected cell sizes with a two-tailed probability value.

Associated risk factors are generally defined independently in the statistical sense: the variable is called an independent risk factor if it has a significant contribution to the outcome in a statistical model that includes established risk factors.

Table 1: The age and gender distribution of catheterized patients: Characters

| Age groups | Male (n=258) | Female (n=132) | Total n = 390 |
|------------|-------------|---------------|---------------|
| No.        | %           | No.           | %             |
| < 15 years | 46          | 26            | 72            | 18.5         |
| 15 – 24 years | 30          | 20            | 50            | 13           |
| 25 – 34 years | 76          | 32            | 108           | 27.8         |
| 35 – 44 years | 38          | 12            | 50            | 12.9         |
| ≥ 45 years | 68          | 42            | 110           | 28.2         |
| Total      | 258         | 132           | 390           | 100          |
| Mean age   | 34.3 years  | 32 years      | 34.1 years    |              |
| S D        | 20 years    | 18.5 years    | 19.3 years    |              |
| Min        | 5 years     | 1 years       | 1 years       |              |
| Max        | 80 years    | 70 years      | 80 years      |              |
| Median     | 30 years    | 29 years      | 30 years      |              |
| Mode       | 60 years    | 40 years      | 60 years      |              |

RESULTS
This prospective analysis included 390 patients undergoing operation between 2017 and 2018 in Al-Thawra Hospital, with indwelling urinary catheters were analyzed for UTI and antibiotic susceptibility, 258 male and 132 female, aged 5 to 80 years (Table 1). Postoperative UTI occurs in 144/390 (37%) of patients following operations (Table 2). The predominant post-operative uropathogen was Escherichia coli (34%), followed by Pseudomonas aeruginosa (27%) and Staphylococcus coagulase negative (16.7%) while other bacterial cause were less frequent (Table 4). In Gram-negative bacteria, a high resistance to ampicillin (95%), nalidixic acid (63%), ceftriaxone (68%), and cotrimoxazole (55%) was recorded, while a moderate sensitivity to amoxicillin/clavulanate (65%), ciprofloxacin (84%), cefixime (76%) etc, and high sensitivity to amikacin (98%), ciprofloxacin (84%), cefotaxime (87%), gentamicin (87%) and imipenem (98%) (Table 5). In Gram-positive bacteria, high resistance to
penicillin (90%), erythromycin (85%), and amoxicillin (78%) was recorded, while moderate resistance to co-trimoxazole (45%), ceftazidime (38%) and cefepime (24%). High sensitivity to aztreonam (94%), augmentin (83%), ciprofloxacin (93%), cefotaxime (86%), gentamicin (85%) and rifampicin (100%) and vancomycin (97%) was recorded (Table 6). The following characteristics are independently associated with postoperative UTI: female sex (OR 2.1, 95% CI 1.3–3.2), Rubber PTFE catheter (OR 4.7, 95% CI 1.99–11.4), longer duration of catheterization >10 days (OR 4.4, 95% CI 2.3–8.3), overweight (OR 1.7, 95% CI 1.1–2.9), and emergency surgery (OR 1.9, 95% CI 1.2–3.0) (Table 3).

**Table 2: The prevalence and association of postoperative UTI among different sex and age groups**

| Factors                        | Positive for POUTI N=144 | OR CI X² p |
|--------------------------------|--------------------------|------------|
| Male n=258                      | 80 31 0.47 0.3-0.7 11.4 <0.001 |
| Female n=132                    | 64 28.5 2.1 1.3-3.2 11.4 <0.001 |
| < 15 years n=72                 | 20 27.8 0.6 0.3-1.0 3.2 0.07 |
| 15 – 24 years n=50              | 16 32 0.77 0.4-1.4 0.59 0.43 |
| 25 – 34 years n=108             | 39 36 0.9 0.6-1.5 0.04 0.83 |
| 35 – 44 years n=50              | 18 36 0.9 0.5-1.7 0.02 0.88 |
| ≥ 45 years n=110                | 52 47.3 1.4 0.95-2.2 3.0 0.08 |
| Total n=390                     | 144 37 |

