Bacteriology and Antibiotic Sensitivity Patterns of Urine in Urology Patients with Indwelling Urinary Catheters at the University Teaching Hospital in Lusaka, Zambia

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DOI: *https://10.53974/unza.jabs.5.3.692*

Abstract

Introduction: Catheter-associated urinary tract infection (CAUTI) is the most common nosocomial infection in hospitals worldwide, and the incidence has been reported to be up to 35%. The growing antibiotic resistance amongst the uropathogens isolated from CAUTI makes it challenging to manage. In Zambia, prolonged catheter use is a burden, particularly in patients awaiting definitive surgery, the elderly and socioeconomically challenged. Bacterial colonisation following catheterisation is inevitable, with reports estimating the risk to be around 5 to 10% per day. By day 10, virtually all patients with urinary tract instrumentation have healthcare-associated UTI, with the duration of catheterisation the most important factor.

Methodology: The study was a descriptive cross-sectional study conducted at the University Teaching Hospital (UTH) over a period of 10 months from July 2015 to May 2016. The cases were in-patients and out-patients with indwelling catheters in situ for not less than three calendar days. Simple random sampling was used to select candidates who were in-patients awaiting definitive surgery and out-patients in the same category as they attended clinics. Data collection and collection of specimens were done by the principal investigator, and then analysed by the microbiologist based at the UTH microbiology laboratory. The patients were recruited at one point, and the data collection exercise employed a questionnaire to collect socioeconomic, demography and clinical information.

The variables were collected using the data collection sheet for each participant. The data was then entered into SPSS software to clean and analyse it. The categorical variables were presented as proportions. The main concerns arising during specimen collection were the duration between the time of specimen collection and transfer to and processing at the main laboratory, which was kept within one hour. Specimens received within two hours of the collection were accepted.

Results: A total of 228 patients were enrolled from both out-patient and in-patient departments. Approximately 75% yielded growth of bacteria, and

25.0% were negative. The pure growth yielded Klebsiella Pneumoniae 28.0% and E. coli 25.2%, as the most isolated pathogens. The antibiotic susceptibility testing revealed the highest resistance of the above isolates to ampicillin, nalidixic acid, norfloxacin, ciprofloxacin, levofloxacin, and borderline with cotrimoxazole. The organisms were least resistant to amikacin, imipenem, nitrofurantoin, and gentamycin. Acetinobacter and Citrobacter species were also highly resistant to the above drugs, with nitrofurantoin in addition, but least resistant to ampicillin.

Conclusion: The study revealed a high prevalence of CAUTI in the urology section of the UTH, and practices such as poor hand hygiene, open catheter drainage, non-aseptic methods of catheter insertion and poor catheter care are possible contributing factors. There is an association between insertion of indwelling catheters and subsequent development of CAUTI, and the strongest factors noted are the size of the catheters used and the patients level of education. High resistance to antibiotics to many organisms of concern was noted.

Keywords: *Catheter-Associated Urinary Tract Infection, Urinary Tract Infection, University Teaching Hospital, Zambia*

Introduction

Ever since the introduction of the first indwelling catheter with an inflated balloon in 1853 by Jean Francois Reynard, it has become clear what a useful instrument urologists were given. However, it has become evident that using such a simple instrument goes along with some risks over the years. To this date, everyday urological practice cannot be imagined without a catheter, but at the same time, it has become clear that the use of the catheter has inevitably put the urologist in a position where he has to deal with the complications that arise from catheterisation. One of the most common catheterisation complications is catheter-associated urinary tract infection [1].

Catheter-associated urinary tract infection is the most common nosocomial infection in hospitals worldwide, and the incidence rate has been reported to be approximately 35%. The duration of catheterisation is a significant risk factor for catheter-associated urinary infections. It is well accepted that bacterial colonisation with catheterisation is inevitable, with some reports estimating the risk to be in the range of 5% per day with almost 100% colonisation risk at 7 to 10 days of catheterisation. The incidence of bacteriuria has been estimated to be about 3% to 10% higher each day after catheter insertion. Therefore, bacteriuria is almost always present in these patients, and it does not require treatment unless symptomatic. Although most catheter-associated urinary tract infections are asymptomatic, they often precipitate unnecessary antimicrobial therapy. Additionally, although there have been recommendations to treat CAUTIs only when they are symptomatic, the symptoms associated with CAUTI have not been clearly defined [2, 3].

A urinary catheter is indicated for both diagnostic and therapeutic purposes. A single-use or rigid catheter is used to obtain a sterile urine specimen for laboratory purposes for diagnosis. These are usually one-time-use catheters, which do not have a balloon at the end to hold them in place.

Therapeutically, a urinary catheter is used to overcome obstruction in the urinary tract, which may be due to retention secondary to benign prostatic hypertrophy, tumours, bladder calculi, strictures, congenital abnormalities and injuries of the urinary tract. Other indications include urinary incontinence, urinary surgery on the prostate or genitals, and debilitating medical conditions. For therapeutic purposes, an indwelling catheter is the method of choice in the intravesical instillation of cytotoxic drugs and BCG in the treatment of bladder carcinoma.

