URINARY TRACT INFECTIONS CAUSED BY ENTERIC BACTERIA AND
ANTIBIOTIC SENSITIVITY AMONG SYMPTOMATIC MALES VISITING
SPECIAL TREATMENT CENTER, NAIROBI CITY COUNTY, KENYA.

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P150/CE/26148/2014

A THESIS SUBMITTED IN FULFILLMENT FOR THE AWARD OF
DEGREE OF MASTER OF SCIENCE IN INFECTIOUS DISEASES
(BACTERIOLOGY) IN THE SCHOOL OF MEDICINE,
KENYATTA UNIVERSITY

OCTOBER, 2020
DECLARATION

This thesis is my original work and has not been presented for a degree or any award in any other university.

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DEDICATION

This work is dedicated to my beloved parents, husband and children who encouraged and supported me all through to this level of education. Above all to God, the creator of all beings, who provided strength, health and favour to enable me see this output.
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Lastly, I will not forget my classmates, Oliver Mbuthia, Caroline Ngetsa, Vincent Mageto and Okoyo Erick, for any of their help in the course of my study.
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Urinary tract infections are not as common in men as they are in women. However, when present, they are considered to be indicative of serious urological abnormalities and thus considered to be complicated infection in men. They can either be typical or atypical. Typical irritative lower urinary tract infection can be presented by most men with clinical symptoms such as frequency or urgency in micturition, nocturia, dysuria, and hematuria. The less common atypical urinary tract infection presents with clinical symptoms such as confusion, urine incontinence and is highly associated with elderly men. Due to the stigma and denial associated with urinary tract infections, male patients with urinary tract infections self-diagnose and use over the counter antibiotics leading to the mismanagement of disease and increase in antibiotics resistance. The study aimed at investigating the prevalence of urinary tract infections caused by enteric bacteria and antibiotic sensitivity among symptomatic male patients visiting special treatment center, in Nairobi, Kenya. A cross-sectional study was carried out among three hundred and eighty-four (384) male patients attending the special treatment center. The male participants were selected using systematic random sampling technique. Aseptic procedure of urine collection was explained to the patient and 10-15ml mid-stream urine sample collected. Urinalysis using dipstick was done, followed by culture on CLED and blood Agar. Kirby Bauer disc diffusion technique for antibiotic sensitivity was done using Ofloxacin, cefaclor, nitrofurantoin, Nalidixic acid, Augmentin, cefuroxime, minocycline, ciprofloxacin and gentamicin. Data was cleaned, coded and entered into the computer and analyzed using Statistical Package for Social Science software version 23. Both descriptive and inferential statistical test techniques were used and the output presented using tables and charts. The prevalence was 65.6% calculated based on the proportion of participants with UTI during the study period. The Gram negative bacteria isolated were: Escherichia coli, Klebsiella pneumonia, Proteus mirabilis and Pseudomonas aeruginosa while Gram positive were Staphylococcus aureus and Staphylococcus saprophyticus. The most frequent bacteria isolated was Escherichia coli (42%) and the least was P. aeruginosa (4.7%). The occurrence of urinary tract infections was noted to be most common between the ages of 20-29 years. There was moderate relationship between P. mirabilis, S. saprophyticus and age ($r= 0.698$, $r=0.85$). There was also a slight statistical significance between age and S. aureus ($p=0.046$). The most effective antibiotic to all bacteria was ofloxacin and the isolates exhibited resistance to nitrofurantoin, augmentin and nitrofurantoin. Sensitivity of P. mirabilis was 100% to cefaclor while P. aeruginosa was 100% resistance to all the drugs. All isolates demonstrated multidrug resistance to more than two drugs. The study therefore recommends a regular surveillance and research of antibiotic use in the management of UTI to avoid multidrug resistance which would otherwise impact on the increasing cost of care.
CHAPTER ONE: INTRODUCTION

1.1 Background to the Study

Urinary Tract Infections (UTI) is known to affect millions of people annually and can lead to serious health problem issues (Tajbakhsh, 2015). Globally, seven million patients visit the outpatient department, one million visits the emergency department visit, and one hundred thousand patients visits the in-patient department annually, from symptomatic UTI (Foxman, 2003). Although Urinary Tract Infections in men occur rarely, when they do occur, they come with very severe implications to the health of the male patient (Tajbakhsh, 2015). There are several factors that lead to men having UTI, they include sex, age, diseases like diabetes, men who have sex with men, men with neurologic disorders, men with defects in the bladder and prostate as well as immune-compromised men (Hsueh, 2011). The reported number of new infections yearly is lower than in women except infections where the patient in catheterized and children (Noor, 2013).

Urinary tract infections in men may clinically present with typical or atypical presentation. Typical irritative lower urinary tract symptoms will be presented by most men with symptoms such as frequency, dysuria, urgency and nocturia. Others may complain of a foul smell in the urine, blood in urine or suprapubic pain (Anuli, 2016). Atypical presentation is frequently seen in older men and may have involuntary leakage of urine and confusion (Foxman, 2014). Different pathogens have been found to cause UTI among male patients. Uropathogenic E. coli (UPEC), a Gram-negative, facultative anaerobe is the predominant isolate (Betsy, 2010).
The UPEC strain that causes UTI is different from the one found in the gastrointestinal tract in that it has a mechanism that enables it to elude the host defense system and attach to the urinary tract by forming biofilms invading the urothelial cell. The *Streptococci* and *Staphylococci* are species among the members of enterobacteriaceae that also cause urinary tract infections (Foxman, 2003).

Urinary Tract Infections in the world today has and continues to cause a big economic impact because of high antibiotic use (Hsueh, 2011). In Africa not much has been documented about the effects of UTI to the economy and the health care system. There is inadequate data concerning the occurrences of various UTI’s, how they affect quality of life of that population. For proper monitoring of UTI’s, such data is required from the public health system (Kurt, 2010). The independent review on antimicrobial resistance estimated that by 2050, infections that are resistant to most antibiotics could cost the global economy 100 trillion dollars killing around 10 million people annually (World Economic Forum, 2014).

Antibiotic resistance is becoming a worldwide cause of alarm, Kenya is no exception. The resistance can arise naturally or due to misappropriation of the antibiotics. Misuse and overuse are the primary causes (WHO, 2018), in Kenya antibiotics can bought by men without a prescription from a trained practitioner. This is usually the chief cause of misuse of antibiotics. Shortage of right and accurate facts about antibiotics also adds to the misappropriation of antibiotics. A survey carried out across 12 countries by (WHO, 2015) showed that 64% of the public believe that an antibiotic can also treat viral infections like common cold and influenza.
This basic gap on common knowledge has led to patients buying and using antibiotics without knowing the consequence on antimicrobial resistance.

Self-diagnosis is another reason for wrong use of antibiotics (Lee, 2015) with the availability of internet, this problem has increased. Thirty-five per cent of American adults have at one point in their lives used internet to diagnose a UTI either for themselves or someone they know. Younger people, especially those with a college degree, have the highest chances of going online to diagnose their infections (Fox, 2013)

There are limited studies carried out on the causes and antibiotic sensitivity patterns of community acquired UTI’s in Kenya among males and especially in the special treatment center, Nairobi. One of the studies carried out in Agha Khan University Hospital in Nairobi in 2012 revealed that up to 70% of the *E. coli* was resistant to Septrin and Augmentin. Resistance to Nalidixic acid was also reported to be quiet high in non-*E. coli* organisms (Okinda, 2012) another one done in Kenyatta Hospital in 2015 investigated ESBL isolates and found the bacteria causing UTI to be resistant to the locally administered antibiotics at the hospital (Magale, 2015). The objectives of this study were to investigate the prevalence of enteric UTI infections among males, the causative agents and the antibiotic susceptibility patterns of isolates, performed within a period of 3 months of 2018 in special treatment center.
1.2 Problem Statement

Urinary tract infection (UTI) is one of the commonest communicable disease and second in antibiotic prescription in many Kenyan hospitals after respiratory infections. The most frequently cited etiology is *E. coli* which causes 90% of the UTIs in anatomically-normal unobstructed urinary tracts. Although UTI in males younger than 50 years is not common, the frequency increases afterwards. Treatment of UTI is easy if antibiotics are used rationally. All male UTI’s are normally considered complicated with the consideration that the infection has ascended to the upper urinary tract. Therefore, culture and analysis of antibiotic susceptibility pattern is more effective in the management of UTI in males because it aids in modification of the treatment plan.

The emergence of antibiotic resistance against commonly prescribed antibiotics in the treatment of UTIs is an ongoing concern worldwide. Several factors including; inappropriate use of antibiotics, availability of counterfeit drugs in the market, non-adherence to the standard treatment guidelines by clinicians and lack of laboratory resources for culture and sensitivity, have been attributed to the growing resistance to antibiotics among men. In Kenya, the prevalence of urinary tract infections is high with poor treatment outcomes due to prescription of low sensitive drugs coupled with inappropriate diagnosis. Most patients are normally treated based on clinical judgment and urine culture done when patients are refractory to antibiotic treatment, this is partly due to the perception that culture and sensitivity tests are expensive and time consuming by clinicians.

Poor monitoring of antibiotic prescription and use in the treatment of UTI is a major contributor to antibiotic resistance. If attempt is not made to stop the progression of antimicrobial resistance, there is a greater risk for developing UTI-related multi drug
resistant (MDR) strains. Moreover, the country will be confronted with increased morbidity and mortality from UTI due to its complicated nature in men therefore leading to higher costs of treatment to the patient and health care system. Therefore, this study aimed to determine the prevalence of UTI, the causative enteric bacteria and antibiotic sensitivity pattern in among males visiting the Special Treatment Center, Nairobi City County.

1.3 Justification

Globally, surveillance of antibiotics on UTI is reported to be uncoordinated. A situation that has led to fragmented or lack of accurate information on antibiotic resistance (WHO, 2014). Very few studies on community-acquired UTI caused by enteric bacteria in males have been published (Wagenlehner, 2008). One of the report has indicated that enteric bacteria are associated with UTI in men, and are easily treated with antibiotics (Kayode 2019). While some men with UTI will not seek treatment leading to a higher risk of complications (Anuli, 2016) majority of men self diagnose and purchase over the counter cheap broad spectrum antibiotics because of their poor health seeking behaviour (Lee 2015) increasing the antibiotic resistant rate of the enteric bacteria hence the need for extensive study on men with UTI.

Special Treatment Center was chosen as the study site because of its high patient volume and specialization on treatment of men with sexually transmitted diseases as compared with surrounding public health facilities in Nairobi County. There is also no evidence documented at STC Casino on the prevalence of UTI or resistance to antibiotics in men attending the facility for services. Therefore, the study aimed to evaluate Urinary Tract Infections and antibiotic susceptibility of the pathogens causing
UTI among symptomatic male patients visiting special treatment clinic (STC) casino, in Nairobi

1.4 Significance of the study

The data on prevalence of UTI among male patients gave an insight as to the extent of infection and age distribution, which is useful for effective management of the infections. The antibiotic sensitivity profile gave a feedback to Ministry of health; Nairobi, county health Department, Pharmacy and Poisons Board and other stakeholders. The study findings on drug sensitivity of enteric bacteria were useful in informing policy makers and help improve standard of UTI diagnostic accuracy by clinicians, hence allowing for appropriate antibiotic therapy. Any male patient found to have urinary tract infection was treated at the Centre.

