

The Prevalence of Nosocomial Urinary Tract Infections in
patients with indwelling urinary catheters at Kenyatta National
Hospital

By

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*A research proposal in part fulfillment of the Master's degree Programme in Human
Pathology.*

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May you be blessed.

Declaration

I Dr Peter Maturi declare that the work contained herein is my original idea and has not been presented at any other place to the best of my knowledge.

Signed.....

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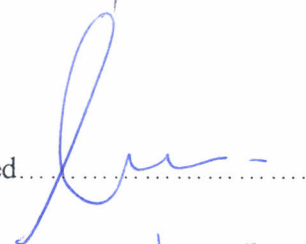
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ABSTRACT

Urinary tract infection is one of the most common forms of nosocomial infection in patients and urinary catheterization is the most frequent predisposing factor. These infections cause considerable morbidity and mortality and confer a great financial burden on the medical care system. This study was performed to determine the incidence of catheter-associated bacteriuria, to isolate the etiologic organisms, and to assess their sensitivity most frequently prescribed antibiotics.

Methods

Two urinary specimens were taken from the catheters of 80 patients admitted at Kenyatta National hospital general wards and special units who carried an indwelling urinary catheter for a duration of >12 hours. The first specimen was taken at the time of catheterization and the second was taken after 72 hours.

Results

Of 80 patients, 16 (20%) had a positive culture from which six different strains were isolated. 37.5% of the strains belonged to *Escherichia coli*. All of these strains were sensitive to Meropenam and Tazopiperacillin. The sensitivity to commonly used antibiotics like Gentamicin and Ciprofloxacin was poor at 43.8% and 37.5% respectively. Most of the organisms isolated were moderately sensitive to Augmentin (62.5%), Cefuroxime (68.8%), Nalidixic acid (56.3%), Amikacin (56.3%), Nitrofurantoin (50%), and Ceftazidime (68.8%)

Conclusion

From this study it is appropriate to conclude that the prevalence rate at KNH is high at 20% and that the commonest Catheter associated urinary tract infections (CAUTI) nosocomial microorganisms are enteric bacteria including *E coli* and *Klebsiella pneumoniae*. Most organisms isolated show considerable resistance to the commonly used antibiotics including Gentamicin, Ciprofloxacin and Ceftriaxone and that Tazopiperacillin and Meropenem seem to be the most effective antibiotics for Nosocomial CAUTI

BACKGROUND

The battle between man and microbe is most obvious in institutions where vulnerable people are crowded together. Historically, hospitals have had a notorious reputation for nosocomial infections.

The hazards of puerperal sepsis and the horrors of septic infection in the pre-Listerian era have been well documented; admission to hospitals in the mid 19th century was a sure way of acquiring gangrene and even possibly death.¹

In the past two decades advances in technology and therapeutics have produced greater number of highly susceptible patients requiring treatment in hospitals and this is aggravated by the occurrence of transferable resistance to antibiotics in pathogenic bacteria and the emergence of new pathogens transmitted by a variety of routes.

Over time, surgical and medical techniques have developed dramatically and basic standards of hygiene have improved and identification and treatment of most infectious microorganisms have been made possible.

In spite of these advances in medicine many countries still have pressure on health care facilities and shortages of trained staff makes it difficult to practice adequate infection control. Infection acquired in hospitals remains a major cause of morbidity and mortality leading directly or indirectly to an enormous increase in the use of hospital care and to the emergence of new health hazards for the community.

Most patients infected with nosocomial infections have a predisposition caused by invasive supportive measures such as intubation and the placement of intravascular lines and urinary catheters.

On average around 7 - 10% of all hospital patients will develop an infection as a result of their stay in the hospital. Urinary (30 – 40%), respiratory and wound infections are the most common.²

In the United States of America nosocomial infections are estimated to occur in 5% of all acute care hospitalizations. The estimated incidence is more than 2 million cases per year, resulting in an added expenditure in excess of \$2 billion.

LITERATURE REVIEW

INTRODUCTION

Infection is a dynamic process-involving invasion of the body of pathogenic microorganisms and reaction of the tissue to organism and their toxins. Soon after birth, a variety of microorganisms colonize the external and internal surface of the human body. These indigenous microorganisms cause no harm and can even be beneficial to the individual. Infection evolves into overt disease when the equilibrium between host and parasite is upset.³

Current thinking concerning clinical disease resulting from host and parasite interrelationships recognizes the role of the general health of the host, his previous contact with infectious microorganisms, his past clinical history and various insults (toxic, traumatic or therapeutic) of non microbial organisms.⁴ Three principal factors determine the likelihood that a given patient will acquire a Nosocomial infection.⁵

1. Susceptibility of patient to the infection
2. Inoculum's and virulence of organism
3. Nature of the patient's exposure to the infecting organism.

Nosocomial infection results from the transmission of pathogens to a previously uninfected patient from a source in the hospital environment (cross infection). Or alternatively the microorganism can come from the patient himself (auto-infection).^{1,6,7} He may be a carrier of the pathogen or become colonized with virulent hospital strains during hospitalization.