Urodynamic investigations and supra-pubic catheterisation without a balloon are other indications. On the other hand, a two-way Foley catheter is an indwelling type of catheter with two channels. One of the channels allows urine to flow from the tip to the end, where it can drain into a collecting bag. The second channel allows inflation of the balloon that holds the catheter in the bladder. A three-way Foley's catheter has an extra channel for instilling medications or irrigation fluids following urological surgery or in case of bleeding from a bladder or prostate tumour to clear blood clots or debris. Condom catheters are most often used in older men with dementia and patients with incontinence. A condom-like device is placed over the penis with a tube that leads from this device to the drainage bag. They are less irritating than the indwelling.

The different catheter types come in various materials and sizes. Issues considered when choosing a catheter are ease of use, tissue compatibility, allergy, a tendency for encrustation and biofilm formation, and comfort for the patient. The materials include latex, which is made from natural rubber, a flexible material but has disadvantages, including potential discomfort due to high surface friction, rapid encrustation by mineral deposits from urine, and implication of allergy reactions to latex in the development of urethritis, urethral strictures or anaphylaxis. Its use is restricted to short term indwelling and is best avoided if possible. On the other hand, a silicone catheter is very gentle for the tissue and is hypo-allergic. Since it is uncoated, it has a relatively large lumen and has a reduced tendency to encrustation. However, the silicone catheter balloon tends to lose fluid, which increases the risk of displacement.

Polytetrafluoroethylene (PTFE) has been developed to protect the urethra from latex. The absorption of water is reduced due to Teflon coating. It is smoother, and this helps to prevent encrustation and irritation. However, its use is not advised in patients with latex sensitivity. Silicon-coated catheters are latex catheters coated inside and out with silicone. It has the strength and flexibility of latex and the durability and reduced encrustation typical of 100% silicone. Hydrogel coated catheters are soft and highly biocompatible. Since they are hydrophilic, they absorb fluid to form a soft cushion around the catheter and reduce friction and urethral irritation. The silver-coated catheter combines a thin layer of silver alloy and hydrogel, which is antiseptic. Silver-hydrogel coated catheters are available in latex and silicone. This type reduces the incidence of asymptomatic bacteriuria but only for a week. There is also a reduced incidence of symptomatic UTI. Catheter diameter size and length are measured in Charriere (Ch or CH), also known as the French Gauge (F, Fr or FG) and indicate the external diameter. 1Ch=0.3mm and sizes range from Ch 6 to 30. For paediatric use, sizes range from 6 to 10. For adults size 10: to clear urine, no debris, no grit (encrustation). Sizes 12 to 14: clear, no debris, no grit, no haematuria, Size 16: slightly cloudy urine, light haematuria; with, without small clots; no or mild grit, mild to heavy debris; Size 18: moderate to heavy grit, moderate to heavy debris. Hematuria with moderate clots; Sizes 20 to 24: used for heavy haematuria, need for flushing [4, 5].

In general, the use of urinary catheters in other regions of Africa and parts of the world has been associated with the development of CAUTI. Unfortunately, inevitably, several patients awaiting definitive treatment in the urology section of the UTH cannot wait without using the catheters because of lower urinary tract symptoms. These patients are likely to develop CAUTI. In Zambia, unlike other parts of Africa and the world, the types of microorganisms, their sensitivity pattern and their prevalence in the urine of these patients are unknown. Hence, the reason the study had to be carried out at the UTH, being the leading health institution in the country.

Materials and Methods

Simple random sampling was used to select candidates from in-patients with indwelling catheters awaiting definitive surgery and out-patients in the same category, as they attend clinics totalling 228 patients. Two data forms were used to collect data from the patients concerning demography and clinical/pathological information. Consent was obtained to collect urine specimens for a microbiological analysis whose data was entered into the same forms once the results were ready. Data collection and collection of specimens were done by the principal investigator, and then analysed by the microbiologist based at the UTH microbiology laboratory. The patients were recruited at one point, and a data collection exercise was employed using a questionnaire tool to collect socioeconomic demography and clinical information from each patient. With consent obtained, urine specimens were collected for analysis at that particular time from midstream urine samples of patients on either continuous drainage (for which catheters had to be clamped prior to collection) or those with spigotted catheters. The urine specimens were collected in sterile 20ml urine containers. The number of specimens collected by the end of the study was 230. In both instances, the initial 10mls is discarded, allowing collection of the mid-stream specimen. Fluid intake is encouraged in those with inadequate production. A urine-wet preparation was done for microscopy as per the approved urine processing sandards procedure. Urine was cultured on blood agar and McConkey agar. The subculture technique available was broth, used particularly when there is no significant growth. Brother allows faster growth of microorganisms since it is a liquid media with readily available nutrients. For the antibiotic susceptibility testing, there were two types of methods available. These include the traditional Diffusion Method, which employs the use of discs and tablets and the Minimum Inhibitory Concentration Method, which employs strips. The former is inexpensive in the short-term but less accurate and more expensive in the long-run. The Minimum Inhibitory Concentration Method is expensive but more accurate and saves resources in the long-term. Four major types of antibiotic discs used at the Main UTH laboratory include Nalidixic Acid, Nitrofurantoin, Norfloxacin and Ampicillin or Sulbacta-ampicillin. These drugs are mandatory.

For Extended-spectrum beta-lactamases (ESBL), third-generation Cephalosporins are the main antibiotic discs used. For Pseudomonas species, the drugs of choice are Ciprofloxacin, Ceftazidime, Gentamycin and Imipenem. For Moraxella species, Erythromycin, Ampicillin and Cotrimoxazole are the main discs used. Vancomycin is used when Methicillin-resistant Staphylococcus (MRSA) is identified or when all the available drugs are resistant. The variables were collected using the data collection sheet for each participant, and the data was entered into SPSS software, a software used to clean and analyse data. The categorical variables were presented as proportions (95% confidence interval, while continuous variables were presented as means$\pm$ SD or Median. A p-value $\leq$0.05 was considered significant.

