PREVALENCE, CAUSATIVE ORGANISMS AND RISK FACTORS FOR URINARY TRACT INFECTIONS IN SPINAL CORD-INJURED PATIENTS.

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DECLARATION

I hereby declare that the work contained in this dissertation is entirely my own, original work, and was not previously submitted, in whole or in part, for application for any other degree.

I declare that any sources consulted or external contributions have been fully referenced and credited. Furthermore, this declaration acknowledges my entire understanding of the national policy on research, the University of Nairobi policy on plagiarism and of the ethical requirements of the Kenyatta National Hospital-University of Nairobi Ethics and Research Committee.

I affirm that I have upheld these requirements.

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LIST OF ACRONYMS AND ABBREVIATIONS

ASB	Asymptomatic Bacteriuria
ASIA	American Spinal Cord Injury Association
CFU	Colony Forming Units
CIC	Clean Intermittent Catheterization
HIV	Human Immunodeficiency Virus
KNH	Kenyatta National Hospital
NIDRR	National Institute on Disability, Independent Living, and Rehabilitation Research
NDO	Neurogenic Detrusor Over activity
SCI	Spinal Cord Injury
SCIP	Spinal Cord Injured Patients
SUSI	Symptomatic Urinary System Infection
UTI	Urinary Tract Infection
UTIs	Urinary tract infections
YLD	Years Lived with Disability
NIDRR	National Institute on Disability and Rehabilitation Research

STUDY DEFINITIONS

Spinal cord injury- Insult to the spinal cord with resultant change in the cord's normal functions

Urinary tract infection – Infection in any part of the urinary system

Bacteriuria- Bacteria in urine

Asymptomatic bacteriuria - Presence of bacteria in a urine specimen from a patient without signs and symptoms of infection

Symptomatic bacteriuria – Presence of bacteria in urine in a patient with symptoms of infection

ABSTRACT

Background: Spinal cord injuries (SCI) is a common occurrence in many hospitals in Kenya. Urinary tract infection is one of the major causes of morbidity and urosepsis in spinal cord- injured patients. The epidemiology of UTI in SCI varies with geographical locations. Data are scarce on the epidemiology of these infections in spinal cord injured patients in Kenya especially the prevalence, contributing factors, and the antimicrobial profile.

Objective: To determine the prevalence, causative micro-organisms and risk factors for UTI in SCI.

Study site: Kenyatta National Hospital.

Method: Using a cross sectional study design, and consecutive sampling approach, patients who had spinal cord injury with an indwelling urethral catheter for at least 2 weeks were recruited and data collected on clinical and demographic factors, this was done at the Kenyatta National Hospital orthopedic wards. The urine was collected using and aseptic technique after change of catheter by trained research assistant. This was then transported in a cool box at 4 degrees celciul where the samples were cultures and Clinical Laboratory Standards Institute (CLSI) guidelines used for antimicrobial sensitivity testing.

Results: In total, the findings reported were based on a sample of N = 69 patients with spinal cord injury. A majority were aged 26 – 40 years (50.7%), with males 88.4% bedridden 91.3% (N = 63), cervical spinal cord injury 39.1% (N = 27), with complete spinal injury 63.8% (N = 44), on latex catheter 53.6% (N = 37) and average catheterization period was 10.23 days (SD = 6.965). The prevalent of UTI was 82.6% (N = 57/69) with the most prevalence pathogens being *Escherichia coli* (33.3%, N = 23), and *Klebsiella pneumoniae* (23.2%, N = 16).

Escherichia coli were most sensitive to nitrofurantoin, aminoglycosides, quinolones, and ceftriaxone. *Klebsiella pneumoniae* were most sensitive to gentamycin, ceftriaxone, amikacin and nitrofurantoin. *Pseudomonas aeruginosa* were most sensitive to quinolones such as norfloxacin and levofloxacin, with amikacin, gentamicin and piperacillin also indicated to be sensitive too. *Proteus spp.* were sensitive to gentamycin only. *Staphylococcus aureus* were sensitive to

ceftriaxone, nitrofurantoin, levofloxacin, amikacin, co-trimoxazole and chloramphenicol while *Enterococcus faecalis* were sensitive to chloramphenicol only.

The main risk factors were being bedridden ($p < 0.001$), prolonged catheterization beyond 2 weeks ($p = 0.031$), and delayed catheter change past 4 weeks ($p = 0.002$) in addition to those with complete spinal cord injury ($p = 0.022$).

Conclusion: This study highlights the high prevalence of UTI among spinal cord- injured patients, with E. coli and Klebsiella pneumoniae being the most common causative organisms. The antimicrobial sensitivity patterns provide valuable insights into appropriate antibiotic choices, with E. coli and Klebsiella pneumoniae showing high sensitivity to the available antibiotics both in oral and parenteral. Additionally, immobility was identified as a significant risk factor for urinary tract infections in spinal cord injured patients. These findings emphasize the need for comprehensive prevention strategies, including mobility promotion and judicious antibiotic use, to reduce the burden of urinary tract infections and improve the overall management of spinal cord injured patients.

INTRODUCTION

1.1 Background

A Spinal cord injury is any lesion to the spinal cord or cauda equine and is classified into traumatic or non-traumatic. A traumatic SCI results from a damaging blow of which in most geographical locations the main causes are falls, injuries sustained in road traffic accidents and sports while a non-traumatic SCI usually has a primary cause such as an infection or a tumor frequently leading to sensory, motor or autonomic loss (1,2).

The global incidence per annum of spinal cord injuries is estimated to be 23 per every million with highest being in North America at 40 cases per million (3). The global age-standardized prevalence for spinal cord injuries stands at 368 for every 100,000 and the age-standardized YLD rate for SCIs stood at 130 for every 100,000 (1). In Africa, there is paucity of data on the true incidence of spinal cord injuries although some studies in sub-Saharan Africa estimate it to be at 21-29 per million (3,4).

The prevalence of significant bacteriuria post spinal cord injury has been estimated to be 10 – 68% in a systematic review (5). In a prospective study of 93 patients by Togan et al, (2014) in Turkey, the estimated prevalence of symptomatic UTI in spinal cord injury was estimated to be 22.6%, with that of asymptomatic bacteriuria being 67.7%. Bacteriuria was estimated to be 90.3% (6).

Urinary tract infection is defined by having both the clinical symptoms as well matching laboratory findings which include leukocyturia and bacteriuria. These two are also the commonest manifestations witnessed in patients with SCI as a result of the disease process itself and the bladder drainage methods (7). The incidence of contracting a UTI after a spinal cord injury stands at 2.5 cases per year(6).

The bladder draining method used is an important risk factor associated with development of UTI in spinal cord injured patients (8). Other etiological factors of UTI in spinal cord- injured patients include, socio-demographic risk factors such as a reduced independence to function or those who required a lot of help had a 10-fold increase in UTI occurrence than other patients. Quadriplegics

are estimated to have a UTI rate of 2.5 times the rate of paraplegics; while patients with a complete spinal cord injuries have twice the rate of developing an UTI than those with an incomplete injury. Patients with thoracolumbar spine injuries also possess a significantly high risk of both serious urinary tract infections and urosepsis (9). Lastly an American Spinal Cord Injury Association (ASIA) impairment scale of C and above have been shown to pose a noteworthy risk of UTI in SCI cases (10). Use of prophylactic antibiotic treatment for UTI prevention has also been associated with greater odds of acquiring symptomatic UTI's or their reoccurrence compared to those who weren't receiving prophylactic treatment (7). Similarly, males are at an increased risk compared to females (10).

Urinary tract infections can be caused by bacteria of both gram-positive and gram-negative type and also certain fungi. Uropathogenic Escherichia coli is the major cause for both complicated and uncomplicated urinary tract infections. Other bacteria strain isolates most frequent from urine specimens in patients with SCI include; *Pseudomonas spp*, *Klebsiella spp*, Proteus spp, *Serratia spp*, *Providencia spp*, *Enterococci spp*, *Acinetobacter spp* and *Staphylococci spp* (8). Candida species contributes to 10-15% of urinary tract infections in patients with SCI (11,12). Emptying the bladder through clean intermittent catheterization reduces infection risk and has also been shown to elevate the life expectancy in patients with SCI, thus is the preferred method(13).

There are significant gaps in understanding the pattern of UTI in patients with SCI with regard to varying etiological and microbial profiles as well as antimicrobial sensitivity patterns. This study therefore, aimed to establish the prevalence of UTI in SCI, associated etiological factors and the antimicrobial sensitivity patterns. Such information will be helpful to guide prevention and treatment efforts.

1.2 Problem statement

Spinal Cord injuries are a prevalent problem in many hospitals and society. However, there is scarcity of data on the epidemiology of spinal cord injuries in Africa as a whole and Kenya as a country. There is minimal and contradictory published information on the magnitude of the risk of acquiring an UTI after SCI.

Literature varies on the risk factors of UTI after SCI especially in regard to gender differences in risk. The role of fungi infections as a causative agent of UTI in patients with spinal cord injuries remains controversial. Controversies also exist as to whether patients receiving antibiotic prophylaxis for UTI prevention possess a higher risk of acquiring symptomatic urinary tract infections or not compared to those who do not. More research is needed in use of probiotics in the management of UTI in patients with spinal cord injury as well as the on the efficacy of silver-hydrogel catheters in prevention of UTI in patients with spinal cord injuries. In Kenya there are no clear guidelines on management of UTI in Spinal Cord Injuries.

1.3 Justification

Understanding the magnitude and risk factors in development of UTI in spinal cord- injured patients is key to their prevention. urinary tract infections cause significant morbidity and mortality in SCI and more research is needed to prevent its occurrence and manage the existing infections.

The findings of this are key in elaboration of etiologies, risk factors and magnitude of UTI in spinal cord- injured patients as well as the antimicrobial sensitivity profile. This will influence local hospital care guidelines and policies on care of patients with SCI.

1.4 Research questions

1. What is the prevalence of UTI in SCI patients?
2. What are the factors associated (causative organisms) in UTI in Spinal cord- injured patients
3. What are the antimicrobial sensitivity patterns of organism in UTI in spinal cord injured patients.