Many nosocomial infections have an iatrogenic basis i.e. result from treatment by the physician and his professional collaboration. Frequent is the prolonged usage of antibiotics and procedures such as indwelling vascular, urinary catheters; tracheostomies and equipment for postoperative respiratory care are responsible for most iatrogenic infections.⁷

Two thirds (67%) of Nosocomial infections involve a single pathogen and about 20% involve multiple pathogens. Pathogens are identified in 85% of the cases and of these 85% are aerobic or facultative bacteria and 7% are fungi.⁵

URINARY TRACT INFECTIONS

Urinary Tract Infections (UTI's) are defined as the microbial colonization of the urine and tissue invasion of any structures of the urinary tract; the bladder, prostate, collecting system, and kidneys after the microbes overcome the structures' strong natural defenses.⁵ However, occasional infection may be restricted to the prostate or kidney abscess. The presence of $>10^5$ CFU/ml of urine is typically the cut off point for indication of a UTI.⁸

The urinary tract has several defense mechanisms against infection but despite these defenses, UTI's are the most common of all infections and can occur at any time in the life of an individual. Almost 95% of cases of UTI's are caused by bacteria that typically multiply at the opening of the urethra and travel up to the bladder (via the ascending route). Much less often, bacteria spread to the kidney from the bloodstream.⁹

In 1997, urinary tract infections (UTI's) accounted for about 8.3 million doctor visits in the US.¹⁰

UTI's may effect the lower or upper urinary tract leading to several possible disease states including; asymptomatic bacteriuria, cystitis, acute pyelonephritis, sub clinical pyelonephritis, renal abscess, and uro-sepsis.

Urinary tract infections (UTIs) acquired in the hospital setting are the most common Nosocomial infection in North America, occurring at a rate of approximately one million episodes per year (35–40%). They are the most frequent cause of Nosocomial bacteremia, and may produce metastatic foci of infection. Although fewer than 5% of catheter-associated UTIs result in bacteremia, 15% of all Nosocomial bacteremias are attributable to Nosocomial UTI as the initial source.¹¹

Most commonly, UTIs result from urethral catheterization, but an estimated 10% result from other urologic procedures. Another 10% are thought to be recurrences of UTI's coincidental with hospitalization.¹²

An increased incidence of UTI is found among patients with recognized risk factors such as surgery, excessive urine output, urinary retention, and urinary incontinence. Other risk factors associated with nosocomially-acquired pathogens are long-term reliance on catheterization, absence of prophylactic antibiotic use, diabetes and poor catheter care.¹⁰

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A higher incidence of UTI is found among women, but renal complications of UTI's, such as renal and peri-renal abscesses, affect men and women with equal frequency. The incidence of this complication, which generally arises from a UTI, ranges from one to 10 cases per 10,000 hospital admissions. Severe cases may progress to perinephric or renal abscess, renal papillary necrosis, xanthogranulomatous or emphysematous pyelonephritis, or cystitis.¹¹

Recent trends in microbial etiology show an increase in the number of infections caused by gram-positive cocci and fewer gram-negative rods. Empiric therapy should include agents active against *Enterococcus*, *Staphylococcus*, *Pseudomonas*, and *Enterobacteriaceae*. Many Nosocomial UTI's are caused by antibiotic resistant bacterial strains.¹³

The use of systemic antibiotics has been shown to postpone the development of UTI and, consequently, bacteremia in catheterized patients. However, the preventive use of antibiotics is effective generally only for the first few days; subsequently, resistant organisms begin to arise. The rapid emergence of resistance and the cost of antibiotic prophylaxis have resulted in many authorities recommending against the practice, except in renal transplant patients and those who are granulocytopenic.¹³

The most frequent pathogens include the flora of the colon. *E. Coli* is the major infectious agent with 6 serotypes of *E. coli* accounting for 85% of UTI's. The serotype in question usually represents the dominant serotype carried in the patient's colon. Virulence factors associated with UTI's include adherence (pili type), LPS, K capsular type, hemolysins, and iron-uptake systems.¹⁴

Exogenous organisms from unwashed hands or contaminated equipment may also contribute to infection.

In general, the further the organ in the urinary tract from the place where the bacteria enters, the less likely the organ is to be infected.

Urethritis

Is infection/inflammation of the urethra. Many sexually transmitted diseases (STD's) appear initially as urethritis. However, stool-related bacteria can also cause urethritis.

Cystitis

Is an infection of the bladder. This is the most common form of UTI; and it is aggravated if the bladder does not empty completely. Symptoms include dysuria, urinary urgency, suprapubic discomfort, and frequent voiding of small amount of urine.

Ureteritis

Is infection of the ureters. This can occur if the bacteria entered the urinary tract from the bloodstream, or if the ureter-to-bladder valves don't work properly and allow urine to "reflux" from the bladder into the ureters.

Pyelonephritis

Is an upper urinary tract infection resulting in inflammation of the renal pelvis and parenchyma. Systemic complaints such as fever and chills, as well as localized flank or back pain accompany this state. It may or may not include bacteremia. Lesions of the kidney are seen in histology. Often this disease is preceded by lower urinary tract infections.