Results

Patient Characteristics

There was a total of 228 patients enrolled for this study. The majority of the enrolled patients were male, 211/228 (92.5%) versus 17/228 (7.5%) female patients. Slightly above three-quarters of the enrolled patients, 178/228 (78.0%), were from Lusaka.

Concerning age distribution, 15/228 (6.6%) patients were in the age range 18 to 25 years, while 30/228 (13.2%) were aged 26 to 35 years. Twenty-eight patients (12.3%) fell in the age range of 36 to 45 years, with the majority; 155/228 (68%) aged 46 years and above.

With regard to educaion, there were 31/228 (13.6%) patients without formal education, 109/228 (47.8%) with primary education, 65/228 (28.5%) with secondary level education and 14/228 (6.1%) with tertiary level education. There were 87/228 (38%) with benign prostate hyperplasia (BPH) as an indication for catheterisation, 70/228 (31%) with urethra stricture indication, while 71/228 (31%) had other indications for catheterisation.

Presence of Infection

There were 51/228 (22.4%) patients with pure infection, 26/228 (11.4%) with mixed-significant infection, 1/228 (0.4%) with mixed-insignificant infection, 25/228 (11%) with no growth/insignificant, while 3/228 (1.3%) samples were rejected and 122/228 (53.5%) were mixed but not isolated. Table 1 shows the summary frequency distribution of patient characteristics.

Patients with pure and mixed-significant infection were grouped together as the presence of infection, while patients with no growth/insignificant and mixed-insignificant were also grouped as the absence of infection. Bivariate analysis was conducted to investigate the association with the presence of infection among patient variables. Rejected and un-isolated samples were excluded from further analysis.

Infection Distribution Pattern

Of patients with laboratory test results, about 75% had an infection, and 25% had no infection, and this difference in proportion distribution was statistically significant; p<0.001.

Bacterial Isolate Distribution

Klebsiella Pneumoniae and Escherichia coli were the two most common organisms isolated at 28% (30) and 25.2% (27), respectively.

Antibiotic Disc Resistance and Sensitivity

Table 2 shows the antibiotic resistance and sensitivity patterns for the top 10 most prescribed antibiotics against the top 7 isolated organisms. Despite being widely prescribed, norfloxacin and nalidixic acid were mostly resistant to most organisms. Gentamicin was sensitive to Klebsiella (50%) and Escherichia Coli (E.coli) (63.6%). Amikacin was also well sensitive to Klebsiella, 8/8 (100%).

Bivariate Analysis

Bivariate analysis was conducted for association with the presence of infection. At a 5% significance level, the size of the catheter (p<0.001) and time from first catheterisation (p<0.001) were associated with the presence of infection (Table 3). Education level was marginally associated with the presence of infection (p0.06). The selection for entry into the logistic regression model was considered at level p<0.20 or known significance. Thus, analysis yielding a p-value <0.20 is considered significant.

Logistic Regression Analysis

Multivariate logistic regression analysis predicting the presence of infection was conducted, and final results are presented in Table 4. Adjusting for confounders, education (primary p0.003) and size of the catheter (18ch p0.004) were found to be independently associated with infection. Compared to patients with secondary school level education or better, patients with primary level education had on average 7 times increased odds for infection [Odds Ratio (OR) = 7.48, 95% confidence interval (CI) = 1.25 – 44.87. P-value = 0.03]. Compared to patients with a size 24 catheter, patients with the size 18 catheter had on average 21 times increased odds for infection (OR = 21.86, CI = 2.64 – 180.88, P-value = 0.004).

Discussion and Main Challenges

Catheter-associated urinary tract infections are a significant cause of morbidity and subsequent mortality in patients due for surgery in the urological section of the Department of Surgery at the University Teaching Hospital, in Zambia. It is unavoidable that such patients' urinary tracts get colonised with bacteria or fungi in the process of waiting. This study was conducted at the UTH from August 2015 to March 2016 to demonstrate the magnitude of the problem.

The investigation showed that as much as three-quarters (75%) of the patients with indwelling urinary catheters ended up with significant UTIs with Klebsiella pneumonia and E.coli leading as the most prevalent organisms isolated. The isolates, in turn, showed high levels of resistance to commonly used antibiotics administered. The result may seem high, but it is reasonably comparable to an outcome of a study done by Mbata *et al.,* [6], which revealed the prevalence of UTI in catheterised patients as high as 77.9% in

Southeastern Nigeria and 60% in Northwestern Nigeria. On the contrary, the prevalence has been as low as 7%, as seen in the research done in Turkey and 10% in Singapore with E.coli, which seems omnipotent over time, place, and person [7]. In a Western study conducted in 1999, causative organisms included E.coli (85%), Proteus mirabilis (6%), Klebsiella pneumonae (4%) as most prominent [8]. In a Nigerian study, Staphylococcus aureus was the most predominant pathogen isolated, followed closely by E.coli, Klebsiella pneumonia and Proteus mirabilis. Pseudomonas aeruginosa was the least isolated pathogen [9]. This supports suggestions of local and regional differences in the prevalence of CAUTI in various settings [10]. This section will discuss in detail the findings of the research conducted.