1.5 Objectives

1.5.1 Broad objective

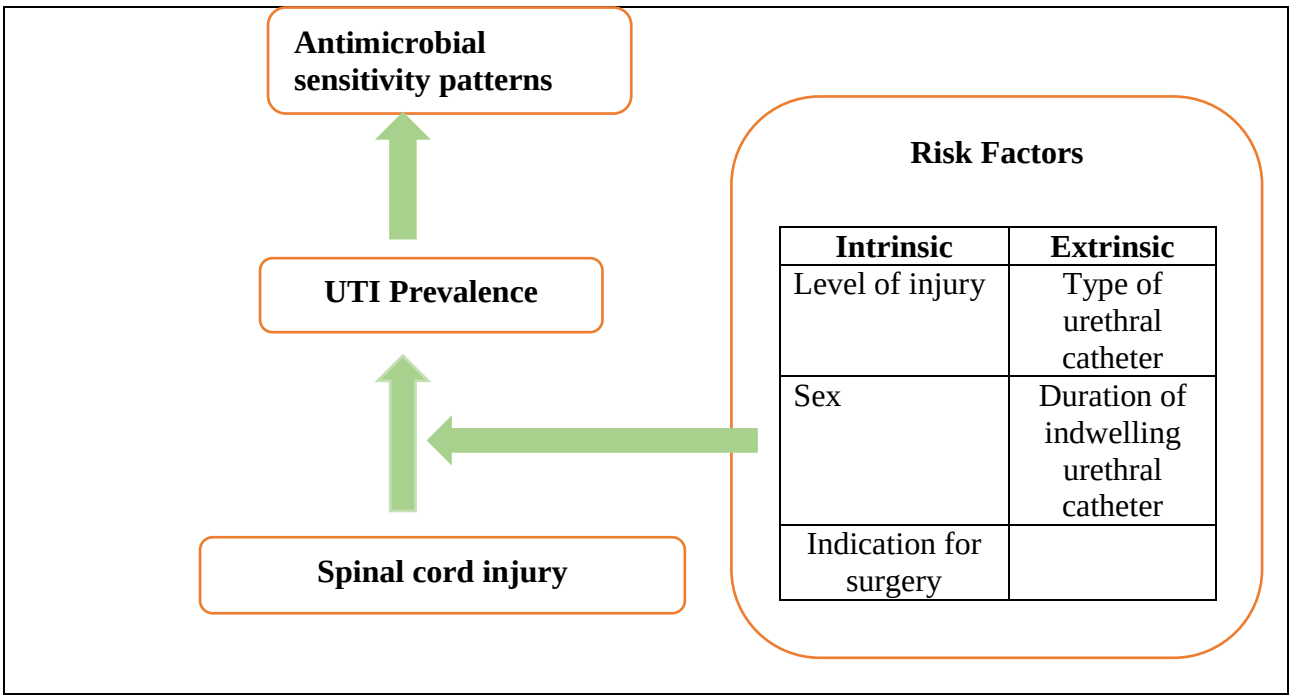
To determine the prevalence of UTI in spinal cord- injured patients, associated risk factors and antimicrobial sensitivity patterns in patients seen at the Kenyatta National Hospital, Nairobi

1.5.2 Specific objectives

i) To determine the prevalence of UTI among spinal cord injured patients.
ii) To determine the causative bacteria for UTI among spinal cord injured patients.
iii) To determine the antimicrobial sensitivity patterns of bacteria causing UTI among spinal cord- injured patients.
iv) To assess the risk factors for UTI among spinal cord injured patients.

1.6 Conceptual framework

Figure 1: Study Conceptual Framework



LITERATURE REVIEW

2.1 Introduction

A traumatic SCI results from a damaging blow of which in most geographical locations the main causes are falls, injuries sustained in a road traffic accident, assault and sports while a non-traumatic SCI usually has a primary cause such as an infection or a tumor. A spinal cord injury normally leads to a sensory, motor and or autonomic loss (1,14).

Worldwide, the incidence of spinal cord injuries is estimated at 23 per every million, with North America leading at 40 cases per million (3). In 2016, the global age standardized incidence of SCI was 13 per every 100,000, the global age standardized prevalence for SCI being 368 for every 100,000 and the age-standardized YLD rate for SCI at 130 for every 100,000 (1).

In Africa, the incidence for spinal cord injuries in Sub-Saharan Africa stands at 21-29 per million (3). Traumatic spinal injuries due to assault are more regular with sub-Saharan Africa at 38% and North Africa/Middle-East at 24%. Figures for incidence in relevant published literature are mainly from developed countries rather than developing countries. In Africa thus, the incidence of spinal cord injuries remains unknown (15). The main cause of the road traffic collisions leading to traumatic spinal cord injuries were burst tires then hitting animals on the road followed. Most involved in the road traffic collisions were passengers and 72% of the people were in single-vehicle accidents(4). A study done at Kenyatta National hospital, Kenya, revealed that road traffic collisions were the major cause of spinal cord injuries amounting to 55% followed by falls from heights at 37%. Other causes included being attacked by animals and industrial accidents however none of the injuries were sports- related (16). However, there are limited published data on spinal cord injuries in Kenya thus true incidence and prevalence are unavailable.

2.2 Prevalence of urinary tract infections in spinal cord- injured patients

Urinary tract infections are one of the most common complications witnessed in patients with SCI as a result of the disease process itself and the bladder drainage methods(5). Urinary tract infections are defined as a patient having both the clinical symptoms as well matching laboratory findings which include leukocyturia and bacteriuria (17). The prevalence of significant bacteriuria post spinal cord injury has been estimated to be between 10 – 68% (5). In a prospective study of 93 patients by Togan et al, in Turkey, the prevalence of UTI in this population was estimated to be 22.6%, with that of asymptomatic bacteriuria being 67.7%. Bacteriuria was estimated to be 90.3% (6).

The incidence of significant bacteriuria as defined as greater than 10^5 CFU/ mL, was about 18.4 while the rate with concomitant fever was approximately 1.82 episodes/person /year. Overall, the rate of UTI in patients with spinal cord injuries was estimated at 2.5 episodes /patient/year (8). The incidence of acquiring UTI may depend on the type of catheterization. It was noted in a prospective study with 64 participants that the incidence of patients who had no catheters was at 1.82 episodes'/person year. Patients managed with intermittent catheterization had an incidence of 2.72 episodes per 100 patients daily, patients being managed with clean intermittent catheterization had an incidence of 0.41 episodes per 100 patients daily, male subjects managed with condoms had an incidence of 0.36 episodes per 100 persons daily, female subjects being managed with suprapubic stimulation had an incidence of 0.34 episodes per 100 patients daily and patients voiding normally had incidence of 0.06 episodes per 100 patients daily (18).

2.3 Pathophysiology of UTI in spinal cord- injured patients

The central and peripheral nervous system that innervate the urinary bladder control both the internal and external sphincters in addition to the bladder wall to ensure a coordinated bladder function. After injury to the spinal cord, either the storage function or the emptying phases are interfered with. In suprasacral spinal cord injury there is neurogenic detrusor over activity (NDO) which results in urinary incontinence. Neurogenic detrusor overactivity pathophysiology can be explained as an interference with the micturition reflex by affecting the innervation thus the

voiding patterns. After an injury, there is the restructuring of synaptic connection resulting in new spinal circuits and thus neurogenic detrusor overactivity. In the sacral region, injuries result in hypoactivity of the detrusor and therefore impaired sphincter functions. Nerve growth factor, a neurotrophic hormone, also tends to increase in the bladder after a SCI which has been shown to affect the morphology and physiology of the bladder resulting in neuropathic bladder dysfunction (19). The neurogenic bladder as a result of spinal cord injury results in urinary stasis which promotes its colonization by bacteria and also diminishes phagocytosis by the epithelial cells lining the bladder.

During catheterization, it is possible to introduce infections into the bladder resulting in bladder colonization and ascending infections (20). The incidence of contracting UTI in this population has been reported to be as high as 2.5 cases per year, while the incidence of infections in clean intermittent catheterization is 10.3 cases for every 1000 catheter days. This then reduces after 3 months to 2 cases for every 1000 catheter days (21).

2.4 Risk factors for UTI in spinal cord- injured patients

The National Institute on Disability and Rehabilitation Research (NIDRR) conference groups the risk factors of UTI according to those involving the anatomy, urinary passageway use, demographic and sociologic factors. Physiological and structural manifestations including urinary tract stones, dyssynergia of the detrusor sphincter, bladder over-distention, high voiding pressures, large residual urine after voiding and of most importance vesicoureteral reflux leading to an elevation in the risk of UTI. In addition, the damage to the renal system worsens with increased severity and duration of the vesicoureteral reflux (22). Sociodemographic risk factors including those with a reduced independence in function or those who require a lot of help had a 10-fold increase in UTI occurrence than other patients. Poor adjustability to spinal disability and inadequate personal hygiene also increased chances of contracting an UTI (10). The SCI level and its completeness affected the type of lower urinary tract manifestations. Quadriplegics have a UTI rate of 2.5 times the rate paraplegics had and patients with a complete spinal cord injuries have twice the rate of developing a UTI than those with an incomplete injury (10) .

The bladder draining method used is considered an important risk in acquiring UTI in patients with SCI. The use of indwelling urethral catheters as a drainage method has been shown to have a bacteriuria incidence of 5 persons in 100 days and the UTI risk increases with the duration of placement. Bladder draining methods such as condom drainage, clean intermittent catheterization (CIC), pubic cystostomy, voiding normally and reflex voiding decreased the risk of acquiring UTI and subsequent bacteriuria (10). The use of CIC reduces the risk to 0.34-0.41, condom drainage reduces the risk to 0.34-0.36, suprapubic cystostomy reduces the risk to 0.34-0.56, reflex voiding reduces the risk to 0.34 and normal voiding decreases the risk to 0.32/100 person days. Increase in the interval between catheterization because of a low catheterization frequency lead to an increase in bacteriuria incidence thus patients unable to carry out clean intermittent catheterization on their own are also placed at greater risk. Patients using clean intermittent catheterization as a drainage method have a similar UTI incidence as those using condom drainage though patients using condom drainage possess a greater urinary incontinence incidence compared to those using clean intermittent catheterization. Suprapubic catheterization is effective in drainage and has low risk of causing urinary tract infections (23).

Early studies showed escalated renal deterioration and complications in the lower urinary passageway when using a suprapubic catheter but these manifestations only presented themselves 5-10 years after as compared to the use of indwelling catheters. When you compare all the draining methods, indwelling catheters use pose the greatest risk of complications which includes urethral strictures, infection, periurethral abscess, urolithiasis and vesico-ureteral reflux (8). Injection of botulinum toxin into the detrusor as a bladder evacuation method increases the chances of developing symptomatic urinary tract infections or their recurrence by approximately 1.5 times. Patients receiving botulinum injections to the detrusor had a symptomatic UTI occurrence of 77% which was higher compared to those who didn’t at 59%. Investigations have shown that the use of botulinum injections have reduced the UTI occurrence rate, however patients on botulinum injections suffer more frequently from urinary tract infections than those who don’t receive.