CLASSIFICATION OF URINARY TRACT INFECTIONS

A recent categorization of UTI's is most helpful clinically because it divides patients into groups based on clinical factors and their impact on morbidity and treatment.¹⁵ These categories are as follows: acute uncomplicated cystitis in young women; recurrent cystitis in young women; acute uncomplicated pyelonephritis in young women; complicated UTI and its subcategories; UTI related to indwelling catheters; UTI in men; and asymptomatic bacteriuria.

a) Acute Uncomplicated Cystitis in Young Women

Those most at risk for UTI's are sexually active young women. Their propensity to develop UTI's has been explained on the basis of anatomy (especially a short urethra) and certain behavioral factors, including delays in micturation, sexual activity, and the use of diaphragms and spermicides (both of which promote colonization of the periurethral area with coliform bacteria).¹⁶ Fortunately, most UTIs in this population are uncomplicated and are rarely associated with functional or anatomic abnormalities.

Therefore, aggressive diagnostic work-ups are unwarranted in young women presenting with an uncomplicated episode of cystitis.^{15,17}

b) Recurrent Cystitis in Young Women

Up to 20 percent of young women with acute cystitis develop recurrent UTIs. During these recurrent episodes, the causative organism should be identified by urine culture and then documented to help differentiate between relapse (infection with the same organism) and recurrence (infection with different organisms). Multiple infections caused by the same organism are, by definition, complicated UTIs and require longer courses of antibiotics and possibly further diagnostic tests. Fortunately, most recurrent UTIs in young women are uncomplicated infections caused by different organisms. These infections are generally not associated with underlying anatomic abnormalities and do not require work-up of the genitourinary tract.^{18,19,20}

c) Complicated UTI

A complicated UTI is one that occurs because of anatomic, functional or pharmacologic factors that predispose the patient to persistent infection, recurrent infection or treatment failure. These factors include conditions often encountered in elderly men, such as enlargement of the prostate gland, blockages and other problems necessitating the placement of indwelling urinary devices, and the presence of bacteria that are resistant to multiple antibiotics. Although antibiotic-susceptible *E. coli* is responsible for more than 80 percent of uncomplicated UTIs, it accounts for less than one third of complicated cases.^{15,21} Clinically, the spectrum of complicated UTIs may range from cystitis to urosepsis with septic shock.

d) Uncomplicated Pyelonephritis

Patients with acute uncomplicated pyelonephritis may present with one of the following: a mild cystitis-like illness and accompanying flank pain; a more severe illness with fever, chills, nausea, vomiting, leukocytosis and abdominal pain; or a serious gram-negative bacteremia. In most patients, uncomplicated pyelonephritis is caused by specific uropathogenic strains of *E. coli* possessing adhesins that permit ascending infection of the urinary tract.

The diagnosis should be confirmed by urinalysis with examination for pyuria and/or white blood cell casts and by urine culture. Urine cultures demonstrate more than 10×10^5 CFU/mL of urine in 80 percent of patients with pyelonephritis. Blood cultures are positive in up to 20 percent of patients who have this infection. With the exceptions of white cell casts on urinalysis, and bacteremia and flank pain on physical examination, none of the physical or laboratory findings are specific for pyelonephritis.²¹

e) UTI in Men

Urinary tract infections most commonly occur in older men with prostatic disease, outlet obstruction or urinary tract instrumentation. These infections occasionally occur in young men who participate in anal sex (exposure to *E. coli* in the rectum), who are not circumcised (increased *E. coli* colonization of the glans and prepuce) or whose sexual partner is colonized with uropathogens.²²

In men (unlike in women), a urine culture growing more than 1,000 CFU of a pathogen per mL of urine is the best sign of a urinary tract infection, with a sensitivity and specificity of 97 %²³ Men with urinary tract infections should receive a minimum of seven days of antibiotic therapy either trimethoprim-sulfamethoxazole or a fluoroquinolone. However, more extensive courses may be required in, for example, men with associated urinary tract infection and prostatitis.

f) Catheter-Associated UTI

The urinary catheter is an essential part of modern medical care. It is widely used to relieve anatomic or physiologic obstructions, to provide a dry environment for comatose or incontinent patients, and to permit the accurate measurement of urinary output in

severely ill patients. Unfortunately, when used inappropriately or when left in place too long, it is a hazard to the very patients that it is designed to protect. Systemic antimicrobial therapy may temporarily reduce the bacterial count in the bladder urine but cannot eradicate infections in patients with indwelling urinary catheters.^{17,21} Inappropriate and excessive use of antimicrobial drugs leads to the selection of antibiotic-resistant microorganisms and Nosocomial outbreaks of infection with multi-resistant strains.