The research was carried out over ten months, capturing 228 patients, of which 92.5% (211/228) were male patients against 7.5% (17/228) female. The difference between the genders was statistically significant, with a p-value at >0.20. The number of catheterised female patients was far less than the male counterparts for the gender factor to be considered. Compared to other studies, such as the one conducted by Kazi *et al.,* [11], which had 34.4% versus 65.6% men, a balanced number of males and females would be required to compare gender as a factor in the rate of infection. However, the anatomical differences between men-long urethra is 14 to 15cm compared with women at 4cm, in addition to the presence of the prostatic gland in the former, predisposes male subjects more to urinary outflow obstruction compared to their counterparts, worse off, as they advance with age (Prostatic pathology). Additionally, the longer urethra leaves men vulnerable to both in vitro injury (iatrogenic injuries as in traumatic catheterisation) as well as external trauma (pelvic fractures and falling astride). The above factors are disputed from results such as those from research done by Rolf *et al.,* [12] on CAUTI in Yaoundé, Cameroon, which were as follows: of the 55 significant samples out of 92 sampled, 46 were female while 9 were male. Analysing prevalence concerning gender, females (83.6%) had a higher prevalence of infection than males (16.4%). Urinary Tract Infection (UTI) prevalence was thus, significantly related to gender (p-value 0.002), contrary to our findings (p>0.20).

The research conducted enrolled clients from both out-patient and in-patient sections of the department. It is worth noting that nearly 80% of the candidates emanated from Lusaka Province, with less than a quarter coming from the rest of the country. Lusaka Province: 78.08% (178/228) provided the most participants since most were within reach of UTH, whether from the peri-urban or the more affluent low-density areas. In contrast, Northwestern, Western and Muchinga Provinces were the least represented, contributing only five out of 228 patients (2.2%). Patients with urological challenges but far off may have sought intervention from the nearest institutions with specialised capacities, such as Ndola Teaching Hospital Urology Section (Luapula, Muchinga and North-western) or

Livingstone General Hospital as in the case of the Western Province or Southern Province to a lesser extent. Thus, proximity to higher health institutions logically explains the distribution according to the residence.

From the perspective of age, slightly above two-thirds of the candidates were aged 46 years or over, showing that most patients were gradually transiting into the non-reproductive age group. Patients aged 18 to 25 years comprised only 6.6% (15/228) of the pool, while the 26 to 35-year-olds contributed about 13.4% (30/228). The 36 to 45 group was almost equally represented at 12.3% (28/228). However, as mentioned, the above 46-year-olds made up approximately two-thirds [68% (155/228)] of the candidates enrolled, which is in contrast to a study done on the prevalence of urinary catheter-related infections in the out-patient department of the federal medical centre in the city of Abeokuta, Nigeria. This study showed that the most frequently affected age group was the 26 to 35year olds (32.0%): Olarian *et al.,* [13]. The study by Rolf [12] revealed a mean age of 39.2 $\pm$ 17.6 years with a median of 35 years, an age lower than what was revealed by our research. The higher age distribution in Zambia may be related to an increased number of patients with bladder outflow obstruction conditions such as BPH and prostate cancer, which are age-related, although urethral stricture diseases tend to present at a younger age. Approximately an equal number of patients with benign prostatic hypertrophy and urethral strictures (about a third each), but the average age may have been offset by the remaining third (Others) of which prostate cancer is a part. Age did not meet the criteria, with a p-value above 0.20.

The participants' level of education revealed an interesting pattern, which did not show proportionality in relation to the rate of infection. Nearly half of the participants had attained primary school education, while the tertiary group were the least represented. Almost a third were secondary school leavers, while 13.6% never stepped into a classroom. The majority of the patients seen were thus, from low-income homes. A few of these attained tertiary level education. Patients with access to high-cost facilities were not captured adequately in this study compared to those accessing low-cost facilities. Hence, the research mostly captured individuals from the lower bracket of the economic spectrum and lower educational standards. A comparison of primary and secondary school leavers in the group revealed a significant relationship with the infection rate with a p-value at 0.003 using the regression method. Thus, patients who attained primary school education had a higher chance of infection than their secondary school counterparts. There were no specific studies that compared levels of patient education to the rates of CAUTI. However, patient education intervention has been seen to reduce the prevalence by as much as half, as demonstrated by the quasi-experimental study by Alison *et al.,* [14], which reduced incidence rates from 8.2 to 4.3 per 1000 catheter days following a three-month intervention. The overall p-value for education was 0.06.

There were various reasons patients were catheterised as they were attended to in the clinics or urological wards. Overall, two indications were found to be the most frequent. These were BPH and urethral stricture diseases, making up approximately two-thirds of the population and contributing a third (31% each).

Benign prostatic hyperplasia (BPH) is exclusively a disease of the elderly, with the frequency increasing from 30 to 40% around the age of 45 in the general population or 40 in a candidate with a family history of the disease, to 80% as the patient approaches the ninth decade. On the other hand, urethral stricture diseases have a varied frequency but affect mostly, the patients in the productive age. The remaining third included such conditions as prostate cancer, pelvic tumours, incontinence and patients requiring postoperative care, among other reasons. Benign prostatic hyperplasia and prostatic cancer have a racial bias towards the negroid race, particularly for the population residing in the urban or peri-urban premises; hence, higher frequency is of no coincidence. There was an association between the indications and the infection rate with a p-value of 0.12.