1.5 Research Questions

i. What is the prevalence of urinary tract infections caused by enteric bacteria in symptomatic males visiting special treatment center?

ii. What are the enteric bacteria causing urinary tract infections in symptomatic male patients visiting special treatment center?

iii. What is the antibiotic sensitivity pattern of the isolated bacteria causing Urinary Tract Infections among symptomatic male patients visiting special treatment center?
1.5 Broad Objectives

1.5.1 General Objectives

To determine Urinary Tract Infections caused by enteric bacteria and antibiotic sensitivity among symptomatic male patients visiting special treatment center (STC), in Nairobi, Kenya

1.5.1 Specific Objectives

i. To determine the prevalence of urinary tract infections caused by enteric bacteria among symptomatic men visiting special treatment center.

ii. To characterize the causative bacteria of the urinary tract infections among symptomatic men visiting special treatment center

iii. To determine the antibiotic sensitivity pattern of the identified bacteria
CHAPTER TWO: LITERATURE REVIEW

2.1 Overview on Urinary Tract Infection

Bacteria commonly cause urinary tract infections when the bacteria enter the urinary tract (foxman, 2010). In most cases, the host defense system removes the bacteria before they can cause any symptoms (Ana, 2015). However, due to some underlying conditions, the body is not able to fight off the bacteria and an infection occurs. Urethritis occurs when the urethra is inflamed, if the bladder is inflamed, cystitis occurs and if the kidney tissue is inflamed, pyelonephritis occurs (Najar, 2009).

Urinary tract infections can be grouped as either uncomplicated (acute) or complicated. Uncomplicated UTIs will occur in people who are healthy with no anatomical or nervous urinary tract anomalies. Male urinary tract infections apart from infants and elderly infections are not considered normal and require urological investigations (Ana, 2015). Men experience UTI infrequently due to the anatomical distance between the anus and urethral meatus and also because of a longer urethra as compared to women. A drier perimeatal environment in men and prostatic secretions also aid in some antibacterial activity (Brusch, 2017).

2.2 Epidemiology

Infections occurring in the urinary tract are ranked highest among bacterial infection managed by the outpatient care setting (WHO, 2018). When presented with these infections, clinicians prescribe antibiotic empirically (Lee, 2015). These infections have caused a huge public health concern globally because of the rising health care cost burden as a result of the antibiotic management.
It is reported that one hundred and fifty million people are affected worldwide each year by urinary tract infections (Flores-Mireles 2014). Frequent agents identified to cause UTI include; *Enterobactericeae coli*, *Klebsiella Pneumoniae*, *Proteus Mirabilis*, *Enterococcus Faecalis* and *Staphylococcus Saprophyticus* (Flores-Mireles, 2014).

The enteric bacterium *E. coli* is documented as the reason for more than 80% of uncomplicated community-acquired UTI (UPEC) (Pabich, 2003). These bacteria normally inhabit the lower intestines as normal flora but when they enter the urinary tract, they form the basis for a UTI (Barber, 2013). Other pathogens commonly associated include; *Staphylococcus saprophyticus*, *Klebsiella* species, *Proteus mirabilis*, and *Enterococcus faecalis*. Complicated UTIs caused by bacteria such as *Neisseria gonorrhea* and *Chlamydia trachomatis* are associated with compromise in the urinary tract or host defense including; urinary blockade, urinary retention caused by nervous disorders, low immunity, kidney failure, kidney transplantation, and gravidity (Flores-Mireles, 2014).

Young men hardly develop UTIs, and the occurrence of bacteruria is 0.1% or less. Mostly, symptomatic dysuria and urinary frequency are often due to sexually transmitted disease (STD)–related infections of the urethra (McBride, 2010). It is reported that the incidence of true UTI in young adult males estimated to be 5-8 per year per 10,000 persons. The frequency of UTI is more in neonates and normally termed as gram negative neonatal sepsis. During the first 10 years of a boy’s life, symptomatic UTI has been reported at 1.1-1.6% (Brusch, 2017).
2.3 Classification of UTI

2.3.1 Uncomplicated UTI (cystitis)

Uncomplicated UTI occurs when the urinary tract is invaded both structurally and functionally by a nonresident infectious organism (Mc Lellan, 2016). Urological abnormalities are associated with male infections which mostly occur in infants and the elderly, making most male UTI’s to be considered complicated (Grabe, 2013). However, acute UTI can occur in men, especially homosexuals, uncircumcised males and those with infected partners (schneede, 2003).

2.3.2 Uncomplicated Pyelonephritis

Uncomplicated pyelonephritis can be a simple urinary tract infection which can be diagnosed by simplified clinical and laboratory procedures. It can also be a severe infection where the kidney parenchyma is involved and specific imaging materials are required for proper diagnosis (Najar, 2009). Most men complain of nausea, vomiting, flank pain, fever (>38°C), and it can occur without symptoms of cystitis (Nieuwkoop, 2017).

2.3.3 Complicated UTI

Complicated UTI occurs when structural, metabolic or functional abnormality in the urinary tract is exist (Brusch, 2017). Structural abnormality occurs when there is a bladder abscess, spinal cord injury and catheters. Metabolic abnormalities which are also hormonal abnormalities include uncontrolled diabetes. Functional abnormalities include impaired host responses such as in patients who have had renal transplant and AIDS patients (Nieuwkoop, 2017).
All UTI’s in men should be considered as complicated, since the majority occurs in infants or the elderly who have urologic abnormalities, that include, bladder outlet obstruction like in prostatic hyperplasia or catheterization (Bergamin, 2017).

2.3.4 Epididymitis and Orchitis

Epididymitis occurs when the epididymis is inflamed. When there is pain and swelling in the testicles that occurs on only one side and is acute onset, it is called epididymo-orchitis (Van Aarle s, 2013). Generally epididymitis in men of 14-35 years is usually caused by E. coli (Trojian, 2009). Most homosexuals have E.coli being the common uropathogens although Haemophilus influenza has also been associated among others including; Ureaplasma urealyticum, Klebsiella pneumoniae, Proteus mirabilis and Pseudomonas aeruginosa. Those at high risk must also be considered for epididymitis due to Mycobacterium tuberculosis infection though this is rare (Al-mohizea, 2014).

Sexually transmitted infections are usually the main cause of Epididymo-orchitis in the younger males, but in the older men bacterial infections causing UTI’s are the main cause (Harper, 2007). Catheterization, surgery or recent urological manipulations are usually associated with the inflamed epididymis, which usually occurs after some time (Al-mohizea, 2014)

2.3.5 Sepsis Syndrome in Urology (Urosepsis)

Urinary tract infections account for only 5% of sepsis in reported literature, 50% of the sepsis is related to pulmonary infections and 24% to abdominal infections. Men account for more sepsis syndrome than women (Van Aarle s, 2013). Diagnosis depends on clinical evidence of infection, which appear together with signs of systemic inflammation (Wagenlehner, 2008).
2.4 Frequently Isolated Causative Organisms

Enterobacteriaceae is among the family of bacteria that causes UTI with *E. coli* occurring the most. Depending on some underlying conditions non-fermenters like *Acinetobacter, P. aeruginosa* and gram-positive cocci like *S. aureus, S. saprophyticus* and *E. faecalis* also causes urinary tract infection (Van Aarles, 2013).

2.4.1. *Escherichia coli*

Over eighty percent of all acute UTI’s are caused by *E coli* infection (Najar, 2009. The recurrence rate of *E. coli* is cited to be 44% in all UTI infections (Totsika, 2012). The distinctive extra intestinal pathogenic *E. coli* (ExPEC) is usually the bacteria that is known to cause UTI but how it colonizes an individual is unknown. Although it is known that the immediate source is host’s own fecal or vaginal flora (Pabich, 2003). These uropathogenic strains (UPEC) are different from those strains that are found in the gastro intestinal tract, because they can evade the immune system of the host better and have mechanisms to attach to the urinary tract (Valerie ,2018). The bacteria cause uncomplicated urethritis, cystitis, symptomatic cystitis, urosepsis, prostatic abscess and pyelonephritis (Grabe, 2013). There are two possible ways that *E. coli* can infect an individual; *E. coli* can trigger an ascending infection by introducing the microorganism into the urethra from faecal matter causing an infection that can disseminate to infect the kidney and other urinary tract parts or it can cause a descending infection where the microorganisms enter the urinary tract system from blood (Najar, 2009).

2.4.2. *Klebsiella pneumoniae*

It is the second pathogen, after *E. coli* to cause urinary tract infection affecting persons with low immunity (Behzadi, 2010). It has challenged antibiotic therapy by producing carbapenemese producing bacteria which has a high resistance level to all beta lactams
antibiotics (Totsika, 2012). Similarly to UPEC, *K. pneumoniae* uses biofilm formation and bladder colonization to cause UTI (Rosen, 2008). This bacterium uses an adhesin similar to the one used by UPEC called TYPE 1 fimbrial adhesin but has different binding specificities (Flores-Mireles, 2014).

### 2.4.3 *Proteus mirabilis*

It is among the bacteria that causes urinary tract infections but not as frequent as *E. coli*. After the first attachment, *P. mirabilis* produces mannose-resistant Proteus-like (MR/P) pili, which are Chaperon-Usher Pathway pili that aid in catheter-associated biofilm formation which precipitates colonization of the kidneys and bladder (Nielubowicz, 2018).

### 2.4.4 *Staphylococcus saprophyticus*

*Staphylococcus saprophyticus*, causes community acquired UTI. Just like *E. coli* it has some virulence properties that inhibit it from detection by the immunity system of the host. The virulence properties include inhibition of growth of other bacteria by producing urease enzyme, haemagglutination and attachment to human uroepithelial cells (Noor, 2013).

### 2.5 Risk factors associated with UTI

#### 2.5.1 Age

The risk of UTI in men rises with the increase in age. The occurrence of a urinary tract infection will occur more during the first few months of life (Anuli 2016). Urinary Tract Infection in young adult males of less than 50 is rare but rises thereafter. This is because of factors such as enlarged prostate, loss of prostatic fluid and kidney stones.
Enlarged prostate gland hinders and slows the flow of urine escalating the risk of infection (Anuli, 2016).

2.5.2 Circumcision

Circumcision is a common practice worldwide and is one of the commonest surgical procedures practiced. As much as the practice is carried out due to cultural and religious belief it has been documented that it protects men from acquiring UTI (Morris, 2016). Men who are not circumcised tend to develop UTI especially if their personal hygiene is not good. Bacteria usually build up at the foreskin, and later on ascend causing urinary tract infection (Schmiemann, 2010).

Several studies conducted among uncircumcised boys and men swabbed before circumcision identified *E. coli*, *Proteus spp.* and *K. pneumonia* as the most frequent agent and *S. aureus* as the least prevalent. The Gram negatives are documented to be higher in occurrence than the gram positives (Krieger and Morris, 2017).

2.5.3 Alterations to the host’s defense mechanism

Patients diagnosed with type 2 diabetes mellitus are predisposed to UTI than the general population. It is usually more severe with a worse outcome than patients without. More often the UTI is triggered by resistant strains of pathogen. This is due to the immune system being impaired, poor metabolic control and bladder dysfunction (Nielubowiz and Mobley, 2010). Kidney stones also lead to Urinary tract obstruction causing acute pyelonephritis. When urine outflow obstruction occurs, there is a possibility of incomplete emptying and urinary stasis which causes bacteria to multiply without being flushed out leading to UTI (Belyayeva, 2019).
Vesico-ureteral reflux a congenital, anatomical and functional disorder has been implicated to cause a high morbidity especially in young children. It occurs when there is a backward flow of urine from the bladder to the kidney. This facilitates movement of the bacteria from the lower urinary tract gain access to the upper urinary tract causing UTI (Duane, 2016).

Human Immunodeficiency Virus is pandemic among people of all age groups, ethnic groups, economic groups, marital groups. However, the youth who are sexually active are the ones mostly affected. Urinary tract infections usually become an opportunistic infection among people living with HIV because of the weakened immune system (schneede, 2003).

2.5.4 Sexual behavior

Insertive anal intercourse was believed to occur only in males who had sex with males, currently the practice is becoming rampant even heterosexual men and women (McBride, 2010). Strain sharing of E. coli strains from one person to another has always been associated with anal intercourse (Noor,2013). A study conducted on a homosexual man who had experienced refractory urinary tract infection (UTI), indicated the same strain of extraintestinal pathogenic Escherichia coli O1/O2; K1:H7 to be genetically identical to the strain that was found in his male sex partner’s fecal isolate. This is an indication that some UTI can be sexually transmitted (Johnstone ,2002).