Patients who received prophylactic treatment for UTI prevention had greater odds of acquiring symptomatic UTI or their reoccurrence compared to those who weren’t receiving prophylactic treatment (24). According to a study, males have a higher rate of these infections than females,

citing anatomical variation, bladder neck occlusion, and accompanying elevated intravesical pressures. In addition to the neurogenic bladder in males with injured spinal cords, their bladder's inherent anatomic predisposition increases their risks of acquiring urinary tract infections. American Spinal Cord Injury Association(ASIA) impairment scale C or worse posed a noteworthy risk of UTI in SCI cases(10). A contradictory article stated that women are at a higher risk of acquiring these infections in comparison to men because women have a shorter urethra which is closer to the anus thus a major source of bacteria (22). This disapproved the earlier notion that men have a higher risk of acquiring urinary tract infections. A low immunity brought by lack of exercise and eating an unhealthy diet lacking important vitamins and minerals influences the body's ability to fight off infections thus increase the risk of UTI in SCI patients (25). Patients with thoracolumbar injuries also possess a significant risk for these infections (9).

2.5 Pathogenic profile in spinal cord injured patients

Urinary tract infections can be caused by bacteria, of both gram-positive and gram-negative types. certain fungi have also been isolated. Uropathogenic *E. coli* is one of the major causes of both complicated and uncomplicated urinary tract infections (14).

Table 2.5. Bacteria isolates from asymptomatic bacteriuria and symptomatic UTI

Microorganism	ASB, No. (%)	SUSI, No. (%)
E.coli	142(50.5)	10(41.7)
Klebsiella spp	55(19.6)	5(20.8)
Enterococcus spp	23(8.2)	2(8.3)
Pseudomonas spp	15(5.3)	2(8.3)
Coagulase negative staphylococcus	8(2.9)	-
Acinetobacter spp	7(2.5)	3(12.6)
Proteus spp	6(2.1)	-
Staphylococcus aureus	4(1.4))	-
Candida spp	4(1.4)	2(8.3)
Enterobacter spp	2(0.8)	-
S.malthophilia, M.morganii, Corynebacterium spp	15(4.6)	-
Total	**281(100.0)**	**24(100.0)**

SUSI=symptomatic urinary system infection

ASB=Asymptomatic bacteriuria

Forty-eight percent of the bacterial strain isolates from the ASB attacks and 66.6% of the symptomatic urinary system infection (SUSI) attacks had a multi-drug resistance. Seventy-point four percent of the Escherichia coli strains and 34.5% of the Klebsiella species strains in patients with asymptomatic bacteriuria (ASB) were multi-drug resistant. Moreover, 80% of the Escherichia coli strains and 80% of the Klebsiella spp. Strains in SUSI were multi-drug resistant. Patients diagnosed with SUSI had a higher ratio of multidrug resistant strains compared to those with ASB($P<0.05$). Fifty-five-point eight percent of the patients with multidrug resistance bacteria isolates had been on antibiotics in the previous 3 months, 14% had been hospitalized within the last year and 38.2% had a UTI history. Leukocytosis was found in 14.1% of ASB attacks and 38.1% of SUSI attacks. The chances of SUSI in patients having leukocytosis was greater by 3.95 (6). In another study the bacteria strain isolates most frequent from urine specimens in patients with spinal cord injuries were Escherichia coli, Pseudomonas spp, Klebsiella spp, Proteus spp, Serratia spp, enterococci, Providencia spp, Acinetobacter spp and staphylococci. The skin surrounding the genitals and the distal urethra in many patients with spinal cord injuries served as

a reservoir for pathogenic organisms which were the cause of many of the clinical infections. With the use of clean intermittent catheterization, reflex voiding or condom drainage normally 1 pathogen is found contributing to significant bacteriuria compared to the use of chronic indwelling catheters which has a complex biofilm and frequently consisting of 2-5 bacterial isolates (8). Approximately 10-15% of urinary tract infections in patients with spinal cord injuries are due to candida species of which the prevalence continues to elevate. In patients on broad-spectrum antibiotics or those having long-term urinary catheter placements, the fungi's clinical course can vary from having no symptoms and self-limiting to fungal septicemia which can result in fatality. All of the candida species can cause UTI though non-Candida Albicans species are now predominating in many centers worldwide. Among the candida species Candida albicans is most common fungal isolate in fungal UTI according to epidemiological studies. Candida glabrata is a non-Candida albicans fungi also implicated in nosocomial urinary tract infections (11,12).

2.6 Treatment and management of UTI in spinal cord- injured patients

Diagnosis of UTI is taken as both having urine positive for bacteriuria at values greater than 1000cfu/ml of urine plus the presence of clinical symptoms (26). These clinical symptoms which include fever, chills, hematuria, malaise, discomfort in the pelvis, confusion, back pain or pain on the side localized above the pelvic girdle and below the rib cage, elevated or new urinary incontinence, needing frequent catheterization, autonomic dysreflexia and elevated spasticity. If the patient's urine has an odor or in the case of pyuria without the clinical symptoms, then there is no indication of UTI (27). The prevalence of UTI is more among patients with spinal cord injuries that are unable to clear bacteria properly due to low frequency of bladder voiding, elevated residual volume and the elevated exposure to uropathogens majorly from several catheterizations. Clinically urinary tract infections are classified as complicated or uncomplicated. Uncomplicated urinary tract infections affect people who are healthy and don't have any abnormalities in terms of the structure or neurons of the urinary system. Complicated UTI is as a result of urinary tract or host defense compromise such as suppressed immunity, kidney failure, pregnancy, the use of indwelling catheters or other drainage methods and neurological disease resulting in urinary obstruction. Therefore, in our case of spinal cord injuries the more accurate term will be complicated urinary tract infections (28).

The use of antibiotics namely fluoroquinolones or cefuroxime have been recommended for the acute phase of spinal cord injuries as bacteria are more resistant while in chronic spinal cord injuries nitrofurantoin or trimethoprim are used as 1st line agents and fluoroquinolones as the 2nd line treatment (28). Although the use of antibiotics for treatment only applies when patients urine dipstick or urine culture comes out positive in addition to patients presenting with any 3 of the clinical symptoms for a duration of 24hrs or more. Another treatment for urinary tract infections due to spinal cord injuries is the use of cranberry which is believed to have an effect on decreasing growth of bacteria by urine acidification and prevention of bacterial adherence to the urinary tract wall (27). However other studies disapprove this and state that cranberry consumption offer no benefit in UTI treatment and thus shouldn't be recommended for UTI treatment in people with spinal cord injuries (27).

One of the causes of urinary tract infections in spinal cord injuries is the method of catheterization which is needed in voiding the neurogenic bladder. To prevent this or rather reduce it clean intermittent catheterization is used which is the gold standard for use in voiding disorders due to a neurogenic bladder. Clean intermittent catheterization is the preferred method of emptying the bladder as it reduces infection risk (29). This method employs the use of a short catheter, 15-40cm in length, which is also flexible to drain the urine from the bladder through its insertion through the urethra. The hands and the area surrounding the urethra are cleaned with soap and the catheter could either be fresh from the sterile pack or a washed one. Clean intermittent catheterization can help improve the expectancy and quality of life in patients with SCIs (27)**.** To improve on this method hydrophilic coated catheters were introduced which lead to a reduction of the odds of UTI by approximately 64% and a reduction of the odds of hematuria by approximately 43% (23,30). The use of silver-hydrogel catheters is a promising method of preventing urinary tract infections in SCI patients using indwelling catheters although it is not well-established. In the short term, catheters impregnated with antibiotics do cause delayed and reduced incidence of ASB. However, there is no evidence of a decrease in symptomatic bacteriuria and thus are not recommended for indwelling catheterization in the long or short term (20,31).

The use of probiotics such as non-pathogenic Escherichia coli or lactobacilli has shown benefits in UTI management in spinal cord injured patients (8). Other methods such as the use of D-

mannose and vitamin C for UTI treatment haven’t been conclusively proven (27). The use of ammonium chloride ,acetazolamide and sodium bicarbonate are not useful in UTI prevention in patients with neurogenic bladders (8).

STUDY METHOD

3.1 Study design

A cross-sectional study where exposure variables such as patient demographics and clinical characteristics were collected at the same time as the outcome data including occurrence of UTI in SCI.

Study Site

This study was conducted at Kenyatta National Hospital orthopedic surgical wards.

KNH is the national referral hospital in Kenya of all public hospital in Kenya, with significant number of patients with Spinal injuries admitted at the institution. Similarly, the KNH is a specialist hospital offering specialist services to patients with Spinal injuries.

Study population

Consisted of patients who had sustained SCI and were undergoing treatment at Kenyatta National Hospital during this study.

3.2 Selection criteria

Inclusion criteria

- All patients with spinal cord injuries seen at Kenyatta National Hospital
- All spinal cord injured patients who gave informed consent to participate.
- Patients aged above 18 years old and able to consent.

Exclusion criteria

- Other injuries such as head injuries limiting communication with the patient.
- Patients who had been on antibiotics in the last two weeks prior to recruitment.
- Patients who did not consent to this study.

3.3 Methods

Using Fisher's et al formula, the sample size was calculated as;

$$\mathrm{N} = \frac{Z^2 P(1-P)}{D^2}$$

Where;

- N = Sample size.
- Z = Standard error from the mean that corresponds to 95% confidence level, 1.96
- P = **22.6%** based on Togan et al. study on the prevalence of UTI in spinal cord- injured patients (6).
- D = Precision/ reliability with which to determine, 5%
-

$$N = \frac{1.96^2 0.226(1-0.226)}{0.05^2} = 269$$

The sample is then corrected, using the formula below, for small population, with number of accessible spinal cord injured patients at KNH estimated to be 90 patients

$$\text{Actual sample } = \frac{N(n)}{N+n}$$

Where;

- N is the estimated accessible population or sampling frame, in this case 90
- n is the pre-calculated sample, in this case 269

Substituting the values, the resulting sample needed is 67 patients; the final sample is adjusted upward by 10% for attrition cases to give a sample of 73 spinal cord- injured patients.

Sampling technique

In total, 73 patients were recruited by consecutive sampling technique. If the selected patient was not eligible or declined consent for participation, the next most eligible patient was approached for possible enrollment. This was repeated to get a sample size of 73 attained.