The researcher had an opportunity to assess how long each patient had the indwelling catheter from the first insertion to the time of enrolment into the research programme. The periods were long-standing, lasting from six (6) months to over a year. Slightly over a third of the candidates (34.2% n=78/228) had indwelling devices for not more than six (6) months, whilst a quarter (24.7% n=49/228) had catheters exceeding twelve (12) months with over a fifth (21.7% n=56/228) having catheters in place for more than seven (7) months but not more than twelve (12) months. This agrees with the notion that most urological patients who are awaiting surgical intervention to relieve urinary outflow obstruction endure chronic catheter stay, exposing them to the subsequent development of urinary tract infections along the way.

In general, latex catheters are the most easily accessible as they are cheap to procure and are readily available even though they are only suitable for short-term use (3 to 7 days). Used for longer than this period, they leave the client vulnerable to developing CAUTIs, bladder stones (grits), ascending UTIs and subsequent sepsis. The basis revolves around the high friction rate of the latex rubber with a subsequent tendency to encrustation and biofilm formation [15]. The catheter type in question made up slightly over half of the tubes used (52.2% n=119/228), while on the other hand, the improved antibiotic coated and silicon catheters with their upgraded properties together made up only under 30% (n=68/228) of the devices. This is a mirror image of the catheter availability scenario in most sub-Saharan African countries, including Zambia. With a p-value >0.20, catheter type had no influence on infection rate in this study.

Research showed that catheters were inserted indiscriminately without considering the specified indications. The majority of the clients had no cloudy urine or haematuria, yet none had 12 or 14 Ch catheters for drainage. The recommended sizes in outflow obstruction remain sizes 12 to 14 to as small as size 10 Ch unless the urine is heavy, blood-stained or encrusted. The larger sizes are associated with an increased rate of UTI due to impediment of epithelial mucous gland secretions. Susan *et al.,* [16], in a study titled *The Association between Indwelling Urinary Catheters and Use in the Elderly,* revealed that 73% of the patients in ICU who received an IUC were above 65 years, of which 46% of the catheters were inappropriately placed and 54% were appropriately placed resulting in 28% developing UTI. Such patients with long-term indwelling catheters experienced bacteraemia with the increasing length of catheterisation [17]. Catheterisation for more than 90 days was further associated with chronic pyelonephritis and chronic renal inflammation [17]. Further analysis with logistic regression showed a strong relation between catheter sizes 18 Ch and size 24 Ch to be associated independently with the rate of infection ($p=0.004$). This supports the call for indications for indwelling urethral catheter placement to be clearly defined.

Bivariate analysis using SPSS software was conducted to investigate the association with the presence of infection among patient variables. The rejected and unisolated samples were excluded from further analysis. Thus, of the patients with laboratory test results, about 75% had an infection, and 25% had no infection. This difference in proportion distribution was statistically significant ($p<0.001$). The prevalence this high is not uncommon in sub-Saharan Africa, as demonstrated by the study by Onipede *et al.,* [18] in South-western Nigeria, which showed a rate of CAUTI at 60.9% and Mbata *et al.,* [7] with the prevalence of UTI in catheterised patients to be as high as 77.9% in Southeastern Nigeria. On the other hand, rates as low as 23% and 21% were reported in Benin [19] and Egypt [20]. A rate of 7% was reported in the Turkish study.

Klebsiella pneumonia was the most frequently isolated microorganism at 28% (30/107) of the isolates, closely followed by E.coli at 25.7%. This is, however, in contrast to many studies, which revealed E.coli to be the most prevalent microorganism. For instance, research done on CAUTI by Mbanga J *et al.,* [21] in Bulawayo, Zimbabwe, showed E.coli (40.3%) as the most prevalent in catheterised patients, followed by Coagulase-negative staphylococcus aureus (16.1%), with Klebsiella species at 11%. In Benin, Tamegnon *et al.,* [19] also revealed E.coli (79%) as by far the most prevalent, followed by pseudomonas spp(11%). Similar outcomes were seen in Abeokuta, Nigeria, with E.coli at 35.40%, while Klebsiella pneumonia accounted for 20.9% [13]. A UK Teaching Hospital study showed E.coli leading at 26.6% in 1996 but dropping to 22% by Wazait *et al.,* [22].

However, a few research findings had matching outcomes, like the 2008 study at Obafemi, Awolowo University Teaching Hospital, Ile-Ife, South-western Nigeria by Onipede *et al.,* [18], showing Klebsiella oxytoca at 28.6% and Proteus Vulgaris at 23.2% in that order. Equal frequencies were observed in research at Vaodgon Prune Hospital India: E.coli (30.5%) and Klebsiella pneumoniae (30.5%) carried out by Kazi *et al.,* [11].

It is clear that Klebsiella pneumonia and E.coli are commonly isolated pathogens for the following reasons: Escherichia coli was found to be the most common pathogen among, the patients in addition to enterococci, pseudomonas and Proteus mirabilis, because it is a naturally existing resident of the colon, which is in close proximity to the urinary tract [23] and Klebsiella pneumonia commonly resides in patients with long-standing urethral catheterisation, which involve urinary bag colonisation. Klebsiella pneumoniae is a frequently encountered hospital-acquired opportunistic pathogen that typically infects patients with indwelling medical devices. Biofilm formation on these devices is important in the pathogenesis of these bacteria. In K. pneumoniae, type 3 fimbriae have been identified as appendages mediating the formation of biofilms on biotic and abiotic surfaces as described by Haili *et al.,* [24] in an article titled: Emergency of two sub-populations of Klebsiella pneumoniae grown in the simulated microgravity environment.