2.6 Antibiotic Resistance pattern.

Widespread emergence of antibiotic resistance mechanisms is evident globally (Foxman, 2014,Harper, 2007,Kaslakioti,2012). This trend is undermining many other advances in health and medicine (WHO, 2015). The rising cases of drug resistance are
as a result of inappropriate use of antibiotics among other associated factors such as poor adherence to infection prevention and control measures. Such practices have been cited to cause unnecessary use of antimicrobials (Seifu, 2018,WHO ,2015). The initial choice of treating UTI in areas where antibiotic resistance is a problem are fluoroquinolone due to the high cure rates and low resistance rate (schneede, 2003). These drugs exhibit a high antibacterial success rates at the same time possessing low resistance to common uropathogens (Betsy, 2010). Due to multidrug resistance concerns, treatment with broad spectrum antibiotics instead of narrow spectrum is now preferred (Brusch, 2017).

Resistance seen in *E. coli* and *K. pneumoniae* explained in literature, is caused by developed plasmids encoding extended-spectrum β-lactamases (ESBLs) which quickly spreads to cause resistance to third-generation cephalosporins (Chen,2013,Gupta, 2014) Other bacteria produce the class C β-lactamases (AmpC enzymes) that are active against cephamycin in addition to third-generation cephalosporins (Gupta ,2014). Horizontal gene transfer or transfer via plasmids is documented to be the most common way that bacteria obtain resistance to many different antibiotics which therefore means that using a single antibiotic, can bring about resistance to many other antibiotics (Foxman, 2014).

Prior and prolonged use of a particular antibiotic is just one of the risk factors for antimicrobial resistance. Initially, antibiotic resistance gives a ‘fitness cost’ on a microorganism inducing a reduced growth rate, when the inhibiting antibiotic has been removed from the environment, the bacterium gets back to being sensitive to that antibiotic again. Many studies have shown that this hardly occurs because bacteria appear to speedily develop ways to fight back for any “fitness costs” brought about by
the resistance (Totsika, 2012). A study done in Sweden showed resistance to trimethoprim-containing drugs, antibiotics used to treat UTI’s in individuals with *E. coli* ended after limiting their use for 24 months (Sundqvist, 2010).

A major challenge is the development of *E. coli* that has got extended spectrum of beta lactamase enzyme brings about resistance to monobactams, penicillin and third - generation cephalosporin (DeBusscher,2009). This is congruent with a study done in one of the hospitals in Gaza by Elmanama, 2018, the results revealed a high number of Gram-negative bacterial isolates that were resistant to amoxicillin/clavulanic acid and piperacillin. The Gram-positive bacterial isolates also exhibited resistance to vancomycin and piperacillin. Overall, 99.5% and 92.3% of the Gram negative and Gram-positive isolates respectively showed multidrug resistant varyingly. Similarly, a study conducted in Bangladesh by Noor, 2013 depicted the highest resistance against ampicillin (98.5%). In that study, the most isolated pathogen was *E. coli* (70% ). This posed a challenge to the management of UTI.

Most African countries are struggling with resistance to antibiotic therapy in men with UTI. In Ethiopia, *E. coli* (50%) was implicated both ambulatory care and inpatients. The study further revealed *E. coli* and *K. pneumoniae* to be 100% resistant to Amoxicillin. The study concluded that resistance of the isolates to common antibiotics disadvantages the clinicians due to the narrowed choice of drugs in empirical treatment of UTI (Bayene, 2011).

Kenya is grappling with antibiotic resistance although not much has been documented on the same. The management of UTI is normally done empirically since most hospitals do not carry out culture and sensitivity as recommended, largely due to poorly equipped
laboratories in most hospitals. Few studies done before confirm that resistance to common antibiotics is a major challenge. A retrospective study done at Aga Kahn University Hospital in Nairobi in 2012 revealed that up to 70% of the *E. coli* was resistant to Septrin and Augmentin. Resistance to Nalidixic acid was also reported to be quiet high in non-*E. coli* organisms. The study recommended that Ampicillin and Cotrimoxazole (Septrin) should not be the first line of empirical treatment because resistance was found to be pretty high (35-52 %) (Okinda, 2012).

2.7 Emerging Therapies

Urinary tract infections cause serious economic and public health burden affecting the quality of life of the affected persons (Kaslakioti, 2012). Drugs such as Trimethoprim sulfamethoxazole, Ciprofloxacin and Ampicillin have long been used as the drugs of choice for UTI (foxman, 2010). However, the increasing rates of prevalence in UTI and the rising cases of antibiotic resistance is causing economic burden to the healthcare system (Gupta, 2014).

To address the challenge of resistance, scientists need to develop alternative therapy that will help in curbing this trend. Various methodologies to developing alternative therapy range from basically analyzing UTI pathogenesis to targeting bacteria virulence pathways. These alternative pathways will supposedly allow effective neutralization of the ability of the bacteria to result to disease, without disturbing the gastro intestinal system normal flora (Zhanel, 2005).

Under development are new antibiotics that will be resistant to inactivation by extended-spectrum β-lactamases (ESBLs), to be used together with β-lactamase inhibitors that target both β-lactamases and *K. Pneumoniae* carbapenemases (KPCs)
These combined therapies are known to be active \textit{in vitro} against carbapenem-resistant members of the family Enterobacteriaceae. A clinical trial on complicated UTI revealed that ceftazidime, a third-generation cephalosporin when combined with the \(\beta\)-lactamase inhibitor avibactam, becomes effective against extended-spectrum \(\beta\)-lactamases (ESBL) and carbapenemase-producing Gram-negative bacteria (Zhanel, 2013).

Further research to evaluate the effectiveness of ceftazidime–avibactam against ESBL, carbapenamases and Amp C-producing gram-negative pathogens is needed. It is documented that drug combination boosts effectiveness against a broad range of cephalosporin-resistant Enterobacteriaceae. Resistance to \(\beta\)-lactamase inhibitors is not well classified as such, posing a challenge to these antibiotic–inhibitor combinations which are thought to be promising (Zhanel, 2013). Moreover, the effectiveness of some particular antibiotic–inhibitor therapies are dependent on the resistance characteristics encoded by each bacterium.

The expression of ESBLs and carbapenemase combinations is cited to enhance resistance to antibiotic–inhibitor therapy (Bouchillon, 2012). For instance; the combination of BAL30072-BAL29880–clavulanate (two \(\beta\)-lactam antibiotics and a \(\beta\)-lactamase inhibitor) is known to be effective against many carbapenem-resistant Enterobacteriaceae. It is imperative to know the antibiotic resistance mechanisms of commonly used antibiotics in order to determine an effective treatment. That is an intervention that will curtail the development of multidrug resistance (Flores-Mireles, 2014).
2.8 Diagnosis

When diagnosing a urinary tract infection, there should be presence of both the pathogen and clinical manifestation (Schmiemann, 2010). Using morning midstream urine, the bacteria is identified by urine culture. This test allows an estimation of the bacteria. Many laboratories use bacteria of more than $10^5$ (cfu)/mL colony forming units as the threshold (Schmiemann, 2010). However, it is noted that this threshold leaves out relevant infections. Unlike women, a single detection of bacteruria of more than $10^5$ (cfu)/mL in men is usually sufficient to make a diagnosis of UTI.

Testing with dip sticks is not very precise in males, urine culture is recommended for confirmation of the diagnosis because UTI in men is mostly categorized as complicated infections (Kang, 2018). Unfortunately, this is never done due to factors such as economic and time issues among others (Kang, 2018). The process of urine culture should be contamination free. Many studies have emphasized on the necessity of collecting midstream urine with prior cleaning of the perineum and vulva or glans of the penis (Schmiemann, 2010). These procedures greatly reduce the level of contaminants and ensure relatively accurate results. It is however dependent on factors beyond the control of researcher because it depends on the compliance of the patient.

2.9 Sexually Transmitted Infections compared to Urinary Tract Infections.

The diagnosis to differentiate STI from a UTI can be difficult because both present with similar symptoms. The symptomatic presentations include complaints of urgency, frequency, dysuria, pelvic pain and unusual discharge are similar in nature (Tomas, 2015). The results of a urinalysis might also present overlapping abnormalities, such as a positive leucocyte, and cloudy or dark urine.
According to the American Society for Microbiology, 64 percent of patients with STIs are diagnosed as having UTIs, this is because they share similar risk factors, such as recent sexual contact, and therefore these infections might frequently coexist. However, research done by Huppert et al., showed STI and UTI to be independent entities (Huppert, 2007). Misdiagnosis may cause an undiagnosed STI to develop into a more serious disease (Lisa, 2016). Additionally, STIs normally present with symptoms such as fever, genital ulcers and/or rashes, joint pains among others.

2.10. National guidelines on UTI treatment

After a midstream urine sample is found positive for leucocytes, proteins and nitrite, it should be taken for culture and sensitivity before any antibiotic is prescribed. After the antibiotic sensitivity results are out, review the best drug of choice. The clinician can change the antibiotic given if symptoms are not improving but using a narrow spectrum drug as much as possible following the susceptibility results (NICE GUIDELINE 2018) (NICE GUIDELINE, 2018).

The recommended antibiotic for men according to the NICE guidelines who are 16 years and above is trimethoprim as the first choice, 200mg give twice a day for one week or Nitrofurantoin 100 mg for a week while considering the previous results obtained from cultures and antibiotic susceptibility tests and the previous antibiotic the male patient was taking. Nitrofurantoin should also not be given to patients whose prostate is affected because it’s not likely to reach the therapeutics levels in that organ. For those male pa
tients under 16 years, trimethoprim is still recommended but it should be given depending on the month of the baby and the weight; 3-5 months can be prescribed a maximum of 200mg per dose or 25Mg twice a day for 3 days, 6 months to 5 years can take 4mg per kilogram and a maximum of 200mg per dose or 50mg two times a day for three days, six months to five years can take the same but they should take 100mg two times a day for 5 days. Twelve to fifteen years, may take cephalexin or Amoxicillin only when the antibiotic susceptibility results are out (Nice Guidelines, 2018).
CHAPTER THREE: MATERIALS AND METHODS

3.1 Study Area

Special Treatment Centre (STC) in Nairobi City County also known as “casino” due to its closeness to a local casino was chosen as the study area. It is a public health facility providing outpatient services, and mainly known for treating sexually transmitted infections, with a well-equipped laboratory. The center is found in Kariokor sub county, Starehe Constituency Nairobi County situated at longitudes 36°45’ East and latitudes 1°18’ South and has a total area of 696.1 Km² lying at an altitude of 1,798 meters above sea level. (Appendix III). The population is 3,138,369, consisting of 1,605,230 men and 1,533,139 females (County Government of Nairobi City, 2018). The study area was chosen because of the high patient volume as it although serves the neighboring sub counties namely; Westlands, Dagoretti and Kamukunji Sub County (Appendix I).

3.2 Study Design

A cross sectional research design was utilized involving one-time sampling of urine specimen from the male patients visiting STC and who were presenting with symptomatic urinary tract infection during the study period (February-May 2018).

3.3 Study Population

The study population consisted of all male patients attending STC with urinary tract infections symptoms (fever, dysuria, frequency and urgency) during the study period.
3.4 Sample Size Determination

Fisher et al., (1993) formula for sample size determination was used. Due to the unavailability of information on the prevalence of UTI among men in Kenya, the study used a prevalence of 50%. The sample size was determined as follows:

\[
n = \frac{z^2pq}{d^2}
\]

\[Z = 1.96\] standard error for 95% confidence;
\[d = 0.05\] the inverse of 95% confidence limit

\[P = \text{postulated prevalence of group that have the condition of interest which is 50\% (the most conservative estimate)} = 0.5
\]
\[q = 1 - p
\]
\[N = \frac{1.96^2 \times 0.5 \times 0.5}{0.05^2} = 384\text{samples}
\]

The desired sample size was 384.