3.4 Variables

Dependent variables

i) Presence of UTI in spinal cord- injured patient
ii) Complications of UTI – Urosepsis, Mortality,

Independent variables

i) Age,
ii) Sex
iii) Type of bacterium of fungi cultured
iv) Type of catheterization method used (suprapubic/ urethral)
v) Type of catheter (silicon / latex / silicon coated/ other)

3.5 Data collection

Data sheet was used to collect data from the patients (Appendix A). Demographic and clinical data was from patient's medical records, interviews with patients and clinical examination. Patients with spinal cord injury were recruited from the orthopaedic wards, 6A, 6C and 6D. Recruitment was done by the principal investigator assisted by two trained research assistants.

3.5.1 Sample collection, transport and laboratory analysis

Twenty milliliter urine samples were collected from participants after change of catheter into sterile containers. This was then transported immediately within 40 minutes to the laboratory and if anticipated for delay, sample was stored in a cool box at 4^0 C. Microscopy was performed on all samples a after centrifugation at 2.0 x 1000rpm for 1 minute in order to concentrate the solid particles, a wet preparation was made on a slide and observed under power 10 and power 40. All

samples were then inoculated onto cysteine lactose electrolyte deficient agar which was incubated at 37 degrees Celsius for 24 hours. identified organisms were then tested using the Clinical and laboratory standards institute(CLSI) tool for sensitivity against the cultured organism. Different types and number of antibiotics were tested depending on the cultured organism. This was then reported as sensitive, intermediate and resistant. In this study, the Leica microscope and Henry Schein centrifuge was used.

3.5.2 Recruitment and training procedures

Two research assistants, who were medical students in year 6, were trained for one day on what the study protocols and what was required of them from the principal investigator. They were trained on how to fill the data collection tool in a standardized and uniform manner.

3.6 Quality assurance measures

Pretesting of the data collection tool was done by interviewing 5% of desired sample size. This helped in estimating the total time and resources it would have taken to complete one form and the efficacy of the tool in capturing adequate data. All questions were filled on the tool.

3.7 Research ethics

Permission to conduct this study was sought from Kenyatta National Hospital- University of Nairobi- Ethical and Research Committee. Thereafter, approval to collect samples and data was also sought from the respective ward administrative offices. This was followed by patient selection and filling of the informed consent. Each participant was given a unique identifier in order to maintain confidentiality. The procedure requiring catheter, all patients were taken through the benefits and risks. There were no rewards or incentives offered for participation in this study

3.8 Data management

Data were entered into a password protected Microsoft Excel spreadsheet. Only the principal investigator, research assistants and statistician were allowed to access the data. All hard copy data collection tools were placed under lock and key to avoid unauthorized access.

3.9 Data analysis

Cleaned data were entered into Statistical Package for the Social Sciences (SPSS) v24.0 for data analysis. To describe characteristics of the study participants, means with standard deviations, medians and ranges were used for continuous data while frequencies and proportions were used for categorical data. Prevalence of UTI in SCI was derived as a proportion of patients who had bacteria in urine out of the total sample size. To identify the factors associated with UTI in SCI, Chi square test were used in assessment of associations for categorical data. For multivariate analysis, logistic regression was used to identify independent risk factors for UTI after SCI. Regression model results were expressed in Odds ratios with the corresponding 95% confidence intervals. Statistical significance was considered for $p < 0.05$. Frequency tables, pie charts, and bar charts are used to present data.

3.10 Data dissemination

The findings of this dissertation book shall be deposited at the University of Nairobi, Faculty of health sciences, departmental repository. I also intend to publish the manuscript in a peer reviewed journal in addition to orthopaedic conference presentation.

RESULTS

4.1 Overview

A total of 73 patients met the selection criteria and were recruited into the study. During the data analysis, four participants were cleaned off after their sample from the lab reported to have been contaminated. Therefore, the data reported in this study is based on a sample of N = 69, which translates to 94.5% response rate of the calculated sample size. The findings are presented in line with the study objectives' flow.

4.2 Baseline Sociodemographic and clinical characteristics

The biodata was analyzed descriptively and reported by assessing the frequency and percentage as summarized in ***table 4.2*** below. Majority of patients were below 40 years old, mainly males most of who were bed ridden with predominant thoracolumbar spine injuries of the complete type. Majority of the patients had indwelling catheters with a duration not exceeding 14 days the predominant catheter being latex catheter followed by latex silicon coated catheters.

Table 4.2: Baseline participants' characteristics

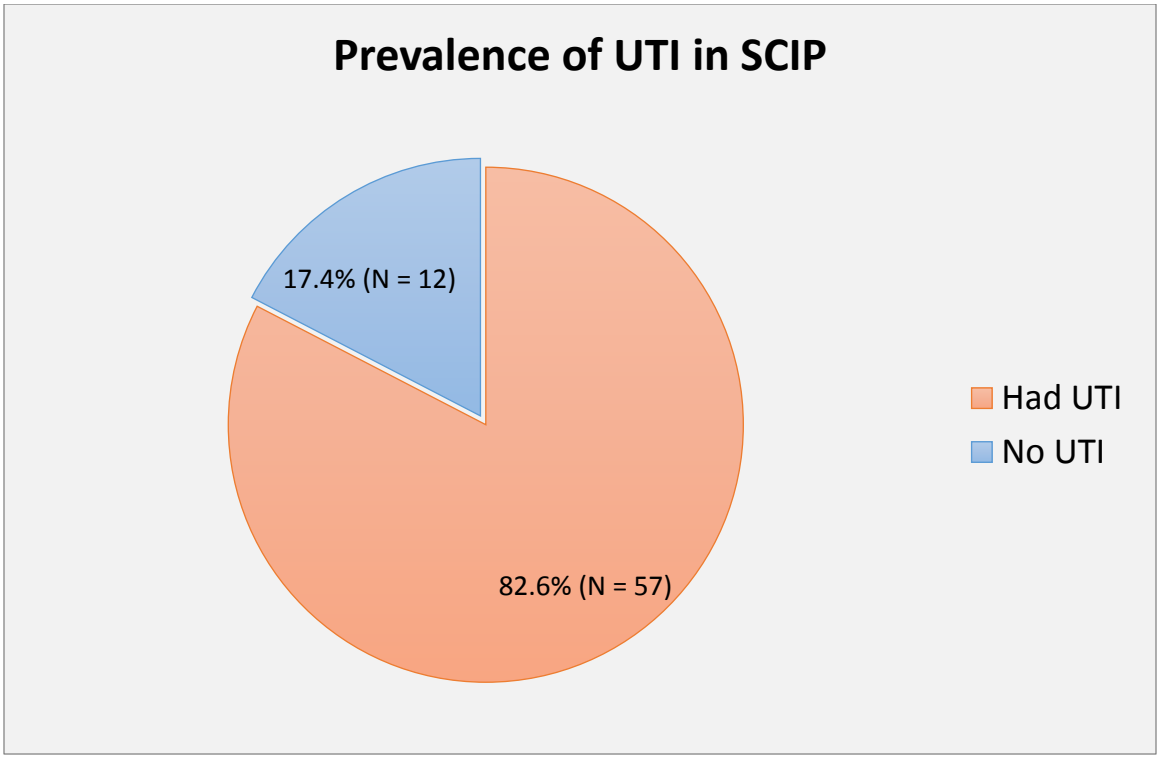
Variable	Category	Frequency	Percentage
Age	≤ 25 Yrs.	14	20.3%
	26 – 40 Yrs.	35	50.7%
	41 – 55 Yrs.	09	13.0%
	≥ 56 Yrs.	11	15.9%
	Mean age =37.43 Yrs. Standard Deviation (SD) = 12.097		
Sex	Male	61	88.4%
	Female	8	11.6%
Mobility	Bed Ridden	63	91.3%
	Ambulating	6	8.7%
Level of Injury	Cervical Injury	27	39.1%
	Thoracic Injury	24	34.8%
	Lumbar Injury	18	26.1%
Extent of Injury	Complete Spinal Injury	44	63.8%
	Incomplete Spinal Injury	25	36.2%

Catheter Type	Silicon coated Catheter	32	46.4%
	Latex Catheter	37	53.6%
Duration of Catheterization	≤ 14 Days	46	66.7%
	15 – 28 Days	11	15.9%
	28 Days	12	17.4%
	Mean length of Catheter stay = 10.23	*SD = 6.965*	
Indicated/Frequency of Catheter Change Time	≤ 14 Days	27	39.1%
	15 – 28 Days	18	26.1%
	> 28 Days	24	34.8%

4.3 The Prevalence of UTI among Spinal cord- injured patients

In total, N = 57 patients had their urine sample testing positive for bacteria translating to UTI prevalence of 82.6%. The proportion of those with UTI for the sample involved in this study is presented in the pie-chart (***Figure 4.3***) below.

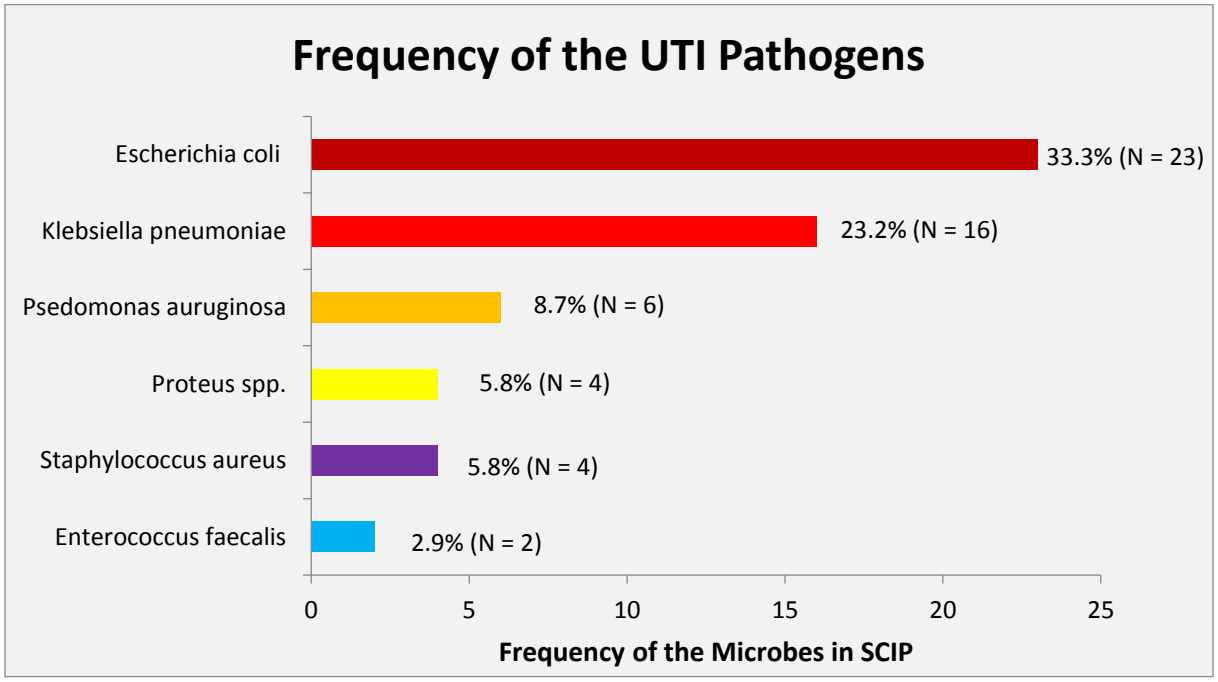
Figure 4.3: Pie chart on prevalence of UTI among spinal cord- injured patients