**Table 3: The relationship between positive urine culture and types of catheters and its duration, etc among post operative patients**

| Factors                        | Positive for POUTI N=144 | OR CI X² p |
|--------------------------------|--------------------------|------------|
| *Independent risk factors      |                          |            |
| Type of catheter               |                          |            |
| Silicon catheter N=48          | 6 12.5 0.2 0.08-0.5 14 <0.001 |
| Rubber PTFE catheter N=342     | 138 40.4 4.7 1.99-11.4 14 <0.001 |
| Duration of catheterization    |                          |            |
| 1-3days N=182                  | 30 16.5 0.16 0.1-0.2 61 <0.001 |
| 4-6days N=90                   | 41 46.7 1.6 1.0-2.5 3.7 0.05 |
| 7-9days N=68                   | 38 55.9 2.5 1.5-4.3 12.7 <0.001 |
| >10 days N=50                  | 34 68 4.4 2.3-8.3 23.7 <0.001 |
| BMI                            |                          |            |
| Underweight n=77               | 35 45.5 1.5 0.9-2.5 2.9 0.08 |
| Normal n=231                   | 70 30.3 0.49 0.3-0.7 10.6 0.001 |
| Overweight n=82                | 39 47.6 1.7 1.1-2.9 5.0 0.02 |
| Diabetes mellitus n=39         | 19 48.7 1.7 0.8-3.3 2.5 0.1 |
| Hypertension n=36              | 14 38.9 1.1 0.5-2.2 0.06 0.79 |
| Type of Surgery                |                          |            |
| *Elective surgery n=273        | 87 32 0.49 0.3-0.7 9.0 0.001 |
| *Emergency surgery n=117       | 56 48 1.9 1.2-3.0 8.5 0.003 |
| Amputation n=32                | 15 47 1.5 0.7-3.2 1.4 0.22 |
| Excision n=65                  | 29 44.6 1.5 0.8-2.5 1.9 0.1 |
| *Others n=293                  | 100 34.1 0.62 0.3-0.9 3.9 0.04 |

**DISCUSSION**

CAUTI is the most common hospital infection and accounts for about 30-40% of all hospital acquired infections and is a major source of hospital sepsis and related deaths in acute care hospitals. Current study examined bacterial POUTI rate in postoperative patients at Al-Thawra University Hospital along with testing for common risk factors and common pathogens associated with bacterial post operative UTI. In the current study, the bacterial POUTI rate was found to be 37% (144/390). These infections are mainly bacterial infections, and previous studies have shown that about 26% of patients who have an indwelling urinary catheter in place for 2-10 days will develop bacteriuria, and 25% of these patients will develop bacterial CAUTI. Obtained results are to some extent higher than published rates perhaps because all of the patients enrolled in this study had undergone operations and stayed longer in hospitals and had a number of risk factors that increase the opportunity of the development of bacterial CAUTI. Substantial research has been done on nosocomial UTIs in general (Ref); nevertheless, research on UTIs is strictly limited in postoperative patients. In this study, a number of potential risk factors for the development of bacterial CAUTI were evaluated.
Obtained results revealed that 48.5% of patients suffering from bacterial CAUTI were female sex is independently associated with postoperative UTI (OR 2.1, 95% CI 1.3–3.2); this is consistent with what has been published in other studies. The mean age of patients was 45 years (SD 19.3 years) and it was noted that only 26.4% of these patients were over 45 years of age; this result differs from many other studies 

Diabetes mellitus was not significant independently associated with postoperative UTI. (OR 1.7, 95% CI 0.8–3.3, p=0.1) (Table 3). These results are contrary to Saint et al., and Lobdell et al., studies where one of the risk factors for developing CAUTI is diabetes mellitus. Emergency surgery was independently associated with postoperative UTI (OR 1.9, 95% CI 1.2–3.0) (Table 3). With respect to post-surgical patients in further surgical specialties, investigation reveals that the appreciable incidence of postoperative UTIs is not exclusive to type of surgery.

Table 4: The frequency of bacterial causative agents of CAUTI in post operative patients

| Bacteria                      | Number | Percentage |
|-------------------------------|--------|------------|
| Escherichia coli              | 49     | 34         |
| Klebsiella pneumonia          | 7      | 4.9        |
| Pseudomonas aeruginosa        | 39     | 27         |
| Proteus mirabilis             | 6      | 4.2        |
| Coagulase negative Staphylococci | 24   | 16.7       |
| Enterobacter spp.             | 5      | 3.5        |
| Staphylococcus aureus         | 11     | 7.6        |
| Enterococcus faecalis         | 3      | 2.1        |
| Total                         | 144    | 37         |

One study exploring the incidence of postoperative UTIs subsequent major surgeries in a variety of specialties discovered that the prevalence is certain similar across multiple surgical services: 30-day postoperative UTI rate for coronary artery bypass, vascular, colorectal, and TJA surgeries were 3.3, 3.4, 4.0, and 3.4%, respectively.