3.5 Sampling Technique.

From the hospital records in STC, it was estimated that 470 male patients visited the outpatient clinic each month in the year 2017, in three months 1410 patients had visited the clinic. Systematic random sampling technique was used to draw the respondents. In systematic sampling, every \(K^{th}\) case in a target population is chosen for inclusion in the sample starting with a randomly chosen element between 1 and \(k\). Therefore, \(K = \frac{N}{n} = \frac{1410}{384} = 4\). Every fourth patient who consented to participate was recruited within a period of three months (February-May 2018).
3.6 Sample Collection

According to the procedure of Frank, 2018, the participants were given instructions on how to collect midstream urine: to clean the head of the penis with a sterile wipe, if uncircumcised, to retract the foreskin first. Let the first flush of urine go into the toilet, then put the polypot under the stream and remove when it is almost full. Finish urinating into the toilet (Frank, 2018).

A sterile universal bottle was used to aseptically collect twenty milliliters of clean catch morning mid-stream urine from the male participants. Proper labeling was done with the patient’s lab number and time of collection properly shown on the sample. Analyzing of the sample was done in less than 6 hours after the sample is brought to the laboratory.

3.6.1. Inclusion Criteria

Male patients who reported symptoms such as fever, dysuria, frequency, urgency and suprapubic pain were included into the study.

Any male patient who had not taken an antibiotic in the last two weeks

All patients who consented to participate.

3.6.2 Exclusion Criteria

Any male Patients with a week’s history of hospital admission to rule out hospital-acquired infections.

Any male patient on or had taken antibiotics in the last two weeks.
3.7 Laboratory procedures

3.7.1 Urine Dipstick

Urine analysis was carried out by first pouring urine on the urinalysis multi stick making sure that the urine covers all the parameters, following Chernecky et al., 2008. It was tapped from the side to remove excess urine, and the color changes noted while comparing it to the color chart provided. Color change on leukocytes, proteins and nitrites parameters were distinguished and the urine cultured.

3.7.1.1 Protein strip test

Immediately after collection of urine, a urine sample was poured in the strip to detect proteins according to Ames-Bayer’s procedure. In the presence of protein, the protein band changed color from yellow to olive green in line with the concentration of protein in the sample this is because the strip is infused with tetra bromophenol indicator. Samples with protein range 0.3g/l and above were taken for culture and sensitivity as they were considered positive for Urinary Tract infections.

3.7.1.2 Nitrite strip test

Examination of nitrites on the strip depends on the bacterial action in urine; converting nitrate to nitrite. After urine is collected, it is poured on the urine strip. Making sure it touches all the parameters. Nitrite is not detectable in normal urine, but in the presence of a bacteria, the nitrite reacts with P-arsanilic acid to form a diazonium compound, which then combines with 1N-(1-naphthyl) ethylenediamine to produce a pink color on the strip (Spicer, 2000).
3.7.1.3 Leucocyte strip test

With the occurrence of granulocyte esterases in urine positive of UTI, derivitized pyrazol ester is broken down to give derivitized hydroxyl pyrazole. The pyrazole then reacts with diazonium salt which produces a pink-red color on the strip. The urine is poured on the strip one after the other using the procedure of Greenwood et al., (1997). Leucocytes as low as 9-15 white blood cells in urine can be detected.

3.7.2 Microbial Culture Method

This procedure used a sterile 4.0 mm wire loop to inoculate about 0.001 mL of the urine. Cysteine-Lactose-Electrolyte Deficient (CLED) agar and blood agar medium were prepared according to the procedure attached in appendix VII and used for culture. Streaking on the media plates was done following the streak plate method shown to ensure single colony culturing.

Figure 3.1: Streaking technique
The cultured plates were incubated at 37°C for 24h and for 48h in cases where growth was not obtained. The isolated bacteria were multiplied by 1000 to estimate bacterial load/mL of the urine sample. A urine sample was considered UTI positive if it had a colony count of more than $10^4$ CFU/ml of single bacterium.

### 3.7.3 Identification of Pure Bacterial Isolates

#### 3.7.3.1 Gram stain

This investigation was used to segregate gram positive organisms from gram negative organisms. Urine was centrifuged at 2000 rpm for 2 minutes and the deposit used to make bacterial culture smears on a clean slide. They were then placed on a staining rack; heat fixed then flooded with crystal violet and allowed to stand for 30 seconds. The slide was then rinsed with water for 5 seconds and then covered with iodine. They were allowed to stand for 1 minute and then rinsed with water. Decolourization was done using 95% ethanol for 15 seconds, followed by rinsing with water. Neutral red was then used as a counter stain. It was flooded for about 60 seconds and the slides rinsed with water and blot dried using a filter paper. Examination was done under a microscope at x100 under oil immersion (Cheesbrough, 2006).

#### 3.7.3.2 Catalase Test

This test was used to differentiate *Staphylococcus* from *Streptococcus*. On a clean microscope slide, drop approximately 2 drops using Pasteur pipette of 3% hydrogen peroxide. A sterile wire loop was used to pick a single pure colony from both CLED and blood agar. The suspected bacteria were placed on the 3% hydrogen peroxide. Evolution of oxygen bubble was observed for a positive sample (WHO, 2014).
3.7.3.3 Coagulase Test

It differentiated coagulase producing bacteria *Staphylococcus* from non-coagulase producing bacteria *Streptococcus*. Anticoagulated (EDTA) human plasma was allowed to warm to room temperature. Plasma (0.2ml) was placed into test tubes; 0.8 ml of test broth culture was added into each test tube. After mixing, they were incubated at 37\(^{0}\)C. Examinations were done after 1 hour, and if there was no clotting, examination was done again after 3hrs. If still there was no clotting, the tests were left at room temperature overnight and examined again the next day (Cheesbrough, 2006).

3.7.3.4 Novobiocin Susceptibility Test

This was a test performed on colonies that were catalase positive, coagulase negative, gram positive cocci; to confirm presence of *Staphylococcus saprophyticus*. The colonies were picked from blood agar to avoid getting false positive results (Karsten, 2014).

Using a pure 18-24-hour culture, a suspension of the organism was prepared; equivalent to a McFarland 0.5 opacity standard; to be identified in tryptic soy broth.

On Mueller Hinton Agar, the bacteria were inoculated using a sterile swab to get confluent growth, prepared (Appendix VIII). The 5ug novobiocin disk was aseptically applied onto the inoculated agar surface and lightly pressed down to ensure full contact with the medium. The plate was aerobically incubated for 18 to 24 hours at 37\(^{0}\)C. The diameter of the zone of inhibition around the novobiocin disk was measured (in millimeters) and recorded as susceptible or resistant.

Resistant – zone size of < 12 mm and sensitive zone were greater than 16mm.
3.7.3.5 Indole, Methyl Red, Voges proskauer and Citrate Utilization Test

These set of tests were used to differentiate members of the family *Enterobacteriaceae*. Indole test determines the presence or absence of the tryptophanase enzyme which breaks down tryptophan broth. Kovac’s reagent was added to the tryptone broth and if indole is present then a red coloration forms at the top (Cheesbrough, 2006).

A MR-VP broth was used to look for mixed acid and butanediol fermenters in the test organisms. One tube was used for each test. Half of the broth, once incubated, was removed and placed into a different tube. Methyl red was added to one tube to see if the pH is neutral (yellow). Barritt’s solution (alphahapthol and potassium hydroxide) was added to the other tube to test the Butanediol fermenters and if the bacteria are butanediol fermenters then the broth turns red (Cheesbrough, 2006).

Citrate utilization test was used to detect the presence of bacteria that utilize citrate as the sole source of carbon. Simon citrate medium was put in bijou bottles in a slant position to prepare slopes. A straight wire was sterilized, and then the slant streaked after the test organism was suspended in normal saline and the butt stabbed. Incubation was done at 35° C for 48 hours. Change in colour of the medium to bright blue was considered for presence UTI (Cheesbrough, 2006).

3.7.3.6 Oxidase test

It was used to determine if a bacterium is producing the enzyme cytochrome c oxidases. When a colony of the test organisms was smeared onto a reagent strip that had phynylendiamine; it was oxidized to give a purple colour by oxidase positive organisms (Cheesbrough, 2006).
3.7.3.7 Urease test

It’s a test for identifying urease producing bacteria, which breaks down urea, to give ammonia and carbon dioxide through hydrolysis. The ammonia released changes the media to alkaline, changing the colour of the indicator to pink red (Brown and Smith, 2014).

Christensen’s modified urea broth (Appendix VIII) was put in a bijou bottle and a dense suspension of the test bacteria inoculated. It was then incubated at 35°C for 12 hrs. Pink coloration was considered positive for urease (Cheesbrough, 2006).

3.7.3.8 Triple Sugar Iron

This was a test used for identifying gram negative bacteria. Triple sugar iron has sucrose concentration 1% and glucose 0.1%. Different bacteria ferment these sugars differently to either produce CO₂ which produces cracks in the agar or ferrous ammonium sulphate to produce black precipitate. If glucose only is fermented the butt becomes yellow and if lactose and sucrose are fermented it becomes yellow all over (Appendix VI).

A colony of the bacteria was stabbed onto TSI media up to the butt, and then streaked back and forth on the slant, and then incubated for 18hrs at 37°C.

The results were interpreted using the following table;
Table 3.1: Interpretation of TSI

<table>
<thead>
<tr>
<th>Organism</th>
<th>Slant</th>
<th>Butt</th>
<th>gas</th>
<th>H2S</th>
</tr>
</thead>
<tbody>
<tr>
<td>E.Coli,</td>
<td>Acid(A)</td>
<td>Acid(A)</td>
<td>Pos(+)</td>
<td>Neg (-)</td>
</tr>
<tr>
<td>K.pneumoniae</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P. Mirabilis</td>
<td>Alkaline(K)</td>
<td>Acid(A)</td>
<td>Pos(+)</td>
<td>Pos(+)</td>
</tr>
<tr>
<td>P.aeuroginosa</td>
<td>Alkaline(K)</td>
<td>Alkaline(K)</td>
<td>Neg(-)</td>
<td>Neg (-)</td>
</tr>
</tbody>
</table>

3.7.4 Antibiotic Susceptibility Testing

An antibiotic susceptibility test was carried out on culture plates. Mueller-Hinton agar (Oxide, Hampshire, England) following the Kirby-Bauer disk diffusion method (Bauer, 1996) Turbidity standard equivalent to McFarland 0.5 was prepared. 1.1% v/v solution of sulphuric and 1% v/v solution of barium chloride was prepared. Then 0.6 ml of the prepared barium chloride was added to 99.4ml of the sulphuric acid solution and mixed. Turbidity shown by the inoculums was adjusted to match that of the standards. Single isolated colonies were identified and transferred to this tube while adjusting the turbity until they match. Using a sterile cotton swab dipped in this suspension, streaking was completed on Muller Hinton culture plate, ensuring even spread of the bacteria (Cheesbrough, 2006) (Appendix VII).
After the agar dried, sterile forceps was used to place the antibiotic disks of different concentrations on the culture plates. To warrant maximum contact, the disc was gently pressed on the agar followed by incubation at 37°C for 24 hours. The zones of inhibition diameters for each antibiotic was then measured using a ruler and recorded in millimeters. *E. coli* ATCC 25922, *P. auroginosa* ATCC 27853, *S. aureus* ATCC 29123, were used as standard strains. The interpretation was done according guidelines provided.