Between 10 and 20 percent of patients who are hospitalized receive an indwelling Foley catheter. Once this catheter is in place, the risk of bacteriuria is approximately 5% per day. With long-term catheterization, bacteriuria is inevitable. Catheter-associated urinary tract infections are the most common source of gram-negative bacteremia in hospitalized patients.²⁴

The diagnosis of catheter-associated urinary tract infection can be made when the urine culture shows 100 or more CFU/mL of urine from a catheterized patient. The microbiology of catheter-associated urinary tract infections includes *E. coli*, *Proteus*, *Enterococcus*, *Pseudomonas*, *Enterobacter*, *Serratia* and *Candida* species. The bacterial distribution reflects the Nosocomial origin of the infections because so many of the uropathogens are acquired exogenously via manipulation of the catheter and drainage device. Bacteriuria is often polymicrobial, especially in patients with long-term indwelling urinary catheters.

Symptomatic bacteriuria in a patient with an indwelling Foley catheter should be treated with antibiotics that cover potential Nosocomial uropathogens. Patients with mild to moderate infections may be treated with one of the oral quinolones, usually for 10 to 14 days. Parenteral antibiotic therapy may be necessary in patients with severe infections or patients who are unable to tolerate oral medications. The recommended duration of therapy for severe infections is 14 to 21 days. Treatment is not recommended for catheterized patients who have asymptomatic bacteriuria, with the following exceptions: patients who are immunosuppressed after organ transplantation, patients at risk for

bacterial endocarditis and patients who are about to undergo urinary tract instrumentation.²⁵

Bacteriuria is almost inevitable with long-term catheterization, and prevention strategies have largely been unsuccessful. In such patients, catheters should be changed periodically to prevent the formation of concretions and obstruction that can lead to infection. The use of proper aseptic technique on insertion combined with a closed drainage system caused a significant reduction in infection in the short term as confirmed by Kunin and McCommarck.²⁶ Prophylactic systemic antibiotics have been shown to delay the onset of bacteriuria in catheterized patients, but this strategy may lead to increased bacterial resistance.²⁵ Prophylactic antibiotic therapy has been successful in reducing the frequency of bacteriuria only in patients who can be weaned from indwelling catheters to intermittent catheterization.

g) Asymptomatic Bacteriuria

Asymptomatic bacteriuria is defined as the presence of more than 10×10^5 CFU/mL of voided urine in persons with no symptoms of urinary tract infection. The largest patient population at risk for asymptomatic bacteriuria is the elderly. Up to 40 percent of elderly men and women may have bacteriuria without symptoms. Although early studies noted an association between bacteriuria and excess mortality, more recent studies have failed to demonstrate any such link.⁹ In fact, aggressively screening elderly persons for asymptomatic bacteriuria and subsequent treatment of the infection has not been found to reduce either infectious complications or mortality. Consequently, this approach currently is not recommended. Three groups of patients with asymptomatic bacteriuria have been shown to benefit from treatment:

- (1) Pregnant women
- (2) Patients with renal transplants and
- (2) Patients who are about to undergo genitourinary tract procedures.²¹

Between 2 and 10 percent of pregnancies are complicated by UTIs; if left untreated, 25 to 30 percent of these women develop pyelonephritis.^{10, 12} Pregnancies that are complicated

by pyelonephritis have been associated with low-birth-weight infants and prematurity. Thus, pregnant women should be screened for bacteriuria by urine culture at 12 to 16 weeks of gestation. The presence of 10×10^5 CFU of bacteria per mL of urine is considered significant.

PATHOPHYSIOLOGY OF URINARY TRACT INFECTIONS:

a) Microbiology of the urinary system

The urinary tract is protected from infection by the "normal" flora serving as a barrier to infection. In males and females the distal portion of the urethra is colonized by an autochthonous flora that protects the mucosal surface by preventing mainly gram-negative organisms from establishing themselves at these sites. These organisms may include *diphtheroids*, *alpha* and *non-hemolytic streptococci*, *Peptococcus*, *Staphylococcus epidermidis*, and *Bacteroides*. In the vagina, *Lactobacillus spp.* is found along with other autochthonous flora, again serving to restrict colonization by principally fecal derived organisms.²⁷

Urine is normally sterile that is, it does not normally contain bacteria. This is a good thing, since the mineral and sugar content of urine make it a great medium for bacteria to grow in. Usually several things keep bacteria out of the urine. These include:²⁸

- The urethral sphincter: when the urethra is squeezed shut, bacteria cannot climb up the urethra from the "meatus" (the outside opening) into the bladder.
- The length of the urethra in males: it's a long way up to the bladder for a bacterium. In woman the urethra is shorter than in men hence women are much more likely than men to get UTI's.
- Frequent washing: any bacteria that make it into the urethra are flushed out the next time one urinates, and since the bladder empties almost completely after urinating any bacteria that get that far are flushed out. Furthermore, there are valves at the points where the ureters enter the bladder to prevent urine from "refluxing" from the bladder to the kidneys, so even if the bladder and its urine is infected the bacteria shouldn't travel up to the kidneys.

- In men, the prostate gland produces secretions that slow bacterial growth.

But despite these safeguards, infections still occur.²⁷

b) How does an infection start?