4.4 The main causative organisms for UTI among spinal cord- injured patients

As presented in ***Figure 4.4*** overleaf, the most prevalent pathogen was *Escherichia coli* observed in 33.3% (N = 23) of the participants. Sixteen participants (23.2%) had *Klebsiella pneumoniae* isolated with another 8.7% (N = 6) presenting with *Pseudomonas aeruginosa*. There were 5.8% (N = 4) cases of *Proteus spp.* and *Staphylococcus aureus* while another 2.9% of the participants (N = 2) had isolates of *Enterococcus faecalis*. Therefore, there were six different microbes isolated from the participant, though at different frequencies.

Figure 4.4: Distribution of the main bacteria evaluated



4.5 Antimicrobial sensitivity patterns of bacteria among spinal cord- injured patients

The drug resistance was assessed for the six bacteria isolated from the study participants for a number of antibacterial agents as summarized in ***Table 4.5a***. *Escherichia coli* was observed to have resistance to all but macrolides and penicillin (piperacillin) antimicrobials with cephalosporin having the highest resistant levels followed by quinolones (Nalidixic acid, levofloxacin, ciprofloxacin), aminoglycosides (amikacin and gentamycin), nitrofurans (nitrofurantoin) and

chloramphenicol. *Klebsiella pneumoniae* resistance almost followed the same trend with *E coli* with high resistance indicated for cephalosporins (ceftaxime, ceflazidime, and ceftriaxone), quinolones (Nalidixic acid, levofloxacin, and ciprofloxacin), aminoglycosides (amikacin), and nitrofurans (nitrofurantoin). However, the drug had low resistance rates with gentamycin, and none with chloramphenicol, macrolides, vancomycin or piperacillin.

Psedomonas auginosa had the least cases of resistance with the antimicrobial agents but had resistance incidences with piperacillin and ceftazidime. *Proteus spp.* had 100% resistance with cephalosporin, quinolones, amikacin, nitrofurantoin while 50% of the cases with this pathogen had a resistance to gentamycin. *Staphylococcus aureus* showed resistance with aminoglycosides, and some specific drugs such as ceftazidime, ceftriaxone, contrimaxazole, ciprofloxacin, nitrofurantoin, chloramphenicol and erythromycin. *Enterococcus faecalis* showed resistance to just a few drugs including levofloxacin, erythromycin, tetracycline, and vancomycin for all the two cases that were isolated with this pathogen.

4.5a Bacteria resistance to antimicrobial agents

Resistant	***E. coli N = 23***	***K. pneumonia N = 16***	***P. aeruginosa N = 6***	***S. aureus N = 4***	***Proteus spp. N = 4***	***E. foecalis N = 2***
Ceftazidime	23(100%)	14(87.5%)	2(33.3%)	4(100%)	4 (100%)	
Cefotaxime	21(91.3%)	16(100%)	6(100%)	0	4(100%)	
Cotrimoxazole	20(86.9%)	12(75%)		2(50%)	4(100%)	
Nalidixic acid	19(82.6%)	10(62%)			4(100%)	
Norfloxacin	13(56.5%)	10(62%)	0		4(100%)	2(100%)
Gentamycin	11(47.8%)	6(26%)	2(33.3%)	2(50%)	2(50%)	
Levofloxacin	10(43.5%)	10(62%)	0	0	4(100%)	2(100%)
Nitrofurantoin	9(39.1%)	12(75%)		1(25%)	4(100%)	0
Amikacin	8(34.8%)	4(25%)	2(33.3%)	2(50%)	0	
Ciprofloxacin	4(17.4%)	10(62%)	2(33.3%)	2(50%)	4(100%)	0
Ceftriaxone	8(34.8%)	10(62%)		4(100%)		
Chloramphenicol				2(50%)		0
Erythromycin				4(100%)		2(100%)
Clindamycin				4(100%)		
Tetracycline						0
Vancomycin						0
Piperacillin			2(33.3%)			
Key: Shaded Cells Means no Culture-Sensitivity Done						

The sensitivity of the antibacterial was assessed in terms of those that showed effectiveness eliminating the pathogens as summarized in ***Table 4.5b*** below.. For *Escherichia coli,* the most sensitive drugs were nitrofurantoin, aminoglycosides, quinolones, and ceftriaxone. Similarly *Klebsiella pneumoniae* was most sensitive to gentamycin, amikacin and nitrofurantoin. *Psedomonas auginosa* was most sensitive to quinolones such as norfloxacin and levofloxacin, with amikacin, gentamicin and piperacillin also indicated to be sensitive too. *Proteus spp.* was sensitive to gentamycin only while *Staphylococcus aureus* was sensitive to ceftriaxone, nitrofurantoin, levofloxacin, amikacin, contrimaxazole and chloramphenicol. *Enterococcus faecalis* was sensitive to chloramphenicol only.

4.5b Bacteria with intermediate response to antimicrobial agents

Resistant	***E. coli N = 23***	***K. pneumonia N = 16***	***P. aeruginosa N = 6***	***S. aureus N = 4***	***Proteus spp. N = 4***	***E. foecalis N = 2***
Amikacin	10(43.5%)	6(26%)	0	0	4 (100%)	
Ciprofloxacin	9(39.1%)	2(12.5%)	2(33.3%)	2(50%)		2(100%)
Levofloxacin	7(30.4%)	0	0	0	0	0
Norfloxacin	5(21.7%)	4(25%)	0			
Gentamycin	4(17.4%)	0	0	2(50%)	0	
Nitrofurantoin	4(17.4%)	0		1(25%)	0	2 (100%)
Chloramphenicol				0		0
Cotrimoxazole	3(13.0%)	0		0	0	
Ceftriaxone	4(17.4%)	3(18.9%)		0		
Ceftazidime	0	2(12.5%)	1(16.7%)	0	0	
Cefotaxime	0	0	0	4(100%)	0	
Nalidixic acid	0	4(25%)			0	
Erythromycin				0		0
Clindamycin				0		
Tetracycline						2(100%)
Vancomycin						2(100%)
Piperacillin			1(16.7%)			
Key: Shaded Cells Means no Culture-Sensitivity Done						

4.5c Bacteria sensitive to antimicrobial agents

Sensitivity	***E. coli*** **N = 23**	***K. pneumonia*** **N = 16**	***P. aeruginosa*** **N = 6**	***S. aureus*** **N = 4**	***Proteus spp.*** **N = 4**	***E. foecalis*** **N = 2**
Nitrofurantoin	10(43.5%)	4(25%)		2(50%)	0	0
Gentamycin	8(34.8%)	10(62.5%)	4(66.7%)	0	2 (50%)	
Ciprofloxacin	10(43.5%)	4(25%)	2(33.3%)	0	0	0
Levofloxacin	6(26.0%)	6(37.5%)	6(100%)	4(100%)	0	0
Ceftriaxone	11(47.8%)	3(18.75%)		0		
Amikacin	5(21.7%)	6(37.5%)	4(66.7%)	2(50%)	0	
Nalidixic acid	4(17.4%)	2(12.5%)			0	
Norfloxacin	5(21.7%)	2(12.5%)	6(100%)			
Cefotaxime	2(12.5%)	0	0	0	0	
Ceftazidime	0	0	3(50%)	0	0	
Erythromycin				0		0
Clindamycin				0		
Tetracycline						0
Vancomycin						0
Piperacillin			3(50%)			
Cotrimoxazole	0	4(25%)		2(50%)	0	
Chloramphenicol				2(50%)		2(100%)
Key: Shaded Cells Mean no Culture-Sensitivity Done						

4.6 Main risk factors for UTI among spinal cord- injured patients

Given that this was a cross-sectional study, the association should not be mistaken with cause-effect relationship but rather the variables that were mainly prominent in the group with UTI isolates in comparison to the group that had no bacteria isolated. The difference in the groups was assessed for homogeneity and a statistical significance interpreted to indicate a risk factor for UTI among SCIP.

The main variables identified to be risk factors were patients who are bed ridden (100% of the UTI vs. 58.3% without UTI, $p < 0.001$), long days of catheterization past 2 weeks (37.0% vs. 16.7%, $p = 0.031$), and delayed catheter change of over 4 weeks (40.3% vs. 8.3%, $p = 0.002$). Those with complete spinal cord injury (70.2% vs. 33.3%, $p = 0.022$) and testing positive for nitrates (47.4% vs. 0%, $p = 0.002$) was also linked with risks for UTI with statistically significant p value.