**Table 3.2: CLSI Guidelines on Zones of Inhibition**

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>Resistant</th>
<th>Sensitive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ofloxacin 30ug</td>
<td>≤12</td>
<td>≥16</td>
</tr>
<tr>
<td>Nitrofurantoin 200ug</td>
<td>≤14</td>
<td>≥17</td>
</tr>
<tr>
<td>Cefaclor 30ug</td>
<td>≤14</td>
<td>≥18</td>
</tr>
<tr>
<td>Nalidixic acid 30ug</td>
<td>≤13</td>
<td>≥19</td>
</tr>
<tr>
<td>Augmentine 30ug</td>
<td>≤13</td>
<td>≥19</td>
</tr>
<tr>
<td>Cefuroxime 30ug</td>
<td>≤14</td>
<td>≥18</td>
</tr>
<tr>
<td>Minocycline 30ug</td>
<td>≤12</td>
<td>≥16</td>
</tr>
<tr>
<td>Ciprofloxacin 5ug</td>
<td>≤15</td>
<td>≥21</td>
</tr>
</tbody>
</table>
3.8 Ethical Approval

Ethical clearance (PKU654/1734) (Appendix III) to carry out the study was pursued from Kenyatta University Ethical Review Committee. Participation was voluntary with informed consent obtained from the participants. Samples and data collected were stored appropriately. Anonymity and confidentiality of the samples were identified using codes rather than patient name. Authorization to run the research was gotten from Nairobi City, health services (Appendix V). There was no language barrier since the researcher understood Kiswahili language spoken by the patients.

3.9 Data Analysis

Data attained was coded and entered into the computer using Statistical Package for Social Science version 23 for analysis. Both descriptive and inferential statistical analyses were done and data presented in percentages, tables and charts.
CHAPTER FOUR: RESULTS

4.1 Prevalence of UTI among male patients visiting STC, Nairobi

Out of the 384 samples collected, 252 positive cases of bacteria were isolated. The overall prevalence of UTI indicated by a positive urine culture among the participants in the study was 65.6%. It was calculated based on the proportion of male participants with positive urine culture during the period of data collection.

Table 4.1: Prevalence of UTI among male participants visiting STC

<table>
<thead>
<tr>
<th></th>
<th>No. of men with UTI</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>252</td>
<td>65.6%</td>
</tr>
<tr>
<td>Negative</td>
<td>132</td>
<td>34.4%</td>
</tr>
<tr>
<td>Total (N)</td>
<td>384</td>
<td>100%</td>
</tr>
</tbody>
</table>

Point Prevalence = O/N * 100,
O = the sum of individuals with positive case of UTI
N = Total sum of patients involved in the study at the study period.
4.1.2 Age distribution of male participants with UTI.

The findings showed that majority of the male participants, 118 (46.8%) with UTI were aged between 20-29 years. Children between the ages of 0-9 accounted for 21% of the total study participants with UTI. The least frequent age with UTI was men aged 50 years and above 3.2 %.

**Table 4.2:** Age distribution of male participants with UTI

<table>
<thead>
<tr>
<th>Age</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-9 years</td>
<td>53</td>
<td>21.0</td>
</tr>
<tr>
<td>10-19 years</td>
<td>26</td>
<td>10.3</td>
</tr>
<tr>
<td>20-29 years</td>
<td>118</td>
<td>46.8</td>
</tr>
<tr>
<td>30-39 years</td>
<td>29</td>
<td>11.5</td>
</tr>
<tr>
<td>40-49 years</td>
<td>18</td>
<td>7.1</td>
</tr>
<tr>
<td>50-59 years</td>
<td>4</td>
<td>1.6</td>
</tr>
<tr>
<td>Above 59 years</td>
<td>4</td>
<td>1.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>252</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

4.2 Bacteria Isolated among the Males Visiting STC, Nairobi

Gram-negative *E. coli, K. pneumonia, P. mirabilis, P. aeruginosa* and Gram-positive *S. saprophyticus* and *S. aureus* were isolated during the study period.

Identification of the bacteria started by grouping the bacteria into lactose fermenters and non-lactose fermenters by observing the colonies. The Lactose fermenters changed the colour of CLED media to yellow. Gram staining was then done to group the isolates into different groups depending on their staining abilities.
Biochemical tests were then carried out to isolate specific bacteria organisms. *Escherichia coli* changed the colour of the medium to yellow to confirm lactose fermentation. The Gram stain film appeared gram negative and indole test tested positive, urease was negative and citrate test negative. The TSI showed that there was production of gas with fermentation of sugar at the slant and butt of the tube.

*Klebsiella pneumoniae* being a lactose fermenter changed the CLED media to yellow, indole test was negative while both citrate and urease test was positive. Triple sugar iron test had production of gas demonstrated by cracks at the bottom of the media with fermentation of sugar, turning the slant and butt to yellow.

*Proteus mirabilis* was a non-lactose fermenter showing a translucent blue color on the media meaning that lactose was not fermented. Both the Gram stain and indole test were negative while citrate and urease test were positive. The TSI slant remained red showing that sugar was not fermented with production of gas presented by cracks in the medium. The butt turned black, marked by hydrogen sulphide production.

*Staphylococcus aureus* was catalase positive and coagulase positive. On Gram stain, they were gram positive cocci while *S. saprophyticus* presented with a positive Novobiocin susceptibility test, positive catalase test and a negative coagulase test.

Out of the 252 samples, Gram negative bacteria were more than the gram-positive bacteria. Gram negatives had an occurrence of 187(74.2%), which were *E. coli* with a large occurrence of 105 (42%), then *K. pneumoniae* at 50(19.8), *P. mirabilis* at 20(7.9%) and *P. aeuruginosa* at 12 (4.7%) while the Gram positives were 65(25.8%) which included; *S. aureus* (16.8%) and *S. saprophyticus* at 23(9.12%). Gram negatives bacteria isolated were; Generally, *E. coli* was the major Gram negative bacteria causing
urinary tract infections, whereas *S. aureus* was the most implicated Gram positive bacteria (Table 4.1).

**Table 4.3:** Distribution of bacterial isolates

<table>
<thead>
<tr>
<th>Gram positive</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><em>S. saprophyticus</em></td>
<td>23</td>
<td>9.12</td>
</tr>
<tr>
<td><em>S. aureus</em></td>
<td>42</td>
<td>16.6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gram negative</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><em>E. coli</em></td>
<td>105</td>
<td>42</td>
</tr>
<tr>
<td><em>K. pneumoniae</em></td>
<td>50</td>
<td>19.8</td>
</tr>
<tr>
<td><em>P. mirabilis</em></td>
<td>20</td>
<td>7.9</td>
</tr>
<tr>
<td><em>P. aeruginosa</em></td>
<td>12</td>
<td>4.7</td>
</tr>
</tbody>
</table>

4.2.1 Distribution of bacteria against different age groups

*Escherichia coli* 105(42) was the most isolated organisms across all age groups whereas *P. aeruginosa* 12(4.7) was the least isolated. Additionally, *S. aureus* 0(0), was not isolated among the patients aged between 10-19 years (Table 4.2). Distribution of all isolated bacteria was generally low among participants who were above 40 years. There was a slight statistical significance between age and *S. aureus* isolate shown by \( p=0.046 \), while others depicted no relationship between age and the isolates.
Table 4.4: Distribution of Bacteria against Different Age Groups.

<table>
<thead>
<tr>
<th>Age</th>
<th>E. coli</th>
<th>K. pneumoniae</th>
<th>P. aeruginosa</th>
<th>S. aureus</th>
<th>S. saprophyticus</th>
<th>P. mirabilis</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-9 years</td>
<td>22(22.4)</td>
<td>12(20.7)</td>
<td>1(8.3)</td>
<td>7(16.7)</td>
<td>6(23.1)</td>
<td>6(20)</td>
</tr>
<tr>
<td>10-19 years</td>
<td>11(11.2)</td>
<td>5(8.6)</td>
<td>2(16.7)</td>
<td>0(0)</td>
<td>7(26.9)</td>
<td>3(10)</td>
</tr>
<tr>
<td>20-29 years</td>
<td>43(43.9)</td>
<td>30(51.7)</td>
<td>7(58.3)</td>
<td>23(54.8)</td>
<td>8(30.8)</td>
<td>14(46.7)</td>
</tr>
<tr>
<td>30-39 years</td>
<td>10(10.2)</td>
<td>6(10.3)</td>
<td>0(0%)</td>
<td>8(19)</td>
<td>2(7.7)</td>
<td>2(6.7)</td>
</tr>
<tr>
<td>40-49 years</td>
<td>5(5.1)</td>
<td>5(8.6)</td>
<td>2(16.7)</td>
<td>4(9.5)</td>
<td>2(7.7)</td>
<td>3(10)</td>
</tr>
<tr>
<td>50-59 years</td>
<td>4(4.1)</td>
<td>0(0)</td>
<td>0(0)</td>
<td>2(4.8)</td>
<td>1(3.8)</td>
<td>0(0)</td>
</tr>
<tr>
<td>Above 59 years</td>
<td>3(3.1)</td>
<td>0(0)</td>
<td>0(0)</td>
<td>1(2.4)</td>
<td>0(0)</td>
<td>2(6.7)</td>
</tr>
<tr>
<td></td>
<td>r=0.168</td>
<td>r=0.21</td>
<td>r=0.175</td>
<td>r=0.399</td>
<td>r=0.85</td>
<td>r=0.698</td>
</tr>
<tr>
<td></td>
<td>p=0.682</td>
<td>p=0.67</td>
<td>p=0.676</td>
<td>p=0.046</td>
<td>p=0.346</td>
<td>p=0.403</td>
</tr>
<tr>
<td>TOTAL</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

4.3 Antibiotic Sensitivity Pattern of the identified enteric bacteria

The most effective antibiotic to all bacteria was Ofloxacin and the isolates exhibited resistance to Nitrofurantoin, Augmentin and Nitrofurantoin. Sensitivity of *P. mirabilis* was 100% to Cefaclor while *P. aeruginosa* was 100% resistance to the antibiotics (Table 4.4). The following tables depict sensitivity patterns of respective bacteria to the different antibiotics subjected to in the study.

4.3.1 Antibiotic susceptibility of *Escherichia coli*

*Escherichia coli* showed sensitivity to Ofloxacin (83.8%), Cefuroxime (76.2%), and Minocycline (74.2%). Moderate resistance to Cefaclor (53.3%) and Nitrofurantoin (56%) was also exhibited.
Table 4.5: *Escherichia coli* antibiotic susceptibility.

<table>
<thead>
<tr>
<th><em>Escherichia coli</em></th>
<th>Sensitivity n (%)</th>
<th>Resistant n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ofloxacin</td>
<td>88(83.8)</td>
<td>17(16.1)</td>
</tr>
<tr>
<td>Nitrofurantoin</td>
<td>46(44)</td>
<td>59(56)</td>
</tr>
<tr>
<td>Cefaclor</td>
<td>49(46.7)</td>
<td>56(53.3)</td>
</tr>
<tr>
<td>Nalidixic acid</td>
<td>61(58)</td>
<td>44(42)</td>
</tr>
<tr>
<td>Augmentin</td>
<td>61(58)</td>
<td>44(42)</td>
</tr>
<tr>
<td>Cefuroxime</td>
<td>80(76.2)</td>
<td>25(23.8)</td>
</tr>
<tr>
<td>Minocycline</td>
<td>78(74.2)</td>
<td>27(25.8)</td>
</tr>
<tr>
<td>Ciprofloxacin</td>
<td>52(49.5)</td>
<td>54(50.5)</td>
</tr>
<tr>
<td>Gentamicin</td>
<td>64(60.9)</td>
<td>41(39.1)</td>
</tr>
</tbody>
</table>

4.3.2 Antibiotic susceptibility of *Klebsiella pneumoniae*

*Klebsiella* showed high sensitivity to Ofloxacin (90%), Cefuroxime (76%), Minocycline (76%) and Cefaclor (60%). High resistance was shown by Nitrofurantoin (92%), Ciprofloxacin (66%) and Gentamicin (66%).