The antibiotic sensitivity pattern outcome was largely influenced by the antibiotic discs accessible during the ten-month course of the investigation. Ideally, four categories of antibiotic discs are required to carry out a microbiological profile if equivocal results are obtained. The discs are grouped as follows: Penicillins (e.g. oamoxyclauv, amoxicillin, oxacillin), Aminoglycosides (e.g. gentamycin, erythromycin, amikacin), Fluoroquinolones (e.g. ciprofloxacin, levofloxacin, norfloxacin) and Cephalosporins (e.g. cefalexin, cefuroxime, cefotaxime). However, the antibiotic disc availability during the investigation was uneven with a bias towards norfloxacin, cotrimoxazole and gentamycin with cephalosporins modestly represented, while penicillins and quinolones were hardly available.

The limited supply of the items in the microbiology laboratory employed can explain the unequal distribution. The ideal situation was beyond the capacity of the researcher. Thus, the antibiotic sensitivity results may not reflect the actual frequency distribution but can be tailored to the research settings. However, all these high resistances were noted with norfloxacin and nalidixic acid and favourable outcomes with gentamycin, nitrofurantoin, amikacin, and imipenem. It is generally clear that microorganisms colonising the urinary tracts of these patients are becoming increasingly resistant to the commonly prescribed antibiotics, leaving hope of eradication of infection to newly developed but more expensive drugs such as imipenem and amikacin, which are in intravenous formulations. Adegun *et al.,* [25] demonstrated in research on Nigerian patients with outflow obstruction that nitrofurantoin was the best drug for all men with CAUTI, although older men had higher rates of multi-resistance. Many studies have reported the presence of ESBL producers, which are related to high resistance in catheterised patients. Maha *et al.,* [20] reported a 21.3% prevalence with ESBL producers: E.coli and Klebsiella pneumonia isolate, making up 78.6% and 56.0%, respectively.

The strength of the relationship between infection rate and the various factors was verified using the 2.1 version of SPSS software with a significance level of 5%. After analysis, the variables with a p-value<0.20 met the criteria to be run through the logistic regression model. Thus, factors such as the size of a catheter (p-value <0.001) and time from first catheterisation (p-value <0.001) were strongly associated with the presence of infection. Others were education levels (p=0.06), indication of catheterisation (p=0.12), duration of (current) catheter in situ(p=0.09), channel types(p=0.04) and drainage system used (p=0.17). The factors with a p-value more than 0.20, namely; gender, age of patient, residence, catheter type and size of balloon inflation, did not meet the criteria, hence, did not influence the infection rate in this study and were dropped. The analyst ran the significant factors using the Multivariate Logistic Regression method, further eliminating weaker variables. Ultimately, the levels of education (primary education versus secondary p0.003) and the catheter sizes (18ch catheter versus 24Ch p0.004) were found to be independently associated with infection. Thus, primary school leavers were seven(7) times more likely to get infected than their secondary school colleagues, and patients with size 18 Ch tubes were twenty-one (21) times more likely to get infected than those with size 24 Ch catheters. From the study, these two factors were of the most importance instead of the duration of catheterisation and types of the catheters used.

In a similar study done by Leelakrishna and Karthik [26] carried out in Tamil Nadu, India, titled: Study of the Risk Factors for Catheter-Associated Urinary Tract Infection, following univariate analysis, the following factors were all significantly associated with the development of CAUTI (p-value 0.000): purpose for urine catheterisation, place of catheterisation, a breach in the closed system of drainage, duration of catheterisation. The sex of the patient (p-value 0.279) and catheter size (p-value 0.279) did not correlate with the increased risk of CAUTI significantly. On multivariate analysis, age, catheter size, diabetes, duration of catheterisation, a breach in the closed system of catheter drainage, and sex were the significant risk factors associated with CAUTI (p<0.05). Thus, it is worth noting that catheter size was a factor in both studies, but the duration of catheterisation and urine bag (integrity or) type did not influence the rate of CAUTI in this study.

From five (5) prospective studies that conducted multivariate analysis on risk factors affecting CAUTI, Tambyah *et al.,* [2] showed that the most important risk factors were duration of catheterisation, being of the female gender, catheterising outside the sterile environment of the operating room, other infections, anatomical abnormalities, altered immunity in the form of diabetes and malnutrition or renal failure as well as keeping the drainage tube above the level of the patient. Antibiotics were protective against infection, but they tended to be caused by multidrug-resistant organisms when it occurred.

Conclusion

The findings revealed that the prevalence rate of CAUTI in the urological section of the UTH was as high as 75% of patients with indwelling catheters pending surgery with K. pneumoniae and E.coli accounting for over 50% of the isolates. Multidrug resistance was high, particularly among the commonly prescribed antibiotics such as ciprofloxacin, norfloxacin, and penicillin, even though the sensitivity of discs' distribution was uneven. Univariate analysis revealed an association between the infection rate with: gender, the size of catheters used, time from the first catheterisation, patient's education level, an indication of insertion, duration of the current catheter, the channel types and the drainage system utilised.