The urinary tract can be infected from above by bacteria entering the kidneys from the bloodstream and descending downward or from below by bacteria entering the urethra ascending the urinary tract.

Infection from above is most often seen in newborns with generalized infection or "sepsis". If there are many bacteria in the bloodstream, some are likely to get through the filters of the kidney to the urine. This is especially likely if the filters are immature, or if there are a lot of bacteria.

In older children and adults infection most often starts from below. In small children still using diapers, stool (which is largely bacteria) can sit for some time right at the meatus; the longer it sits there, the more likely it is that bacteria may enter the urethra. Note, though, that bacteria can hang out in any moist, warm area, and that UTI's seem to happen more often in uncircumcised boys than in circumcised boys since bacteria can accumulate beneath the foreskin. Older girls may become prone to UTI's through wiping back-to-front when they are first toilet-trained, which pulls stool into the vaginal/meatal area. Sexually active teenage and adult women are more prone to UTI's because of friction at the meatus, which tends to push bacteria into the urethra (urinating after intercourse helps avoid UTI's); the same mechanism may cause UTI's in teenage boys and adult men, although they are again less prone to UTI's than women of the same age.^{28, 27}

c) Mechanisms of how indwelling catheters cause infections

The mechanisms by which the indwelling catheters produce infection are now well established. These consist initially of ascending colonization of the urine within the catheter lumen and eventually along the space between the urethra and the catheter surface to reach the bladder, or by entering at the urethral meatus and migrating up the urethra around the catheter.²⁹ Dukes³⁰ demonstrated the efficacy of closed drainage to

block ascending infection in 1928. Disposable closed drainage systems became widely available almost 40 years ago.³¹ None of the numerous attempts to improve the system have been shown to be more effective than simple closed drainage. The only truly novel drainage bag that is a non-reusable system containing a water-absorbing polymer that traps bacteria and urine.²⁵ It is purported to avoid ascending infection and cross-contamination.

The more common and significant mechanism of how catheters cause bacteriuria occur at the time of insertion of the catheter, since even in-out catheterization has a significant incidence of bacteriuria.²⁹

SYMPTOMS OF URINARY TRACT INFECTIONS

The symptoms a person has with a UTI depend on how old the person is and on where in the urinary tract the infection is located.¹³

Cystitis may show up as burning on urination, often in the "middle" of urination. However, it may have no symptoms other than fever, lower abdominal way down -- just above the pubic bone pain, or even just a funny smell or color or appearance such as cloudy, dark, even blood-tinged to urine.⁸

Blood in the urine can be a sign and sometimes the only sign at first of a urinary tract infection. It can result from microscopic bleeding within the kidneys, or from an abscess if the infection is far advanced. Blood can also appear in urine from a bleed anywhere between the kidneys and the urinary meatus. Blood that appears just as a patient starts to urinate and clears up as the flow continues indicates that the bleeding is in the urethra and on the other hand, blood that is uniformly mixed with the urine is likely coming from the kidneys or the ureters.³²

Pyelonephritis may appear as pain at the flanks or in the abdomen. Fever usually comes along with this pain. If the kidneys are severely affected, then there may be features of renal failure.³

MICROORGANISMS CAUSING NOSOCOMIAL INFECTIONS:

Viruses are the leading etiologies of Nosocomial infections. Bacterial and fungal infections are less common. However they are significantly associated with more morbidity and mortality.³³

With the advent of surgery and intensive care, use of broad-spectrum antibiotics and immunosuppressive drugs, gram-negative bacteria increased in importance. Many such e.g. *Pseudomonas aeruginosa* are opportunistic microbes capable of causing infections in immune-compromised patients. Such microbes may be found in patient's own flora or in a dump environment including equipment and medication. They may exhibit natural resistance to many antibiotics and antiseptics and have the ability to colonize traumatized skin such as burns and bedsores.¹³

Normal urine is sterile. It contains fluids, salts, and waste products, but it is free of bacteria, viruses, and fungi. An infection occurs when microorganisms, usually bacteria from the digestive tract, cling to the opening of the urethra and begin to multiply.

Most nosocomial urinary tract infections arise from one type of bacteria, *E. coli*, which normally lives in the colon. However it is less important in Nosocomial infections than *Klebsiella*, *Enterobacter* and *Pseudomonas* and other antimicrobial resistant microorganisms.

Microorganisms causing infection in dominiciary practice in order of frequency include.