Table 4.6: *Klebsiella pneumonia* antibiotic susceptibility.

<table>
<thead>
<tr>
<th><em>Klebsiella</em></th>
<th>Sensitivity n (%)</th>
<th>Resistant n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ofloxacin</td>
<td>45(90)</td>
<td>5(10)</td>
</tr>
<tr>
<td>Nitrofurantoin</td>
<td>4(8)</td>
<td>46(92)</td>
</tr>
<tr>
<td>Cefaclor</td>
<td>30(60)</td>
<td>20(40)</td>
</tr>
<tr>
<td>Nalidixic acid</td>
<td>30(60)</td>
<td>20(40)</td>
</tr>
<tr>
<td>Augmentin</td>
<td>24(48)</td>
<td>26(52)</td>
</tr>
<tr>
<td>Cefuroxime</td>
<td>38(76)</td>
<td>12(24)</td>
</tr>
<tr>
<td>Minocycline</td>
<td>38(76)</td>
<td>12(24)</td>
</tr>
<tr>
<td>Ciprofloxacin</td>
<td>17(34)</td>
<td>33(66)</td>
</tr>
<tr>
<td>Gentamicin</td>
<td>17(34)</td>
<td>33(66)</td>
</tr>
</tbody>
</table>
4.3.4 Antibiotic susceptibility of *Proteus mirabilis*

*Proteus mirabilis* showed high sensitivity to Cefaclor (100%), Ofloxacin (80%), and Ciprofloxacin (85%) Cefuroxime (85%), and high resistance was shown by Minocycline (85%), Nalidixic acid (80%), Gentamicin (60%) and Nitrofurantoin (60). The least sensitivity was showed Minocycline (15%) and Nalidixic acid (20%).

**Table 4.7: *Proteus mirabilis* antibiotic susceptibility.**

<table>
<thead>
<tr>
<th><em>P. mirabilis</em></th>
<th>Sensitivity n (%)</th>
<th>Resistant n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ofloxacin</td>
<td>16(80)</td>
<td>4(20)</td>
</tr>
<tr>
<td>Nitrofurantoin</td>
<td>8(40)</td>
<td>12(60)</td>
</tr>
<tr>
<td>Cefaclor</td>
<td>20(100)</td>
<td>0</td>
</tr>
<tr>
<td>Nalidixic acid</td>
<td>4(20)</td>
<td>16(80)</td>
</tr>
<tr>
<td>Augmentin</td>
<td>9(45)</td>
<td>11(55)</td>
</tr>
<tr>
<td>Cefuroxime</td>
<td>17(85)</td>
<td>3(15)</td>
</tr>
<tr>
<td>Minocycline</td>
<td>3(15)</td>
<td>17(85)</td>
</tr>
<tr>
<td>Ciprofloxacin</td>
<td>14(70)</td>
<td>6(30)</td>
</tr>
<tr>
<td>Gentamicin</td>
<td>18(40)</td>
<td>2(60)</td>
</tr>
</tbody>
</table>

4.3.5 Antibiotic susceptibility of *Pseudomonas aeruginosa*.

*Pseudomonas* showed high sensitivity to Ofloxacin (91.6%), Minocycline (91.6%), and Cefuroxime (84%). High resistance was shown by Cefaclor (100%), Nitrofurantoin (83%). and Ciprofloxacin (83%) and Nalidixic acid (83%).
Table 4.8: *Pseudomonas aeruginosa* antibiotic susceptibility.

<table>
<thead>
<tr>
<th>Pseudomonas</th>
<th>Sensitivity n (%)</th>
<th>Resistant (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ofloxacin</td>
<td>11(91.6)</td>
<td>1(8.4)</td>
</tr>
<tr>
<td>Nitrofurantoin</td>
<td>2(17)</td>
<td>10(83)</td>
</tr>
<tr>
<td>Cefaclor</td>
<td>0</td>
<td>12(100)</td>
</tr>
<tr>
<td>Nalidixic acid</td>
<td>2(17)</td>
<td>10(83)</td>
</tr>
<tr>
<td>Augmentin</td>
<td>4(33.3)</td>
<td>8(66.6)</td>
</tr>
<tr>
<td>Cefuroxime</td>
<td>10(84)</td>
<td>2(16)</td>
</tr>
<tr>
<td>Minocycline</td>
<td>11(91.6)</td>
<td>1(8.4)</td>
</tr>
<tr>
<td>Ciprofloxacin</td>
<td>2(17)</td>
<td>10(83)</td>
</tr>
<tr>
<td>Gentamicin</td>
<td>11(91.6)</td>
<td>1(8.4)</td>
</tr>
</tbody>
</table>

4.3.6 Antibiotic susceptibility of *Staphylococcus aureus*

*Staphylococcus aureus* exhibited high sensitivity to Ofloxacin (95.2%), Cefuroxime (85.7%), Minocycline (70) and Cefaclor (52.4%). It showed high resistance to Gentamicin (73.6%) and moderate resistance to Augmentin (59.5%) and Nalidixic acid (57.1%).

Table 4.9: *Staphilococcus aureus* antibiotic susceptibility.

<table>
<thead>
<tr>
<th>S.aureus</th>
<th>Sensitivity n (%)</th>
<th>Resistant n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ofloxacin</td>
<td>40 (95.2)</td>
<td>2 (4.8)</td>
</tr>
<tr>
<td>Nitrofurantoin</td>
<td>21 (50)</td>
<td>20 (50)</td>
</tr>
<tr>
<td>Cefaclor</td>
<td>22 (52.4)</td>
<td>20 (47.6)</td>
</tr>
<tr>
<td>Nalidixic acid</td>
<td>18 (42.9)</td>
<td>24 (57.1)</td>
</tr>
<tr>
<td>Augmentin</td>
<td>17 (40.5)</td>
<td>25 (59.5)</td>
</tr>
<tr>
<td>Cefuroxime</td>
<td>36 (85.7)</td>
<td>6 (14.3)</td>
</tr>
<tr>
<td>Minocycline</td>
<td>26 (70)</td>
<td>16 (30)</td>
</tr>
<tr>
<td>Ciprofloxacin</td>
<td>24 (57.1)</td>
<td>18 (42.9)</td>
</tr>
<tr>
<td>Gentamicin</td>
<td>19 (45.2)</td>
<td>23 (73.6)</td>
</tr>
</tbody>
</table>
4.3.7. Antibiotic susceptibility of *Staphylococcus saprophyticus*

*Staphylococcus saprophyticus* isolates were more susceptible to Gentamicin 22(96%) followed by Ofloxacin (95.2%) and Minocycline (91.3) respectively. Highest resistance was to Augmentin (86%) and Nitrofurantoin (74%) moderate resistance to Nalidixic acid (65%) and Cefaclor (52%).

**Table 4.10: Staphilococcus saprophyticus antibiotic susceptibility.**

<table>
<thead>
<tr>
<th><em>S. saprophyticus</em></th>
<th>Sensitivity n (%)</th>
<th>Resistant n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ofloxacin</td>
<td>20(95.2)</td>
<td>3(4.8.)</td>
</tr>
<tr>
<td>Nitrofurantoin</td>
<td>6(26)</td>
<td>17(74)</td>
</tr>
<tr>
<td>Cefaclor</td>
<td>11(48)</td>
<td>12(52)</td>
</tr>
<tr>
<td>Nalidixic acid</td>
<td>8(35)</td>
<td>15(65)</td>
</tr>
<tr>
<td>Augmentin</td>
<td>3(14)</td>
<td>20(86)</td>
</tr>
<tr>
<td>Cefuroxime</td>
<td>10(44)</td>
<td>13(56)</td>
</tr>
<tr>
<td>Minocycline</td>
<td>21(91.3)</td>
<td>2(8.7)</td>
</tr>
<tr>
<td>Ciprofloxacin</td>
<td>16(70)</td>
<td>7(30)</td>
</tr>
<tr>
<td>Gentamicin</td>
<td>22(96)</td>
<td>1(4)</td>
</tr>
</tbody>
</table>

4.3.8. Multiple drug resistance patterns of bacterial isolates from urine samples

All isolates of Gram-negative bacteria and Gram positive bacteria showed resistance to two or more drugs. Resistance to one drug was seen with *P. mirabilis* (Table 4.7)
Table 4.11: Multiple drug resistance patterns of isolates.

n =252

<table>
<thead>
<tr>
<th>Organism</th>
<th>Total</th>
<th>R0</th>
<th>R1</th>
<th>R2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gram negative</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E.coli</td>
<td>105 (42%)</td>
<td>0</td>
<td>0</td>
<td>105 (100%)</td>
</tr>
<tr>
<td>K. pneumonia</td>
<td>50 (27%)</td>
<td>0</td>
<td>0</td>
<td>15 (100%)</td>
</tr>
<tr>
<td>p. mirabilis</td>
<td>20 (11%)</td>
<td>0</td>
<td>1</td>
<td>19 (95%)</td>
</tr>
<tr>
<td>P. aeruginosa</td>
<td>12 (6.4)</td>
<td>0</td>
<td>0</td>
<td>12 (100%)</td>
</tr>
<tr>
<td>Gram positive</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S. aureus</td>
<td>23 (35%)</td>
<td>0</td>
<td>0</td>
<td>23 (100%)</td>
</tr>
<tr>
<td>S.saprophyticus</td>
<td>42 (65%)</td>
<td>0</td>
<td>0</td>
<td>42 (100%)</td>
</tr>
<tr>
<td>Total</td>
<td>252 (100%)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

R0-sensitive to all antibiotics tested; R1 (resistant to one) >R2 (resistant to more than two).
CHAPTER FIVE

DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

5.1. DISCUSSION

The study investigated 384 samples from male participants with urinary tract infections attending STC Clinic Nairobi County distributed across all age groups. The study sought to find out the prevalence of urinary tract infections in symptomatic male participants, bacteria causing UTI and the antibiotic susceptibility patterns of the bacteria to selected drugs.

5.1.1. Prevalence of UTI

Urinary tract infections among symptomatic male patients visiting STC Nairobi during the period of data collection had a prevalence of 65.6% (Table 4.1). This prevalence compares well with Hummers et al., (2004) study, where the results showed a prevalence of 60%. This rate was higher as compared to a similar study done in Nakuru Provincial Hospital which revealed a prevalence of 37.9% and another carried out by Mehr, et al., (2019) which indicated 40.2%. The high prevalence of urinary tract infections could be attributed to misuse of antibiotics resulting from self-diagnosis and treatment with easily accessible over the counter antibiotics available locally. The high risk of exposure of UTI to men living in urban areas where practices like casual sex with multiple sexual partners and anal sex is considered a norm could also be considered as a reason for the high prevalence.

The distribution among the different age groups with urinary tract infections was varied (Table 4.2). Majority of participants between the age of 20-29 years presented with the highest rate of urinary tract infection (46.8%), followed by age group 0-9 years (21%)
and the least infection rate being among participants of 50 years and above (3.2%). This results corresponds to a study carried out in Nakuru Level 5 Hospital which also revealed that male patients between the age of 25-34 years had the largest occurrence of UTI 125 (32.4%) (Gachui, 2017). Similarly, research done at Teerthanker Mahaveer Medical College and Research Centre India corresponds with the results of this study which depicted UTI to be highest in age group (20-29) years (Mahak, 2015) male patients between the age of 25-34 years had the highest number of UTI 125 (32.4%) (Gachui, 2017). Similarly, research done at Teerthanker Mahaveer Medical College and Research Centre India corresponds with the results of this study which depicted UTI to be highest in age group (20-29) years (Mahak 2015). This large occurrence of participants between ages 20-29 years can probably be due to them being at their topmost reproductive years, and the males being sexually active and receptive to new sexual ideas. Individuals in this age group have a high probability of self-diagnosis and treatment due to availability of information that can be read online. Inappropriate use of antibiotics without proper prescription and may lead to bigger chance of wrong, unwarranted treatment, wrong diagnosis, delays in proper treatment and increased disease (Bennadi, 2014).