It is worth noting that despite the gender factor having a significant impact on the rate of infection with the male factor more susceptible than their female counterparts, the ratios were not balanced enough to conclude. The drainage system was marginally related with the infection rate despite the closed type having a higher infection rate than the open type and nearly a tenth of clients not accurately accounted for. Multivariate analysis singled out education levels (primary seven-fold more likely than secondary school leavers) and catheter size (size 18 Ch 21 times more likely than 24 Ch) as independently the cardinal factors influencing the rate of CAUTI.

The patient's age, residence, type of catheter material used and volume of balloon inflation were all found not to affect the rate of infection. Other factors such as a breach in the drainage system influence of the tube level above the bladder and the immunity and anatomical abnormalities were outside the realms of the study.

Acknowledgements

The authors acknowledge the immense contributions of Dr Michael Silumbe and Dr Basem on the topic suggestion and invaluable guidance, respectively. We also acknowleddge Dr Lukwesa's constructive comments, which are most helpful in forming the backbone of data collection from the Microbiology Department, and the statisticians Mr Yolan Banda and Mr Mulele for their contributions on analysis and interpretation. The authors also acknowledge the nursing staff in the urology clinic: Sr. Pasomba, Sr. Kayoba and Sr. Rommy and Sr. Chanda in G-Block and the clinical officer from Apex University, Mr Siame, as well as the laboratory technicians: Mr Joseph Banda, Mr Kambwili, Mr Lweendo and Mrs Christine.

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TABLES AND FIGURES

Table 1. Patient Characteristics Frequency Distribution

Variable	Frequency (n=228)	Per cent
Sex		
Male	211	92.5
Female	17	7.5
Age		
18-25 Yrs	15	6.6
26-35 Yrs	30	13.2
36-45 Yrs	28	12.3
46 Yrs and above	155	68
Province		
Lusaka	178	78.0
Copperbelt	6	2.6
Muchinga	1	0.4
Southern	12	5.2
Northern	6	2.6
N/Western	2	0.9
Eastern	15	6.7
Western	2	0.9
Central	8	3.5
Education		
Uneducated	31	13.6
Primary level	109	47.8
Secondary level	65	28.5
Tertiary level	14	6.1
Unknown	9	3.9
Indications of catheter		
BPH	87	38.2
Urethral Stricture	70	30.7
Other	71	31.1
Duration of catheter in situ		
3-7 days	24	10.5
8-30 days	60	26.3
> 30 days	144	63.2
Time from the first catheterisation		
0-6 months	78	34.2
7-12 months	49	21.5

>12months	56	24.6
Unknown	45	19.7
Types of catheters used		
Latex	119	52.2
Antibiotic-coated	54	23.7
Silicone	14	6.1
Other	2	0.9
Unspecified	39	17.1
Size of catheter used		
2 way	179	78.5
3 way	2	0.9
Unknown	47	20.6
Size of catheter (Ch)		
16	42	18.4
18	109	47.8
20	25	11
24	20	8.8
Unknown	32	14
Procedure		
Urine bag	100	43.9
Spotted	103	45.2
Unindicated	25	11
Presence of infection		
Pure	51	22.4
Mixed-Significant	26	11.4
Mixed-Insignificant	1	0.4
No growth/Insignificant	25	11
Mixed-not isolated	122	53.5
Rejected	3	1.3

	Organism													
Antibiotic	**Klebsiella**		**E.Coli**		**Citrobacter**		**Enterobacter**		**Proteus mirabilis**		**Enterococcus**		**Acinetobacter baumani**	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Norfloxacin														
Resistant	26	89.7%	17	73.9%	8	72.7%	6	85.7%	6	75.0%	6	100.0%	3	75.0%
Sensitive	3	10.3%	5	21.7%	2	18.2%	1	14.3%	2	25.0%	0	0.0%	0	0.0%
Intermediate	0	0.0%	1	4.3%	1	9.1%	0	0.0%	0	0.0%	0	0.0%	1	25.0%
Nalidixic acid														
Resistant	20	90.9%	15	83.3%	8	80.0%	4	80.0%	5	71.4%	0	0.0%	4	100.0%
Sensitive	2	9.1%	3	16.7%	2	20.0%	1	20.0%	1	14.3%	0	0.0%	0	0.0%
Intermediate	0	0.0%	0	0.0%	0	0.0%	0	0.0%	1	14.3%	0	0.0%	0	0.0%
Cotrimoxazole														
Resistant	12	70.6%	6	42.9%	9	90.0%	1	50.0%	7	87.5%	0	0.0%	7	100.0%
Sensitive	5	29.4%	6	42.9%	1	10.0%	1	50.0%	1	12.5%	0	0.0%	0	0.0%
Intermediate	0	0.0%	2	14.3%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Levofloxacin														
Resistant	15	88.2%	8	72.7%	5	62.5%	2	66.7%	6	75.0%	4	100.0%	3	75.0%
Sensitive	2	11.8%	3	27.3%	3	37.5%	1	33.3%	2	25.0%	0	0.0%	1	25.0%
Intermediate	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Gentamicin														
Resistant	4	40.0%	4	36.4%	4	50.0%	1	50.0%	3	60.0%	2	100.0%	1	33.3%
Sensitive	5	50.0%	7	63.6%	4	50.0%	1	50.0%	1	20.0%	0	0.0%	2	66.7%
Intermediate	1	10.0%	0	0.0%	0	0.0%	0	0.0%	1	20.0%	0	0.0%	0	0.0%

Table 2: Antibiotic resistance and sensitivity patterns for the top 10 most prescribed antibiotics against the top 7 isolated organisms.