26, 34

<i>Escherichia coli</i> and other coliforms	68-80%
<i>Proteus mirabilis</i>	12%
<i>Klebsiella pneumoniae</i>	4-6%
<i>Pseudomonas</i>	12%
<i>Enterococcus faecalis</i>	16%
<i>Staphylococcus aureus</i>	10%

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Enterococci are frequently encountered uropathogens in complicated UTIs. In areas in which vancomycin-resistant *Enterococcus faecium* is prevalent, the investigational agent quinupristin-dalfopristin (Synercid) may be useful.³⁵

Studies have shown that gram-positive and gram-negative bacteria account for nearly 50% of the infections (63/133 or 47%, and 70/133 or 53% of the isolated microorganism, respectively). Generally, there has been an increase in vancomycin-resistant *Enterococcus* and in quinolone-resistant *Pseudomonas aeruginosa*.³⁶

One-day point-prevalence survey conducted in Turkey by Leblebicioglu et al showed that 78.4% of UTIs were culture-proven. *Escherichia coli* (32.4%) was the most common reported pathogen, followed by *Klebsiella pneumoniae*. (17.0%), *Candida spp.* (12.8%), *Pseudomonas aeruginosa* (11.7%) and enterococci 8.5%.³⁷

Chlamydia and *Mycoplasma* may also cause UTIs in both men and women, but these infections tend to remain limited to the urethra and reproductive system. Unlike *E. coli*, *Chlamydia* and *Mycoplasma* may be sexually transmitted, and infections require treatment of both partners. .³⁸

Despite growing patterns of resistance, there is evidence that overall rates of Nosocomial infection have remained stable during the past decade. Nonetheless, rates of Nosocomial bloodstream infection appear to have increased, according to the National Nosocomial Infection Surveillance System data.³⁹

DIAGNOSTIC CRITERIA FOR URINARY TRACT INFECTIONS

Table 1⁸

Condition	Significant bacteriuria (CFU/mL)
Acute cystitis	10 ³ (? 10 ²)
Acute uncomplicated pyelonephritis	10 ⁴
UTI in males	10 ⁴
Suprapubic aspirate	Any isolates
Catheterized specimen	10 ³
Asymptomatic bacteriuria	10 ⁵ of a single species in 2 specimens

The diagnosis of UTI was once based on a quantitative urine culture yielding greater than 1 x 10⁵ CFU of bacteria per milliliter of urine, which was termed "significant bacteriuria."

⁴¹ This value was chosen because of its high specificity for the diagnosis of true infection, even in asymptomatic persons. However, several studies⁴² have established that one third or more of symptomatic women have CFU counts below this level (low-coliform-count infections) and that a bacterial count of 100 CFU/mL of urine has a high positive predictive value for cystitis in symptomatic women.

Unfortunately, some clinical laboratories do not report counts of less than 10⁴ CFU/mL of urine. As a result, low-coliform-count infections are not diagnosed by these laboratories.

In view of the limited spectrum of causative organisms and their predictable susceptibility, urine cultures and susceptibility testing add little to the choice of antibiotic for the treatment most UTI's. Therefore, urine cultures are no longer advocated as part of the routine work-up of these patients. Instead, these patients should undergo an abbreviated laboratory work-up in which the presence of pyuria is confirmed by traditional urinalysis (wet mount examination of spun urine), the cell-counting chamber technique or a dipstick test for leukocyte esterase.^{43,44}

A positive leukocyte esterase test has a reported sensitivity of 75 to 90 percent in detecting pyuria associated with a UTI. Gram staining of unspun urine can be used to detect bacteriuria. In this semi-quantitative test, one organism per oil immersion field correlates with 10⁴ CFU/mL by culture⁴⁴. Because the procedure is time-consuming and

has low sensitivity, it is not routinely performed in most clinical laboratories unless it is specifically requested. In today's office practice, the dipstick test for nitrite is used as a surrogate marker for bacteriuria. It should be noted that not all uropathogens reduce nitrites to nitrite. For example, enterococci, *S. saprophyticus* and *Acinetobacter* species do not and therefore give false-negative results.

COMPLICATIONS OF UTI IN CATHETERIZED PATIENTS

Urinary catheterization is such a common procedure that even if the rate of complications is low, a significant number of patients will develop complications.¹³

The biggest problem with a UTI is if it progresses to pyelonephritis. This can result in scarring and damage to the kidney tissue and may lead to kidney failure, and if it is bad enough and long-lasting enough the only solutions are dialysis and a kidney transplant which also poses many risks and problems.⁸

A different complication occurs if the pressure-regulation tissues of the kidney are scarred leading to poor regulation of the blood pressure.³²

These problems may occur rapidly, but only if the infection is very severe. More often, the damage done by the initial infection, even if it is not compounded by future infections, progresses over many months or years. In particular renal failure may not be complete until long after the first UTI.

PREVENTIVE AND CONTROL MEASURES

An estimated 4 million patients are subjected yearly to urinary catheterization and, therefore, are at risk for catheter-associated infection and its related sequelae. One of the most important infection control measures is to limit the use of urinary catheters to carefully selected patients, thereby reducing the size of the population at risk. Generally, urinary catheterization is indicated:

- To relieve urinary tract obstruction
- To permit urinary drainage in patients with neurogenic bladder dysfunction & urinary retention

- To aid in urologic surgery or other surgery on contiguous structures, and
- To obtain accurate measurements of urinary output in critically ill patients.

Specifically, urinary catheterization should be discouraged as a means of obtaining urine for culture or certain diagnostic tests such as urinary electrolytes when the patient can voluntarily void or as a substitute for nursing care in the incontinent patient.