Urinary tract infections among respondents aged between 0-9 years (Table 4.2) as alluded by (Yamma, 2018) could be due to factors like being uncircumcised and long use of disposable diapers. The study found out that with a lowered frequency of diaper change among infant boys, there was a high chance of bacterial build up from urine and faeces which then colonizes the peri-urethral area which ascends up the urethra to the bladder causing urinary tract infection (Yamma, 2018).
5.1.2 The causative bacteria of UTI

Gram negative bacteria (74%) were shown to majorly cause UTI in males visiting STC as compared to gram positive bacteria (26%) (Table 4.3). Among the gram negative bacteria, *E. coli* (42%) was the most implicated bacteria causing infections. This trend was the same as in many other studies where *E. coli* was the main and most implicated cause of UTI (Akoachere 2012, Frank 2018, Brusch 2017, Gachuhi 2017). This predominance might be attributed to the fact that *E. coli* has a natural way of colonizing the urinary tract and evading the immune system, as well as being able to move from the perineum area that contaminated with fecal matter into the penile region. (Nayareen, 2016).

The second most common gram negative was *Klebsiella pneumonia* 50 (19.8%) then followed by *P. Mirabilis* 20 (4.7%) (Table 4.3). This finding is similar to findings of (Foxman, 2010; Harper & Fowlis, 2007; Noor et al., 2013; Seifu & Gebissa, 2018). *Klebsiella pneumoniae* is commonly associated with respiratory infections. Special Treatment Center being a center known by the community for treating respiratory infections and giving care to HIV patients will in most cases be visited by persons with low immunity who may be suffering from respiratory diseases which will be treated with antibiotics, leading to resistance of the bacterium some common antibiotics.

The gram-positive bacteria (*S. saprophyticus and S. aureus*) 25.8% were fewer compared to the gram-negative bacteria (74.2%) isolated (Table 4.3). Gram positive bacteria are not commonly implicated in urinary tract infections (Hamdan 2015). However, a study carried out by Karsten *et al.*, (Karsten, 2014) associated *S. saprophyticus* with its reservoir being gastrointestinal tract. Therefore, there is a possibility that the bacteria can gain entry into the penile region causing urinary tract
infection. The other gram-positive organisms that was also isolated among the participants is *S. aureus* which was at 54.8% among the male aged 20-29 years but none was isolated in the ages of 10 to 19 years (Table 4.4). Despite the fact that *S. aureus* is usually associated with in-patients who have invasive procedures carried out like insertion of catheters, presence of this strain of bacteria among the participants attending STC which is an outpatient facility contradicts the fact that it can only be acquired nosocomial (Noor 2013) This study finding might suggest that the bacterium was acquired from the community thus prompting an in-depth community survey to be done to ascertain the prevalence of *S. aureus* in community acquired UTI

5.1.3 Antibiotic sensitivity pattern

Nine antibiotics were tested invitro against all the bacteria that were isolated in the study to determine their antibiotic sensitivity pattern. These are the drugs that are commonly prescribed for treating UTI by the Ministry of Health. Before giving an antibiotic to a patient, occurrence of antibiotic resistance, patient’s allergy history, patients’ compliance to treatment, availability and cost of medicine are some of the factors that can be looked into to give individualized treatment (Robert, 2008). It is a well-known fact that the same species of bacteria can have different sensitivity patterns depending on region and time as postulated by Capan *et al.*, 2016. (Copan 2016). It therefore underscores the importance of antimicrobial sensitivity testing to distinguish the pattern of antibiotic resistance among uropathogens and thereby provide accurate treatment regimes.

There was high resistance of *S. aureus* to gentamicin (73.6%) and augmentine (59.5%) (Table 4.9) These are the antibiotics used in the treatment of UTI in many public hospitals in Kenya. The trend is similar to a survey carried out in Nigeria by Adebola,
who reported a resistance rate of 73.9% for gentamicin and 69.6% for augmentin (Adebola, 2012). The study is also similar to a study on Gram-positive UTI bacteria undertaken by Urmi et al., 2019, the highest level of antibiotic resistance by *S. aureus*, and *Enterococcus* species was to the aminoglycoside group of antibiotics including augmentin, gentamicin and amikacin. He attributed these findings to the many counterfeit and substandard drugs available in the market, together with indiscriminate use of these drugs among patients, a factor that could be the case at STC (Urmi, 2019). Resistance of *S. aureus* as depicted by this study could be important input in informing policy towards change of the standard treatment guidelines for UTI management.

*Escherichia coli* showed a high resistance to Nitrofurantoin (56%) and cefaclor (53.3%). It was sensitive to ofloxacin (83.8%) followed by cefuroxime at (76.2%). (Table 4.5) Cefuroxime is a broad spectrum antibiotic which can only be administered intravenously and is quiet expensive, the drug is mainly administered in cases of complicated urinary tract infections. Unavailability of oral tablets of cefuroxime over the counter minimizes the chance of the drug being abused and decreases the chances of resistance by enteric bacteria (Bouchillon, 2012).

*Klebsiella pneumoniae* was sensitive to ofloxacin while nitrofurantoin (92%) was highly ineffective. Ofloxacin was also found to be the most effective antibiotic across all age groups too (Table 4.6) This was consistent with that of a study done in Iraq where the sensitivity pattern of ofloxacin was found to be (40.5%) in the management of urinary tract infections (Razgar, 2018) The susceptibility to Nitrofurantoin in this study was contrary to a study done in Nakuru level 5 Hospital where it was established to be very effective (100%) in all the bacteria isolated (Gachuhi, 2017).
The bacterium *P. aeruginosa* was reported to be resistant to cefaclor (100%) as shown in table 4.8, which was otherwise found to be very effective on *P. mirabilis* (Table 4.7). As explained in a study done in Pakistan, the characteristic way of developing antibiotic resistance of *P. aeruginosa* includes an outer lower membrane that is very permeable, increasing the flow of efflux pumps of different specificity and occurrence of Amp C beta-lactamase which cause disorder which allows the bacteria to develop resistant mechanisms to commonly prescribed drugs (Shah, 2015). *Proteus mirabilis* was sensitive to cefaclor in this study (Table 4.7), it is known to exhibit multi drug resistance to several classes of antibiotics complicating treatment of UTI (Noor, 2013). Many studies have also linked *P. aeruginosa* resistant strains to indiscriminate prescription of medicines leading to a failed empirical therapy which then leads to development of more resistant strains of the bacterium (Dania, 2015). Culture and sensitivity testing to single out *P. aeruginosa* before prescribing an antibiotic is recommended in many studies (Goldstein, 2010).

Sensitivity towards gentamicin by *S. saprophyticus* (Table 4.10) conforms to findings in a study done in Ethiopia where they found out that gentamicin was the drug of choice for treating UTI caused by *S. saprophyticus* (Gebissa, 2015). Gentamicin and other aminoglycosides have been documented as the best drugs to be used in treatment of UTI’s caused by *S. saprophyticus* (Urmi, 2019)

Multidrug resistance has stern consequences on the health of the populace (Murugesh, 2014). It is quite alarming to note that almost all bacteria in this study reported a resistant to two or more antibiotics (Table 4.11) which is higher but almost similar to what was reported in Ethiopia (95%) (Ifeanyichukwu, 2013). The high proportion of antibiotic resistance that is portrayed by many of the commonly prescribed antibiotics
in the study may be because of the availability of the antibiotics in the pharmacies and them being sold cheaply and without prescriptions (Eyasu, 2014). It may also be attributed to the use of the drugs for other nonhuman purposes like in livestock farming and animal husbandry activities, which leads to a rise in antibiotic resistance (Ifeanyichukwu, 2013). With the antibiotic resistance trend rising against most of the common antibiotics, the future of our health care is very complicated and difficult. Also, the rise of multi-drug resistant (MDR) bacteria which makes most antibiotics not to be effective by developing newer and very complex resistance mechanisms is quiet alarming. The antibiotic sensitivity biogram investigated outlines clearly the trend followed by the antibiotics allowing this study to be used to bring forth evidence-based information on the best antibiotic therapy against bacteria in UTI patients.

**5.2 Conclusions**

1. The prevalence of urinary tract infection in patients who attended STC between the months of February to May 2018 was 65.6% which was high.

2. The highest prevalence of the enteric bacterial isolates was *E. coli* at 42% whereas *P.auroginosa* was the least at 4.8%.

3. The occurrence of UTI in men was most common between the ages of 20-29 years and least at the age of above 50 years.

4. There was high variability in effectiveness to antibiotics displayed by the isolated organisms. Overall ofloxacin was the most effective against most bacteria whereas Nitrofurantoin was the least effective.
5.3 Recommendations

1. Regular surveying of UTI caused by enteric bacteria should be carried out in hospitals especially *E. coli*, to aid in the proper management of UTI.

2. The effective antibiotics like ofloxacin, cefuroxime and minocycline should be used for the treatment of UTI as most isolates were susceptible to them.

3. Follow-up of treated individuals to determine effectiveness of treatment would also help in addressing cases of failed treatment and prevent advancement of antibiotic resistance.
REFERENCES


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APPENDIX I: MAP OF STC LOCATION

Adapted from Google maps@2016
APPENDIX II: CONSENT FORM.

**Research Title:** Urinary Tract Infections and Antibiotic Sensitivity Pattern among Symptomatic Men Visiting Special Treatment Center in Nairobi County, Kenya.

**Name of principal investigator:** Dinah Moraa

**Organization:** Kenyatta University

**Supervisors:** Dr. Scholastica Mathenge (Kenyatta University)

Dr. Washington Arodi (Kenyatta University)

**INTRODUCTION**

My name is Dinah Moraa Ondari, a postgraduate student from Kenyatta University undertaking a Master of Science degree in infectious diseases (Bacteriology). I am conducting a study on “Urinary tract infections caused by enteric bacteria and antibiotic sensitivity among symptomatic male patients center Nairobi.” The results from the study will be used by the Ministry of Health to improve the diagnosis and treatment of urinary tract infections among male patients.

**Procedures to be followed**

Participation in this study will require that patients seeking treatment in the center for symptomatic urinary tract infection be recruited through systematic sampling method. Willing participants will be guided on how to aseptically collect urine sample after giving an informed consent.

Your participation is fully voluntary and therefore has the right to decline and withdraw at any stage of the study. Your decision will not affect your medical treatment from this center. You are free to ask questions and seek clarification related to the study at any time.
Benefits

Participation in this study will not benefit you directly but it will help in improving best practices in the laboratory diagnosis of urinary tract infections. This will help in tackling the rising cases of antibiotic resistance.

In case of a confirmed case of UTI you will be treated with appropriate antibiotics.

Risks

There are no potential risks that you will be exposed to in this study as it only involves collection of a urine sample.

Confidentiality

The details you will volunteer will be kept confidential. Your name will not be recorded anywhere. The urine sample will bear initial only known to the researcher. Interaction with the clinician will be done in a private setting within the clinic. Should you want to withdraw from the study you are free to do so without coercion.

Contact Information

In case of any questions or concerns about the study you can contact the Kenyatta University Ethical Review Committee Secretariat on: chairman.kuerc@ku.ac.ke or secretary.kuerc@ku.ac.ke or ercku2008@gmail.com.

You can also contact Dr. Scholastica Mathenge on 0722 936 884 or Dr. Washington Arodi on 0733 805 224.
Participants Statement

The information explained to me on participation in the study is clear and I have understood. All the concerns I had have been addressed by the principle investigator to my satisfaction. I voluntarily agree to participate in this study and I have not been coerced in any manner. I have been made to understand that I can terminate my participation at any stage and time of this study without any consequences in this study setting or any other setting.