Table 5: Antibiotic pattern of Gram negative bacteria (101) isolated from post-operative patients, Sana’a, Yemen.

| Antimicrobial agents        | Sensitive % | Resistance % |
|-----------------------------|-------------|--------------|
| Amikacin                    | 98          | 2            |
| Amoxicillin/clavulanic acid | 65          | 35           |
| Ampicillin                  | 5           | 95           |
| Ciprofloxacin               | 84          | 16           |
| Clarithromycin              | 47          | 53           |
| Cotrimoxazole               | 45          | 55           |
| Ceftriaxone                 | 32          | 68           |
| Cefixime                    | 76          | 24           |
| Cefazidime                  | 73          | 27           |
| Cefotaxime                  | 87          | 13           |
| Cefepine                    | 74          | 26           |
| Gentamicin                  | 87          | 13           |
| Imipenem                    | 98          | 2            |
| Naldixic acid               | 37          | 63           |
| Nitrofurantoin              | 71          | 29           |
| Norfloxacin                 | 93          | 7            |

In the current study, the predominant post-operative uropathogen was Escherichia coli (34%), followed by Pseudomonas aeruginosa (27%) and Staphylococcus coagulase negative (16.7%) while other bacterial cause...
were less frequent (Table 4). Current results are different from other nosocomial investigation studies published in Europe and North America that support E. coli, Klebsiella spp., and Enterococci spp. as the prevalent bacterial pathogens cause CAUTI. Also, the current study results are different from findings by Rehmann and Greene study; and Gaynes and Edwards reviews in which Klebsiella spp. were the most commonly identified bacteria (8/16, 50%), followed by Enterococci (7/16, 44%). Although E. coli is known to be the most predominant etiology for UTI, it was isolated from 34% of positive bacterial culture patients enrolled in this study. This finding might suggest dissimilarity in bacterial population consistent with different locality and suggests a role of the environment in determining the bacterial population in each hospital. All bacterial postoperative uro-pathogens were found to be resistant to most of the tested antimicrobials (Table 5 and Table 6). These results are consistent with previous studies that demonstrated that organisms recovered from hospitalized patients are often resistant to multiple antibiotics. The high rate of MDR among nosocomial pathogens reflects the extensive use of antimicrobials in the hospital in addition to the huge ability of the organism to acquire resistance genes. Amikacin and imipenem were the most active drugs against Gram negative bacteria (98% sensitivity). Rifampicin and vancomycin were the most active drugs against Gram positive bacteria (100% and 99% sensitivity, respectively). The current findings are similar to that reported by Daef et al., study and Daef et al., in which Gram negative bacteria Klebsiella spp. were highly sensitive to amikacin and imipenem (100% sensitive in 2008, 94.4% in 2010, 87.5% in 2013). On the other hand, other antibiotics were found to have high and moderate resistance to all bacterial postoperative uro-pathogens, and this constant increase in antibiotic resistance over time is frightening and might suggest dissimilarity in bacterial population in each hospital. Universal Journal of Pharmaceutical Research 2020; 5(3):21-26

CONCLUSION

Present study has identified multiple properties independently associated with postoperative UTIs, which may be helpful for clinicians in classifying patients at risk. While this information alone may have the potential to improve the quality of patient care, at this time, the clinical utility of these risk factors is unproven. Further research such as a prospective study stratifying patients into risk groups to guide postoperative management or perioperative catheterization may be employed to establish practical utility.

RECOMMENDATIONS

CAUTI remains a huge problem in our hospitals and what makes it worse is that all causative microorganisms are MDR with few treatment options. According to obtained results, amikacin, and imipenem can be used for empirical treatment. The Comprehensive Unit-based Safety national program, must be applied in our hospitals that aim to reduce catheter-associated urinary tract infections (CAUTIsts) by focusing on proper technical skills, behavioral changes, education, and feedback. Implementation of the CUSP recommendations to reducing catheter use and CAUTIs in post-operative patients. The program will be likely successful because it included both socio-adaptive and technical changes and allowed the individual hospitals to customize interventions based on their own needs.

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CONFLICT OF INTEREST

No conflict of interest associated with this work.

AUTHORS CONTRIBUTION

Clinical works were performed by the Abdul Salam Mohamed Al Makdad and Mohammed Kassim Salah. Laboratory work, data collection, analysis, and article writing were performed by the Abdulrahman Y. Al-Haif and Hassan A. Al-Shamahy.

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