Table 4.6: Risk factors for UTI in spinal cord- injured

Variable	With UTI N (%)	Without UTI N (%)	P value
Age of the Patient			
≤ 25 Yrs.	11 (19.3%)	3 (25.0%)	0.329
26 – 40 Yrs.	28 (49.1%)	7 (58.3%)	
41 – 55 Yrs.	08 (14.0%)	1 (8.3%)	
> 55 Yrs.	10 (17.5%)	1 (8.3%)	
Sex			
Female	8 (14.0%)	0 (0.0%)	0.334
Male	49 (86.0%)	12 (100%)	
Patient Mobility			
Bed Ridden	57 (100.0%)	7 (58.3%)	< 0.001
Ambulating	00 (0.00%)	5 (41.7%)	
Type of Catheter			
Silicon coated catheter	30 (52.6%)	2 (16.7%)	0.028
Latex	27 (47.4%)	10 (83.3%)	
Catheterization Time			
≤ 14 Days	36 (63.1%)	10 (83.3%)	0.031
15 – 28 Days	09 (15.9%)	02 (16.7%)	
> 28 Days	12 (21.1%)	00 (0.00%)	
Indicated Catheter Changed Time			
≤ 2 Weeks	20 (35.1%)	7 (58.3%)	0.002
2 – 4 Weeks	14 (24.6%)	4 (33.3%)	
> 4 weeks	23 (40.3%)	1 (8.3%)	
Level of Injury			
Cervical	22 (38.6%)	5 (41.7%)	0.682
Thoracic	19 (33.3%)	5 (41.7%)	
Lumbar	16 (28.1%)	2 (16.7%)	
Extent of Injury			
Complete SC Injury	40 (70.2%)	4 (33.3%)	0.022
Incomplete SC Injury	17 (29.8%)	8 (66.7%)	
Urine Nitrites			
Positive	27 (47.4%)	00 (0.0%)	0.002
Negative	30 (52.6%)	12 (100%)	

DISCUSSION

5.1 Demographic and clinical characteristics

This study aimed to determine the prevalence, causative organisms, antimicrobial sensitivity patterns, and risk factors for urinary tract infections among spinal cord injured patients. The mean age was 37.43 (SD = 12.097) years which is consistent several other studies in which spinal cord injuries were observed to occur in a young patient(32). The mean age of individuals with spinal cord injuries is influenced by various factors: While there is a peak incidence among younger age groups, particularly between 16 and 30 years old, spinal cord injuries can occur at any age. The predominance of injuries in young adults is often attributed to their participation in high-risk activities such as sports, motor vehicle accidents, and falls (1, 14). However, the mean age can also be influenced by factors such as the overall age distribution of the population, lifestyle choices, occupational hazards, and medical conditions that increase the risk of spinal cord injury. Additionally, advancements in healthcare, safety measures, and increased awareness may contribute to changes in the age profile of spinal cord injuries over time (3). Male patients were 49(86.0%) keeping in line with various studies that have identified the male population as the most involved in spinal cord injury(32). Most of the injuries were at the cervical level (38.6%) followed by thoracic(33.3%) and lumbar(28.1%).

5.2 The prevalence of UTI among spinal cord- injured patients

The study findings revealed a high prevalence of bacteria in patients with spinal cord injuries, with a prevalence rate of 82.6%. A study by Kang et al in newly admitted patients, similarly found significant bacteriuria of 73.4% among 2629 urine samples(33). Another study by Amela Dedeic-Ljubovi et al. reported a rate of 87.3% out of 4539 urine samples(34). Ryu et al also found a positive culture rate of 74.8% in a urine sample size of 1236 specimens(35). All these indicating high levels of bacteriuria. The mechanism behind colonization and subsequent development of a UTI has been postulated to be due to neurogenic bladder as a result of spinal cord injury resulting in urinary stasis which promotes its colonization by bacteria. Catheterization can also be a means by which microorganisms can be introduced into the urinary tract to cause infections (20).This

emphasizes the need for effective preventive measures and appropriate management strategies to reduce the burden of urinary tract infections in spinal cord injured patients.

5.3 The causative organisms for UTI among spinal cord- injured patients

The most frequently identified causative organism in UTI among spinal cord injured patients was *Escherichia coli* (*E. coli*), followed by *Klebsiella pneumoniae* with a percentage of 33.3% and 23.2% respectively. This is consistent with previous studies that have identified these organisms as common pathogens in UTI (6, 8, 14). Urinary tract infections have been established to be caused by bacteria, of both gram-positive and gram-negative types. Uropathogenic *E. coli* is one of the major causes of both complicated and uncomplicated urinary tract infections (14). The bacterial strain isolates most frequent from urine specimens in patients with spinal cord injuries are *Escherichia coli, Pseudomonas spp, Klebsiella spp, Proteus spp, Serratia spp, enterococci, Providencia spp, Acinetobacter spp* and *Staphylococcus spp*. The skin surrounding the genitals and the distal urethra in many patients with spinal cord injuries serve as a reservoir for pathogenic organisms which are the cause of many of the clinical infections (8). The dominance of *E. coli* suggests the importance of addressing factors related to gastrointestinal colonization and contamination, which are often implicated in the pathogenesis of UTI.

5.4 The antimicrobial sensitivity patterns of UTI among spinal cord injured patients

The antimicrobial sensitivity patterns of the isolated bacteria were analyzed, revealing differences in susceptibility to various antibiotics. *Escherichia coli* exhibited the highest sensitivity to ceftriaxone 47.8%, nitrofurantoin 43.5%, and ciprofloxacin 43.5%, indicating that these drugs could be considered as suitable treatment options for UTI caused by *E. coli*in this population. However, *E. coli* demonstrated absolute resistance to ceftazidime and a significantly high resistance to cefotaxime, cotrimoxazole, nalidixic acid, levofloxacin, and amikacin. On the other hand, Klebsiella pneumoniae demonstrated higher sensitivity to Gentamycin 62.5% followed by amikacin 37.5%, and levofloxacin37.5%. These findings highlight the importance of appropriate antibiotic selection based on the identified causative organisms and their susceptibility patterns,

which can contribute to better treatment outcomes and reduced antibiotic resistance. High resistance was observed with cefotaxim and ceftazidime. Levofloxacin and norfloxacin were equally efficient for pseudomonas aeruginosa, both with 100% sensitivities followed by amikacin, and gentamycin each with 66.7. The use of antibiotics namely fluoroquinolones or cefuroxime have been recommended for the acute phase of spinal cord injuries as bacteria are more resistant while in chronic spinal cord injuries nitrofurantoin is used as 1st line agents and fluoroquinolones as the 2nd line treatment (28). Although the use of antibiotics for treatment only applies when patients' urine dipstick or urine culture comes out positive in addition to patients presenting with any 3 of the clinical symptoms for a duration of 24hrs or more. A study by Togan et al. reported a resistance rate of E. Coli against, ciprofloxacin-61.2 % , co trimoxazole, 67.81%, ceftriaxone 50% and gentamycin 38.8% while that of Klebsiella pneumonia at; ciprofloxacin 31.7%, trimoxazole, 45%, ceftriaxone 33.0% and Gentamycin at 23.3% (6). The findings in our study varies with other study findings and we attribute this to a small sample size. Bacteria such us , *P. aeruginosa* (n= 6), *S. aureus* (n=4), *Proteus spp.*(n=4), and *E. foecalis* (n= 2)exhibited very low numbers and therefore the data generated from them might not be generalized.

5.5 The risk factors for UTI among spinal cord injured patients

Identifying risk factors associated with urinary tract infections in spinal cord injured patients is crucial for implementing targeted interventions. In this study, 1. Being bedridden was identified as a significant risk factor ($p < 0.001$). Reduced mobility in spinal cord injured patients can lead to prolonged periods of catheterization, compromised bladder emptying, and impaired urine flow, which provide favorable conditions for bacterial growth and infection (10). It is essential to emphasize the importance of frequent repositioning, proper hygiene, and regular bladder emptying techniques to minimize the risk of urinary tract infections in this patient population. 2, Catheterization practice, which includes type of catheter, catheterization time, and frequency of catheter change, proved to be critical in terms of risk for UTI in SCIP. Similar studies have identified these as risk factors for UTI(32). Our findings are in agreement with previously published evidence encouraging least catheterization time, and alternative urine voiding practice. Bladder draining methods such as condom drainage, clean intermittent catheterization (CIC), pubic cystostomy, voiding normally and reflex voiding decreased the risk of acquiring a UTI and

subsequent bacteriuria (10). Increase in the interval between catheterization because of a low catheterization frequency led to an increase in bacteriuria incidence thus patients unable to carry out clean intermittent catheterization on their own are also placed at greater risk. Patients using clean intermittent catheterization as a drainage method have a similar UTI incidence as those using condom drainage though patients using condom drainage possess a greater urinary incontinence incidence compared to those using clean intermittent catheterization. Suprapubic catheterization is effective in drainage and has low risk of causing urinary tract infections (23).

In addition to these risks, this study also established that those with complete spinal cord injury ($p = 0.022$) were at considerable risk for UTI in. Complete spinal injury is most likely correlated with other risk factors such being bedridden, a functional independent score of less than 74 and prolonged catheterization, thus the increased risks for UTI(32). However, our study showed there was no statistically significant associations between age ($p = 0.329$), sex ($p = 0.334$), or level of injury ($p = 0.682$ with UTI in SCIP. However, a study by Torgan et all identified a level of cervical lesion as a significant risk factor for UTIs(6). A study by Ruez et al. also identified cervical injury as a significant risk factor while sex wasn't. this is in comparison to our study that did not find any association in the two categories(32).

5.6 Study Limitations

While this study has provided valuable insights into the prevalence, causative organisms, antimicrobial sensitivity patterns, and risk factors for urinary tract infections among spinal cord injured patients, there are certain limitations that should be considered. Firstly, the study design was cross-sectional, which limits the ability to establish causality and determine the temporal relationship between risk factors and urinary tract infections. Secondly, the study was conducted at a single center, which may limit the generalization of the findings to other settings. Future research should consider longitudinal designs and multi-center collaborations to further explore the complex interplay between risk factors, causative organisms, and urinary tract infections in spinal cord injured patients

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusion

This study highlights the high prevalence of urinary tract infections among spinal cord injured patients, with *E. coli* and *Klebsiella pneumoniae* being the most common causative organisms. The antimicrobial sensitivity patterns provide valuable insights into appropriate antibiotic choices, with E. coli showing high sensitivity to Nitrofurantoin and Levofloxacin, and *Klebsiella pneumoniae* being more sensitive to Gentamicin, Levofloxacin, and Amikacin. Additionally, mobility was identified as a significant risk factor for urinary tract infections in spinal cord injured patients. These findings emphasize the need for comprehensive prevention strategies, including mobility promotion and judicious antibiotic use, to reduce the burden of urinary tract infections and improve the overall management of spinal cord injured patients.

6.2 Recommendations

The inferences arrived at from the study findings guide on the following recommendations;

1. The drug of choice for UTI in spinal cord- injured patients should be fluoroquinolones but culture and sensitivity should precede prescription of antibiotics.
2. Encourage patient mobility and encourage urethral catheter change within 14 days to reduce the risk of acquiring urinary infections.
3. There should be a standardized catheterization protocol based on evidence, that should be followed for spinal cord injured patients, which would be critical to reducing UTI incidences

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APPENDICES

Appendix A: Questionnaire

Title: **PREVALENCE, CAUSATIVE ORGANISMS AND RISK FACTORS FOR URINARY TRACT INFECTIONS (UTI) IN SPINAL CORD INJURED PATIENTS.**

Investigator: Dr. Erick Misati Bwengi, Resident Department of Orthopedics and Trauma Surgery, University of Nairobi

Form no: ……..