Code of participant …………………………………………………………………

Signature or Thumbprint ………………………………. Date ……………………

Statement of the principle investigator

I confirm that the participant was explained to in a language that he/she understood the procedure, benefits and risks of the study. He/she was given a chance to ask question which I answered to the best of my knowledge.

Name of investigator …………………………………………………………………

Investigator’s signature …………………………. Date …………………………. 
APPENDIX III: QUESTIONNAIRE

QUESTIONNAIRE....................

ID__________________________

SOCIODEMOGRAPHIC CHARACTERISTICS.

1. What is your age in years?
   a. 0-9
   b. 10-19
   c. 20-29
   d. 30-49
   e. 50-59
   f. ≥ 60

2. Do you have a history of hospitalization in the past two weeks?
   NO
   YES.

3. Have you had a UTI in the past two weeks?
   YES
   NO
2. CLINICAL CHARACTERISTICS OF UTI

1. Are you experiencing the following symptoms? Please tick YES or NO accordingly.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>A strong persistent urge to urinate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A burning sensation when urinating</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passing urine that is cloudy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A white, yellow or green discharge from the penis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Painful or swollen testicles?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blood in urine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Involuntary leakage of urine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urinary urgency</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX IV: ETHICAL CLEARANCE

KENYATTA UNIVERSITY
ETHICS REVIEW COMMITTEE

Fax: 8711242/8711575
Email: kaere.chairman@ku.ac.ke
kaere.secretary@ku.ac.ke
Website: www.ku.ac.ke

P. O. Box 43844,
Nairobi, 00100
Tel: 8710901/12

Our Ref: KU/ERC/COND.APPR.1/VOL.1 (35) Date: 20th April 2017

Dinah Moraa Ondari
Kenyatta University
P. O. Box 43844 – 00100
NAIROBI

Dear Dinah,

APPLICATION NUMBER: PKU/654/1734 "Urinary Tract Infections caused by Enteric Bacteria and Antibiotic Sensitivity among Male Patients visiting Special Treatment Centers in Nairobi City County, Kenya"

3. IDENTIFICATION OF PROTOCOL
The application before the committee is with a research topic “Urinary Tract Infections caused by Enteric Bacteria and Antibiotic Sensitivity among Male Patients visiting Special Treatment Centres in Nairobi City County, Kenya” Received on 16th March, 2017 and discussed on 11th April 2017.

2. APPLICANT
Dinah Moraa Ondari

3. SITE
Nairobi County, Kenya

4. DECISION
The committee has considered the research protocol in accordance with the Kenyatta University Research Policy (section 7.2.1.3) and the Kenyatta University Ethics Review Committee Guidelines, and is of the view that against the following elements of review,

i. Scientific design and conduct of study,
ii. Recruitment of research participant,
iii. Care and protection of research participants
iv. Protection of research participant’s confidentiality,
v. Informed consent process.
vii. Community considerations.

AND APPROVED and that the research may proceed ON CONDITION that you incorporate its advise below.

4. ADVICE/CONDITIONS

Scientific design and conduct of study,
- Need to include more than one treatment center.
- Need to include more antibiotics in the sensitivity desk.
- Specify which antibiotics the patient will have taken for them to be excluded from the study.
- Pg 13 states that the inclusion into the study will be done consecutively. Is this random?
- Explain the time and place for taking samples.
- Elaborate on the design and capture the lab component of the study.

Protection of research participant’s confidentiality,
- Explain how samples will be protected.
- Explain how the disposals of the discs and results, will be done

Informed consent process,
- Any feedback to the participants
- Translate the consent and the questioners to Kiswahili

Community considerations
- Indicate whether there will be feedback to the patient and the centers where the research will be undertaken.

The above specific conditions must be fulfilled in writing before an approval can be granted. The manner of fulfilling these should be outlined and submitted to KU-ERC as soon as possible.

When replying, kindly quote the application number above.
If you accept the decision reached and advice and conditions given please sign in the space provided below and return to KU-ERC a copy of the letter.

DR. TITUS KAHIGA
CHAIRMAN ETHICS REVIEW COMMITTEE

I .......................................................... accept the advice given and will fulfil the conditions therein.

Signature........................................ Dated this day of .................................................... 2017.

cc. DVC: Research Innovation and Outreach
APPENDIX V GRADUATE SCHOOL APPROVAL

KENYATTA UNIVERSITY
GRADUATE SCHOOL

E-mail: dean-graduate@kun.ac.ke
Website: www.ku.ac.ke

FROM: Dean, Graduate School
TO: Dinah Moraa Ondari
C/o Medical Laboratory Science Dept.

DATE 24th February, 2017
REF: P/150/CE/26148/2014

SUBJECT: APPROVAL OF RESEARCH PROPOSAL

We acknowledge receipt of your revised Research Proposal as per our recommendations raised by the Graduate School Board of 25th January, 2017 entitled “Urinary Tract Infections Caused by Intestinal Bacteria & Antibiotic Sensitivity, Among Male Patients Visiting Special Treatment Centre, Nairobi City County, Kenya”.

You may now proceed with your Data Collection, Subject to Clearance with Director General, National Commission for Science, Technology and Innovation.

As you embark on your data collection, please note that you will be required to submit to Graduate School completed Supervision Tracking Forms per semester. The form has been developed to replace the Progress Report Forms. The Supervision Tracking Forms are available at the University’s Website under Graduate School webpage downloads.

Thank you.

Gideon Kamenyi FOR DEAN, GRADUATE SCHOOL

Cc: Chairman, Department of Medical Laboratory Science.

Supervisors:

1. Scholastica Mathenge (PhD)
   C/o Department of Medical Laboratory Science
   Kenyatta University

2. Dr. Washington Arodi (PhD)
   C/o Department of Medical Laboratory Science
   Kenyatta University

GR/ico
APPENDIX VI: CITY COUNCIL APPROVAL

NAIROBI CITY COUNTY

Telephone 020 344194
Web: www.nairobi.go.ke

COUNTY HEALTH SERVICES

REF: CHS/J/133/SS - 018
TO: DINA MORAA ONDARI
KENYATTA UNIVERSITY
P. O. BOX 41844-00100
NAIROBI

DATE: 3rd APRIL, 2018

RE: RESEARCH AUTHORIZATION FOR URINARY TRACT INFECTIONS CAUSED BY ENTERIC BACTERIA & ANTIBIOTIC SENSITIVITY, AMONG MALE PATIENTS VISITING SPECIAL TREATMENT CENTRE, NAIROBI CITY COUNTY

Reference is made to a letter from the Director Human Resource Management


Authority is hereby granted to you to carry out research on “Urinary Tract Infections Caused By Enteric Bacteria & Antibiotic Sensitivity, Among Male Patients Visiting Special Treatment Centre, Nairobi City County.”

Please note that your research runs for three (3) Months w.e.f from 1st February 2018 to 31st May 2018.

During the course of your research you will be expected to adhere to the rules and regulations governing the Nairobi City County.

You will also be expected to submit a copy of your research project to the office of the undersigned.

By a copy of this letter, the SCM/DT/State Sub – County is requested to accord you the necessary assistance.

Research subject five thousand (5000) has been paid.

SINCERELY

CHIEF ADMINISTRATIVE OFFICER – CHS

CC: SCM/DT - State

SOMA/DL - State

In/charge - STC: Gasana H/C.
APPENDIX VII: NACOSTI PERMIT

This is to certify that Mrs. Dina Njora, a student of Kenyatta University, has been licensed to conduct research in Nairobi on the topic: urinary tract infections caused by enteric bacteria and antibiotic sensitivity among male patients visiting a special treatment center, Nairobi, for the period ending 30th March 2021.

License No: NACOSTLP/30/2020

Applicant Identification Number

839208

Director General
NATIONAL COMMISSION FOR
SCIENCE, TECHNOLOGY & INNOVATION

Verification QR Code

NOTICE: This is a computer-generated Licence. To verify the authenticity of this document, scan the QR Code using a QR scanner application.
APPENDIX VIII: PREPARATION OF CLED

18g of the medium was suspended in half liter of distilled water.

to dissolve it, bring to boil while agitating

Sterilize by autoclaving at 121°C for 15 minutes.

Cool and dispense into culture plates after mixing well

After solidification, in order to prevent moisture formation, invert the culture plate.

Store at in a sterile cool place.
APPENDIX IX: PREPARATION OF MUELLER HINTON AGAR

1. 18gm of the media was dissolved in half litre of purified water.

2. to dissolve it, bring to boil while agitating.

3. Sterilize by autoclaving at 121°C for 15 minutes.

4. cool and dispense into culture plates

5. Allow the plates to solidify.

6. Store the culture plates in a cool and sterile place.
APPENDIX X; PREPARATION OF CHRISTENSENS UREA BASE BROTH

1. Suspend 12.05 grams of urea base broth in 475 ml of distilled water.

2. Bring to boil in order to dissolve the broth

3. Autoclave at 115°C.

4. Add 25ml of the sterile 40% urea solution slowly to the broth

5. Distribute into sterile test tubes and allow to cool in a horizontal position.

6. Store in a cool, sterile place
APPENDIX XI: PREPARATION OF TRIPLE SUGAR IRON

1. Suspend 32.21 grams of the agar in 500 ml purified water.

2. While agitating, bring the agar to boil.

3. Dispense into sterile tubes and sterilize

4. Let it to set in horizontal procedure a slant.
APPENDIX XII: SENSITIVITY PLATE OF S.aureas
APPENDIX XIII: ABSTRACT OF PUBLICATION OF THE WORK

International Journal of Advanced Multidisciplinary Research
ISSN: 2393-8870
www.ijarm.com
DOI: 10.22192/ijamr Volume 6, Issue 2 -2019
Research Article
Antibiotic Susceptibility Pattern among Male Patients with Urinary Tract Infection in Special Treatment Centre, Nairobi County, Kenya.
Dinah Moraa1*, Dr. Scholastica Mathenge2, Dr. Arodi Washington3, Torome Tom4, Oliver Muthia5, Martin Kinyua6
1,2,3,5,Kenyatta University, Medical Laboratory Department. P.o Box 43844-00100. Nairobi, Kenya
4Meru University of Science and Technology P.o Box 972-60200, Meru, Kenya
6Mbathani District Hospital, P.o Box 40205-00100, Nairobi, Kenya.
*Correspondence: moraakintet@gmail.com

Abstract
The occurrence of urinary tract infections in men can be very serious although not very common. Antibiotic resistance is becoming a global concern and Kenya is no exception.

The aim and objective of the study was to investigate the causative bacteria and antibiotic susceptibility patterns among male patients with urinary tract infection visiting Special Treatment Centre, Nairobi County.

Method: A descriptive cross-sectional study design was adopted from January 2018 to March 2018. Three hundred and eighty four (384) participants were recruited into the study using systematic sampling technique using structured questioners. Clean morning midstream urine was then cultured on Cysteine-Lactose-Electrolyte Deficient (CLED) agar and blood agar medium as per the standard urine culture. Antibiotic sensitivity test was then done on Mueller-Hinton agar using Kirby-Bauer disk diffusion method according to CLSI guidelines. Appropriate biochemical tests were done to identify the isolated bacteria.

Results: The highest number of isolates was found to be Escherichia coli isolates (105) and the least was Pseudomonas auriginosa (12). Ofloxacin, 113(45.2) was found to be most effective antibiotic (x²=18.2, p=0.01) and the least effective being Augmentin (x²=1.56, p=0.811). Resistance was found to be high to Nitrofurantoin (65%) and least to Oflocaxin(13%).

Conclusion: Bacterial cultures and sensitivity should be done on all cases of UTI’s to determine causative agents so as to guide clinicians in determining the most appropriate treatment. This will help in addressing cases of emerging multidrug resistance to the commonly used antibiotics. Follow-up of treated individuals to determine effectiveness of treatment would also help in addressing cases of failed treatment and prevention of resistance.