Ampicillin														
Resistant	8	100.0%	8	100.0%	1	100.0%	1	50.0%	0	0.0%	1	16.7%	2	100.0%
Sensitive	0	0.0%	0	0.0%	0	0.0%	4	50.0%	0	0.0%	5	83.3%	0	0.0%
Intermediate	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Amikacin														
Resistant	0	0.0%	0	0.0%	0	0.0%	0	0.0%	1	33.3%	3	100.0%	0	0.0%
Sensitive	8	100.0%	3	100.0%	3	100.0%	2	100.0%	2	66.7%	0	0.0%	3	100.0%
Intermediate	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Ciprofloxacin														
Resistant	4	66.7%	4	66.7%	1	100.0%	1	100.0%	0	0.0%	5	100.0%	1	33.3%
Sensitive	2	33.3%	1	16.7%	0	0.0%	0	0.0%	1	100.0%	0	0.0%	1	33.3%
Intermediate	0	0.0%	1	16.7%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	1	33.3%
Nitrofurantoin														
Resistant	3	60.0%	3	30.0%	1	100.0%	2	40.0%	0	0.0%	0	0.0%	2	100.0%
Sensitive	0	0.0%	6	60.0%	0	0.0%	1	20.0%	1	100.0%	0	0.0%	0	0.0%
Intermediate	2	4000.0%	1	10.0%	0	0.0%	2	40.0%	0	0.0%	1	100.0%	0	0.0%
Tetracycline														
Resistant	0	0.0%	5	83.3%	1	50.0%	3	100.0%	0	0.0%	5	100.0%	2	100.0%
Sensitive	1	100.0%	1	16.7%	1	50.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Intermediate	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%

Table 2 continued: Antibiotic resistance and sensitivity patterns for the top 10 most prescribed antibiotics against the top 7 isolated organisms.

Table 3. Bivariate Analysis

Variable	Infection Absent		Infection present		P-value
	n	%	n	%	
Sex					
Male	24	92.3%	72	93.5%	0.99[f]
Female	2	7.7%	5	6.5%	
Age					
18-25 Yrs	2	7.7%	5	6.5%	0.50[f]
26-35 Yrs	5	19.2%	7	9.1%	
36-45 Yrs	2	7.7%	10	13.0%	
46 Yrs and above	17	65.4%	55	71.4%	
Province					
Lusaka	18	69.2%	56	72.7%	0.73[c]
Other provinces	8	30.8%	21	27.3%	
Education level					
Uneducated	5	19.2%	5	6.7%	0.06[f]
Primary	8	30.8%	40	53.3%	
Secondary or better	13	50.0%	30	40.0%	
Indications of catheter					
Other	14	53.8%	24	31.2%	0.12[c]
BPH	7	26.9%	32	41.6%	
Urethral stricture	5	19.2%	21	27.3%	
Duration of catheter in situ					
3-7 days	3	11.5%	11	14.3%	0.09[f]
8-30 days	4	15.4%	28	36.4%	
> 30 days	19	73.1%	38	49.4%	
Time from the first catheterisation					
0-6 months	6	23.1%	37	48.1%	<0.001[f]
7-12 months	4	15.4%	13	16.9%	
>12months	2	7.7%	17	22.1%	
Unknown	14	53.8%	10	13.0%	
Types of catheters used					
Latex	7	58.3%	38	55.1%	0.66[f]
Antibiotic-coated	5	41.7%	23	33.3%	
Silicone/others	0	0.0%	8	11.6%	
Channel type used					
2 way	12	46.2%	53	68.8%	0.04[c]
3 way/unknown	14	53.8%	24	31.2%	

Size of catheter (Ch)					
16	6	23.1%	13	16.9%	<0.001[f]
18	2	7.7%	42	54.5%	
20	3	11.5%	8	10.4%	
24	1	3.8%	9	11.7%	
Unknown	14	53.8%	5	6.5%	
Drainage system					
Urine bag	16	72.7%	39	56.5%	0.17[c]
Spigotted	6	27.3%	30	43.5%	
Balloon size on deflation (m/s)					
(n,mean, SD)	12, 11.25, 3.22		72, 11.78, 3.78		0.65[t]

[t]=Independent Samples T-test, [c]=Chi-Square, [f]=Fisher's exact test

Variable correlation

		Sig. (2-tailed)	.	.259	.515	.691	.004	.730
		N	228	228	183	196	202	219
	Q6DurationinSitu	Correlation Coefficient	.075	1.000	.280**	-.106	.164*	.029
		Sig. (2-tailed)	.259	.	.000	.138	.019	.671
		N	228	228	183	196	202	219
	Q7Timefromfirst	Correlation Coefficient	.048	.280**	1.000	-.014	.161*	.070
		Sig. (2-tailed)	.515	.000	.	.850	.041	.356
		N	183	183	183	181	162	178
	Q10Size	Correlation Coefficient	.029	-.106	-.014	1.000	-.104	-.023
		Sig. (2-tailed)	.691	.138	.850	.	.173	.757
		N	196	196	181	196	173	189
	DrainageSysemt	Correlation Coefficient	.204**	.164*	.161*	-.104	1.000	-.005
		Sig. (2-tailed)	.004	.019	.041	.173	.	.945
		N	202	202	162	173	202	194
	Q4Education	Correlation Coefficient	.023	.029	.070	-.023	-.005	1.000
		Sig. (2-tailed)	.730	.671	.356	.757	.945	.
		N	219	219	178	189	194	219

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).