1. Age…….. years
2. Sex: Male / Female
3. When did you sustain the SCI? dd/mm/yyyy ……..
4. Level of spinal cord injury
    a. Cervical
    b. Thoraxic
    c. Lumbar
    d. Sacral
5. Did you have a pre-existing bladder pathology at time of injury: Yes / No
6. Do you have any preexisting comorbidities……..
    a. Associated injuries
    b. Diabetes
    c. Hypertension
    d. Others ……..
7. Duration of catheterization……. Days
8. Frequency of catheter change…..
9. Type of catheterization
    a. Suprapubic.

b. Urethral.

c. Intermittent.

10. Type of catheter

a. Silicon latex coated catheter.

b. Latex

11. Stool incontinence ……

12. Patient mobility

a. Bed ridden

b. Ambulating.

13. Sensitivity of identified bacteria to administered antibacterial medication

Appendix B-I: Consent form – English Version

PARTICIPANT INFORMATION AND CONSENT FORM FOR ENROLLMENT IN THE STUDY: ADULT PATIENT CONSENT FORM

Title of Study: PREVALENCE, CAUSATIVE ORGANISMS AND RISK FACTORS FOR URINARY TRACT INFECTION(UTI) IN SPINAL CORD INJURED PATIENTS.

Principal Investigator: Dr. Erick Misati Bwengi

Institution: Resident at The University of Nairobi**,** Department of Orthopedics Surgery.

Introduction:

I am Dr Erick Misati Bwengi. I am a master's student in orthopedic surgery currently undertaking my research in urinary tract infections in patients with spinal cord injury.

This consent informs you on this research for purposes of making a decision on whether to participate. You are free to ask questions, its purpose, implications

, risks and benefits, volunteer rights, and any added information not included in this form that needs clarification.

You should understand the general principles which apply to all participants in medical research:

i) Participation in the study is on voluntary basis.
ii) You have a right to withdraw from this study without citing reasons.
iii) Declining to consent to this study, will not in any way affect services accorded to you in Kenyatta National Hospital.

A copy of this form will be provided to you for your records.

May I continue? YES / NO

This study has approval by The Kenyatta National Hospital-University of Nairobi Ethics and Research Committee Protocol No. P185/03/2023

What Is This Study About?

The above researchers are interviewing individuals who have spinal cord injury.

All those who take part in this research study may have their past records interrogated. You will also be required to provide a urine sample for analysis. The urine sample shall further be assessed for presence of microbials, and antibiotic sensitivity patterns shall be assess as well. There will be approximately 73 participants in this study who are randomly chosen. We request for your consent to consider taking part in this study.

What Will Happen If You Decide To Be In This Research Study?

If you agree to take part in this research, the following will happen:

You will be interviewed in an area where your privacy guaranteed and you are comfortable to answer questions. The interview will take few minutes. If necessary, we will ask your phone number to contact you. Any contact information you provide will be used only by people conducting this study and will never be shared with others.

Are There Any Risks, Harms Discomforts Associated with This Study? Generally, medical research has the potential to introduce psychological, social, emotional and physical risks. One of the risks of being in the study is loss of privacy. Any information you give us is confidential and we will keep it private. We will identify you with a code-number in a password-protected computer database and all our paper records will be kept in a secure cabinet. You have the right to decline the interview or any questions asked in the process. Also, all our staff conducting this study are professionals with training in these examinations/interviews.

Are There Any Benefits Being In This Study?

The study will help us understand better the rates of urinary tract infection after spinal cord injuries and contributing factors at Kenyatta National Hospital and other selected hospitals. This will further enable us to create feasible local guidelines guiding the same.

Will Being In This Study Cost You Anything?

No additional costs will be incurred.

Can I Withdraw From The Study Anytime?

Participation in the study is on voluntary basis and you have a right of withdrawal from the study and that at anytime you can decide to withdraw from the study without necessarily giving a reason for your withdrawal. This does not in any way affect services provided to you in the facility or in any other health facility.

For more information about your rights as a research participant you may contact the following persons:

Principal investigator:

Dr. Erick Misati Bwengi, Department of Orthopedics and Trauma surgery**,** University of Nairobi,

Lead Supervisor:

DR. GEORGE K. MUSEVE, Department of Orthopedics and Trauma surgery, University of Nairobi. Tel no.:+254733610775

Or

The Secretary,

Kenyatta National Hospital-University of Nairobi Ethics and Research Committee

Telephone No. 2726300 Ext. 44102

Email: uonknh_erc@uonbi.ac.ke.

Appendix B-II: Consent Form (Statement of Consent)-ADULTS

Participant's statement

1. I have read or had the content read to me and understood.
2. I have been given the chance to ask questions about this research study.
3. My questions have been adequately answered in a language I understand.
4. The potential risks and benefits have been clearly explained.
5. I voluntarily accept to participate and can withdraw anytime.

By signing this consent form, I have not given up my legal rights as a participant in this research.

I agree to participate in this research study: Yes/ No

Participant printed name: _____

Participant signature / Thumb stamp _____ Date _____

Researcher's statement

I, the undersigned, have explained the details of this research to the participant named above and believe that the participant has understood and willingly and freely given his/her consent.

Researcher's Name: **Dr. Erick Misati Bwengi**

Date: _____ Signature _____

Role in the study: Principal investigator.

For more information, contact:

Principal investigator:

Dr. Erick Misati Bwengi, Department of Orthopedics and Trauma surgery, University of Nairobi. Phone: +254722814185

Lead Supervisor:

DR. GEORGE K. MUSEVE, Department of Orthopedics and Trauma surgery, University of Nairobi. Tel no.:+254733610775.

Or

The Secretary,

Kenyatta National Hospital-University of Nairobi Ethics and Research Committee. Telephone No. 2726300 Ext. 44102. Email: uonknh_erc@uonbi.ac.ke.

Appendix C-I: Fomu ya Idhini Ili Kushiriki Katika Utafiti- (Watu Wazima)

Kichwa: PREVALENCE, CAUSATIVE ORGANISMS AND RISK FACTORS FOR URINARY TRACT INFECTION(UTI) IN SPINAL CORD INJURED PATIENTS.

Mpelelezi Mkuu Na Ushirika Wa Kitaasisi: Dr. Erick Misati Bwengi, Mwanafunzi wa Shahada ya Uzamili Katika Chuo Kikuu Cha Nairobi, Idara ya Magonjwa ya mifupa

Mimi ni Daktari; Hivi sasa ninaendelea na masomo yangu ya uzamili katika Chuo Kikuu cha Nairobi.

Katika masomo yangu, ninahitajika kufanya utafiti. Ninafanya utafiti kuchunguza magonjwa ya mfuko wa maji kwa wale walio umia uti wa mgongo.

Ningependa kukuelezeakuhusu utafiti huu. Madhumuni ya fomu hii ya idhini ni kukupa habari kukusaidia kuamua iwapo utakuwa mshiriki au la. Uko huru kuuliza maswali yoyote, madhumuni yake, maana ya wewe kushiriki , hatari yoyote inayohusika, faida yoyote, haki za kujitolea,. Baada ya kuridhika, utafanya uamuzi kushiriki au la. Utaratibu huu unajulikana kama 'idhini ya habari'. Baada ya kukubali kushiriki, nitakuomba utie sahihi na jina lako kwenye fomu hii.

Unapaswa kuelewa kwamba

i. Kushiriki katika utafiti ni kwa hiari.
ii. Unaweza kuamua kujiondoa wakati wowote bila kupeana sababu.
iii. Kutoshiri katika utafiti, haiathiri huduma unayopewa katika kituo hiki cha Kenyatta National Hospital.
iv. Tutakupa nakala ya fomu hii kwa rekodi zako.

Naweza kuendelea? NDIO AU LA

Utafiti huu umeidhinishwa na Itifaki ya Kamati ya Maadili na Utafiti ya Hospitali ya Kitaifa ya Kenyatta-Chuo Kikuu cha Nairobi Nambari (P185/03/2023)

Utafiti Huu Unahusu Nini?

Watafiti hapo juu wanawahoji wagonjwa ambao wana shida ya uti wa mgongo na wale ambao wanatumia mpira katika shughuli ya haja ndogo. Sababu ya mahojiano ni kujua umri wako, aina ya mpira, na muda wa kutumia mpira wa mkojo. Kutakuwa na takriban washiriki 80 katika utafiti huu ambao wamechaguliwa bila mpangilio. Tunaomba idhini yako kufikiria kushiriki katika utafiti huu.

Je, Nini Kitatokea Ukiamua Kuwa Kwenye Utafiti Huu?

Ukikubali kushiriki katika utafiti huu, yafuatayo yatatokea:

Utahojiwa katika eneo ambalo faragha yako imehakikishiwa na unahisi vizuri kujibu maswali. Baada ya mahojiano, tutabadilisha mpira wa mkojo kisha tutachukua mkojo ili kupima.. Maelezo yoyote ya mawasiliano utakayotoa yatatumika tu na watu wanaofanya utafiti huu na hawatashirikiwa na wengine.

Je, Kuna Athari Zozote, Madhara, Usumbufu Zinazohusiana Na Utafiti Huu?

Kwa ujumla, utafiti wa matibabu una uwezo wa kuanzisha hatari za kisaikolojia, kijamii, kihemko na kiafya. Moja ya hatari ya kuwa katika utafiti huu ni kupoteza faragha. Habari yoyote unayotupatia ni ya siri.

Tutatumia nambari ya kukutambulisha kwenye hifadhidata ya kompyuta inayolindwa na nywila na rekodi zetu zote za karatasi zitahifadhiwa kwenye baraza la mawaziri iliyofungwa. Una haki ya kukataa mahojiano au maswali yoyote yanayoulizwa katika mahojiano. Pia, wafanyikazi wetu wote wanaofanya utafiti huu ni wataalamu wenye mafunzo mahojiano haya.

Je, Kuna faida zozote ziko katika huu utafiti?

Utafiti huo utatusaidia kuelewa vizuri jinsi za kuchunguza ukuaji mzuri wa kijusi. Hii itapanua zaidi ufahamu wetu.