In selected populations, other methods of urinary drainage exist as possible alternatives to the use of the indwelling urethral catheter. Condom catheter drainage may be useful for incontinent male patients without outlet obstruction and with an intact voiding reflex. Its use, however, requires meticulous nursing care if local complications such as skin laceration or phimosis are to be avoided. In addition, frequent manipulation of the condom catheter drainage system (e.g., by agitated patients) has been associated with an increased risk of urinary tract infection⁴.

Another alternative, suprapubic catheter drainage, is most frequently used in patients on urologic or gynecologic services. Although preliminary data on the risk of infection are encouraging^{81,82}, the benefit of the suprapubic catheter with regard to infection control has not been proven by controlled clinical studies.

For certain types of patients with bladder-emptying dysfunction, such as those with spinal cord injuries or children with meningomyelocele, a third alternative, intermittent catheterization, is commonly employed. The "no-touch" method of intermittent catheterization advocated by Guttman³⁴ is generally reserved for patients hospitalized during the acute phase of their spinal cord injury, while the clean, nonsterile method of Lapides⁴⁵ is frequently used by ambulatory patients for whom the practice of aseptic catheter insertion is difficult to maintain. As with suprapubic catheterization, however, well-designed clinical trials comparing the efficacy of intermittent catheterization by either method to indwelling catheterization in minimizing the risk of infection are lacking.

For patients who require indwelling urethral catheterization, adherence to the sterile continuously closed system of urinary drainage is the cornerstone of infection control.

For short-term catheterization, this measure alone can reduce the rate of infection from an inevitable 100% when open drainage is employed to less than 25%⁴². All other interventions can be viewed as adjunctive measures since none have proven to be as effective in reducing the frequency of catheter-associated urinary tract infections.

Efforts have been made to improve the design of the closed urinary drainage system by modifying or adding to the basic unit introduced and widely adopted in the 1960s. Two modifications, the addition of urine sampling port in the drainage tubing and the pre-connected catheter/collecting tube system seem to have been logical advances since they discourage or prevent opening the closed system which has been well-documented to predispose patients to infection⁴⁶. Other alterations have included the insertion of air vents, drip chambers, and one-way valves that were designed to prevent the reflux of contaminated urine.

Although these modifications have some theoretical basis, none have been shown to be effective in reducing the frequency of catheter-associated infections. Additionally, overly complex drainage systems can affect the ease of operation or more easily malfunction⁴². These latter factors can influence the acceptance of different systems by hospital personnel and ultimately affect infection control.

Other efforts to reduce the incidence of catheter-associated infections have been directed toward:

- Preventing microorganisms at the meatus from entering the bladder and
- Eradicating microorganisms that gain entry into the urinary tract before they can proliferate⁴⁶.

Measures directed toward the first objective include aseptic catheter insertion, daily meatal cleansing, and daily application of antimicrobial ointments or solutions. On the basis of recent studies that have shown that catheterized patients colonized at the meatus with gram-negative bacilli or enterococci are at increased risk for subsequent infection^{63,70}, these measures have some theoretical value and can be expected to delay or prevent the onset of infection. Generally, clinical trials that have attempted to demonstrate their

efficacy have not been well designed or did not include the use of the closed system of urinary drainage. However, two recent prospective, controlled studies conducted by the same research group have shown that meatal care as it is currently commonly practiced (either twice-a-day cleansing with povidone-iodine solution followed by povidone-iodine ointment or daily cleansing with soap and water) was ineffective in reducing the frequency of catheter-associated infections in patients on closed urinary drainage ^{25,31}. The value of different regimens (e.g., more frequent application, other concentrations, or other antimicrobial agents) is not known and requires further evaluation.

Infection control measures for purposes of eradicating microorganisms in the urinary tract before they can proliferate and cause infection include irrigation of the bladder and the use of prophylactic systemic antibiotics. In one controlled study, continuous irrigation of the bladder with non-absorbable antibiotics was associated with frequent interruption of the closed drainage system and did not bring about a reduction in the frequency of catheter-associated infections ⁹. It is not known, however, whether such irrigation would be effective if the integrity of the closed drainage system could be maintained. Several recent studies have shown that prophylactic systemic antibiotics delay the emergence of catheter-related infection ^{10,46}, but this protective effect was transient and was associated with the selection of antibiotic-resistant microorganisms. Thus, controversy regarding the value of prophylactic systemic antibiotics remains.

When cross-infection is likely to be responsible for the spread of catheter-associated infections, additional measures have been proposed ¹². In several outbreaks of Nosocomial urinary tract infections, catheterized patients with asymptomatic infections served as unrecognized reservoirs of infecting organisms, and the mechanism of transmission appeared to be carriage on the hands of patient-care personnel. ^{47,48} In these outbreaks, the implementation of control measures to prevent cross-infection, including renewed emphasis on hand washing and spatial separation of catheterized patients, particularly infected from uninfected ones, and effectively ended the outbreak. In the absence of epidemic spread or frequent cross-infection, spatial separation of catheterized patients is probably less effective in controlling catheter-associated infections.