Je, Kuna Gharama Kuwa Katika Utafiti Huu?

Hakuna gharama za ziada zitakazopatikana.

Je, Ninaweza Kuondoka Kwenye Utafiti Wakati Wowote?

Kushiriki utafiti huu ni kwa hiari. Una haki ya kujiondoa wakati wowote bila kutoa sababu.. Hii haiathiri kwa vyovyote huduma unazopewa katika kituo hiki.

Kwa habari zaidi juu ya haki zako kama mshiriki wa utafiti kuwasiliana na watu wafuatao:

Mchunguzi Mkuu:

Dr. Erick Misati Bwengi: Department of Orthopedics and Trauma surgery, University of Nairobi. Nambari ya Simu.: +254722814185

Msimamizi Mkuu:
DR. GEORGE K. MUSEVE, Department of Orthopedics and Trauma surgery, University of Nairobi. Nambari ya Simu:+25473310775

Ama,

Katibu,

Kenyatta National Hospital-University of Nairobi Ethics and Research Committee. Nambari ya simu :. 2726300 Ext. 44102. Email:uonknh_erc@uonbi.ac.ke.

Appendix E: Fomu Ya Idhini (Watu Wazima)

Kichwa Cha utafiti: PREVALENCE, CAUSATIVE ORGANISMS AND RISK FACTORS FOR URINARY TRACT INFECTION(UTI) IN SPINAL CORD INJURED PATIENTS.

Jina la Mtafitu: Dr. Erick Bwengi, mwanafunzi wa Shahada ya Uzamili Katika Magonjwa ya mifupa **Chuo Kikuu cha Nairobi, Idara ya** Magonjwa ya mifupa

1. Nimesoma/ nimesomewa fomu hii ya idhini na nimeelewa.

2. Nimepewa nafasi ya kuuliza maswali juu ya utafiti huu.

3. Maswali yangu jamejibiwa katika lugha ninayoelewa.

4. Nimeelezewa hatari na faidha zote zinazowezekana.

5. Ninaelewa kuwa nashiriki kwa hiari na kwamba ninaweza kujiondoa wakati wowote.

Kwa kutia sahihi fomu hii, sijatoa haki yoyote ya kisheria ambayo ninayo kama mshiriki.

Ninakubali kushiriki katika utafiti huu: Ndio / Hapana

Ninakubali kutoa habari ya mawasiliano kwa ufuatiliaji: Ndio / Hapana

Jina: _____

Saini ya mshiriki / Stempu ya kidole gumba _____

Tarehe _____

Kauli ya mtafiti

Mimi, aliyesainiwa chini, nimeelezea maelezo yanayofaa ya utafiti huu kwa mshiriki aliyetajwa hapo juu na ninaamini kwamba mshiriki ameelewa na kwa hiari ametoa idhini yake.

Jina la mtafiti: DR. Erick Misati Bwengi.

Saini _____
Wajibu katika utafiti: Mchunguzi mkuu.

Kwa habari zaidi, wasiliana na:

Mchunguzi Mkuu:

Dr. Erick Bwengi, Department of Orthopedics and Trauma surgery, University of Nairobi. Nambari ya Simu.: +254722814185

Msimamizi Mkuu:

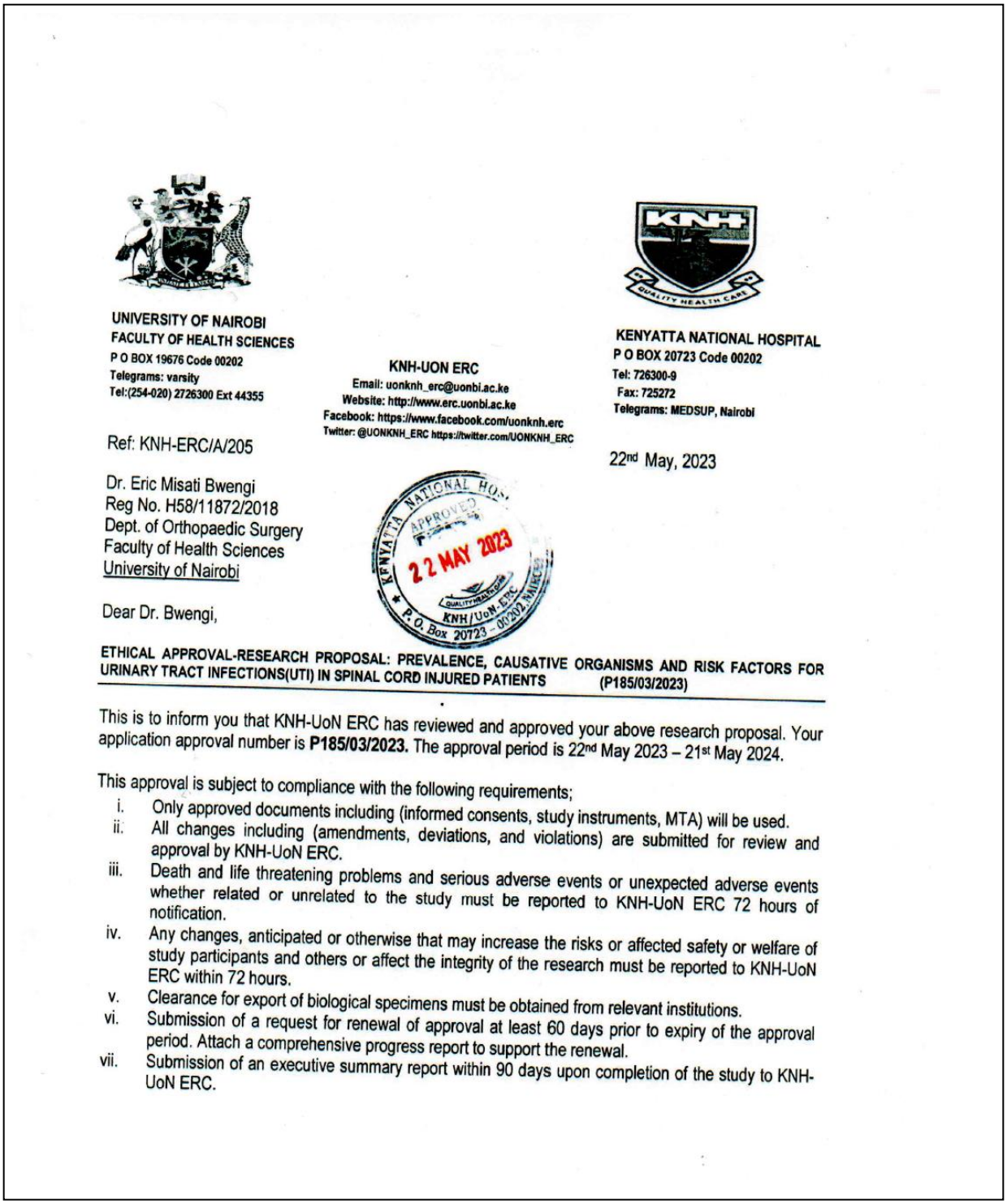
DR. GEORGE K. MUSEVE, Department of Orthopedics and Trauma surgery, University of Nairobi. Nambari ya Simu: +254733610775

Ama,

Katibu,

Kenyatta National Hospital-University of Nairobi Ethics and Research Committee, Nambari ya simu :. 2726300 Ext. 44102. Email:uonknh_erc@uonbi.ac.ke.

Appendix F: Ethical approval



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Ref: KNH-ERC/A/205

22nd May, 2023

Dr. Eric Misati Bwengi
Reg No. H58/11872/2018
Dept. of Orthopaedic Surgery
Faculty of Health Sciences
University of Nairobi

KENYATTA NATIONAL HOSPITAL APPROVED 22 MAY 2023 KNH/UoN-ERC P.O. Box 20723 - 00202 NAIROBI

Dear Dr. Bwengi,

ETHICAL APPROVAL-RESEARCH PROPOSAL: PREVALENCE, CAUSATIVE ORGANISMS AND RISK FACTORS FOR URINARY TRACT INFECTIONS(UTI) IN SPINAL CORD INJURED PATIENTS (P185/03/2023)

This is to inform you that KNH-UoN ERC has reviewed and approved your above research proposal. Your application approval number is **P185/03/2023.** The approval period is 22nd May 2023 – 21st May 2024.

This approval is subject to compliance with the following requirements;

i. Only approved documents including (informed consents, study instruments, MTA) will be used.
ii. All changes including (amendments, deviations, and violations) are submitted for review and approval by KNH-UoN ERC.
iii. Death and life threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to KNH-UoN ERC 72 hours of notification.
iv. Any changes, anticipated or otherwise that may increase the risks or affected safety or welfare of study participants and others or affect the integrity of the research must be reported to KNH-UoN ERC within 72 hours.
v. Clearance for export of biological specimens must be obtained from relevant institutions.
vi. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. Attach a comprehensive progress report to support the renewal.
vii. Submission of an executive summary report within 90 days upon completion of the study to KNH-UoN ERC.

Prior to commencing your study, you will be expected to obtain a research license from National Commission for Science, Technology and Innovation (NACOSTI) https://research-portal.nacosti.go.ke and also obtain other clearances needed.

Yours sincerely,

DR. BEATRICE K.M. AMUGUNE
SECRETARY, KNH- UoN ERC

c.c. The Dean, Faculty of Health Sciences, UoN
The Senior Director, CS, KNH
The Chairperson, KNH- UoN ERC
The Assistant Director, Health Information Dept., KNH
The Chair, Dept. of Orthopaedic Surgery, UoN
Supervisors: Dr. George K Museve, Dept. of Orthopaedic Surgery UoN
Dr. Edward M Gakuya, Dept. of Orthopaedic Surgery UoN

Appendix G: National Commission for Science, technology and innovation license

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **746503**

Date of Issue: **27/July/2023**

RESEARCH LICENSE

This is to Certify that Dr.. Erick Misati Bwengi of University of Nairobi, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Nairobi on the topic: PREVALENCE, CAUSATIVE ORGANISMS AND RISK FACTORS FOR URINARY TRACT INFECTIONS (UTI) IN SPINAL CORD INJURED PATIENTS for the period ending : 27/July/2024.

License No: **NACOSTI/P/23/28130**

746503

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

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See overleaf for conditions

Appendix- H Plagiarism report

Dr Mwenve G.K 12/10/23

Dr. Nyaim 19/10/23

DEPARTMENT OF SURGERY
FACULTY OF HEALTH SCIENCES
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Final Research Report - Dr. Bwengi-1.docx

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