The establishment of an effective infection control organization is the responsibility of a good management team of any hospital. Consists of usually two parts:

1. An infection control council

- Meets regularly
- Formulates and updates policies

2. Infection control team:

- The leader of this team is usually a doctor (preferably a microbiologist)
- Function: day to day running of the unit.
- Surveillance and control of infections and monitoring of hygiene

SURVEILLANCE - THE ROLE OF THE LABORATORY

In detection and characterization of hospital infection incident or outbreak rely on laboratory data that alerts the infection control team to unusual clusters of infection or to the sporadic appearance of microorganisms that are present or present a particular infection risk and management problem. This is sometimes referred to as 'alert organism' system. Bacterial typing check and antibiogram are important in this regard. Regular visits to the ward are important to record data on uninfected patients for whom specimens have not been received and to respond to problems as they occur.⁴⁹

Regular bacteriologic monitoring of catheterized patients has been advocated to ensure early diagnosis and treatment of urinary tract infections⁵⁰. It's possible value as an infection measure lies in its potential usefulness in detecting and initiating treatment of clinically in apparent infections, which may serve as reservoirs of hospital pathogens, and thus, reducing the likelihood of cross-infection. However, the potential benefit of bacteriologic monitoring for such a purpose has not been adequately investigated.⁵¹

Effective surveillance leads to reduction in infection rate. The dictum of Florence Nightingale that '*the very first requirement in a hospital is that it should do the sick no harm*' remains the goal.¹³

RATIONALE FOR STUDY:

Urinary Tract Nosocomial Infections in patients with indwelling catheters are common with a prevalence of 1.7-3.2% in areas where studies have been done. They are an important cause of preventable morbidity and mortality; and they also result in significant socioeconomic costs.

The commonest causes of catheter associated nosocomial UTI's include enteric coliforms e.g. *E. coli*, *Klebsiella pneumoniae*, *Proteus spp* and others e.g. *Pseudomonas aeruginosa*, *staphylococcus spp*. Most of these isolates are associated with anti-microbial resistance and are common flora in any hospital setup.

There are no documented studies available locally. It is expected that the prevalence rate in our setup will be higher than in the western countries where stringent infection control measures are followed and where most of the studies quoted above were done.

This study intends to highlight the prevalence of UTI Nosocomial infections in catheterized patients at Kenyatta National Hospital, the microbes commonly associated with these infections and finally to establish the anti-microbial sensitivity of these microorganisms with a view to highlight any morbidity and mortalities that result from these infections.

The outcomes may help improve and set guideline for rationale use of antimicrobials, improve on infection control procedures and thereby reduce incidence of morbidity and mortality.

OBJECTIVES

a) Broad Objectives

To determine the prevalence of hospital-acquired urinary tract infections in catheterized patients at Kenyatta National Hospital and identify the predominant infecting organisms and their sensitivity patterns.

b) Specific objectives

1. To determine the Prevalence of urinary tract Nosocomial infections in catheterized patients at KNH

2. To determine the type of Nosocomial urinary tract organisms predominant in catheterized patients at KNH.
3. To determine the antibiotic sensitivity patterns of these organisms.
4. To make any relevant recommendations to the clinicians and to the management on Nosocomial UTI's in patients with indwelling urinary catheters.

HYPOTHESIS

1. The Prevalence of nosocomial urinary tract infections in patients with indwelling urinary catheters at KNH is high.
2. The commonest microbes are Gram-negative enterics.
3. Organisms isolated will show considerable resistance to the commonly used antibiotics.

METHODOLOGY

a) Study design and area

This was a cross sectional descriptive study carried out at the Kenyatta National Hospital general and specialized units, which included Surgical, Medical, and Gynecological, High dependent unit (HDU), Intensive care unit (ICU), and Burns unit. There are eight surgical wards, eight medical wards, four gynecology wards, one ICU, one HDU unit and one Burns unit. An average of thirty and ten patients are admitted in the admitting Medical ward and surgical ward respectively. Each of these wards admits every eighth day. The Gynecological wards, ICU, HDU and Burns unit admit on a daily basis at an average of two patients per day. In the Medical, Gynecological and Surgical wards an average of one patient per ward are catheterized on or as soon as they are admitted while in the ICU and Burns unit almost all patients will be catheterized on admission as a standard procedure.

c) Study population

i) Inclusion criteria

- All patients occupying a hospital bed at the specified wards over a 48-hour period.

- Patients with indwelling urinary catheters introduced at admission or within the first 12 hours of admission.

ii) Exclusion criteria

- Already catheterized patients referred to KNH
- Those already diagnosed with a urinary tract infection at admission
- Those with positive cultures in the first sample collected.
- Those patients referred from other hospitals
- Patients who have been bedridden.
- Debilitated patients and those with other underlying medical conditions
- All the patients who or whose relatives decline to sign consent

d) Sample size

80 Clients using formula;

$$n = \frac{(1.96)^2 p (1-p)}{d^2}$$

Where n = sample size

p = prevalence = 3.2%

d = level of precision = 0.05

N/B:

The Prevalence rate of Nosocomial UTI's in catheterized patients was derived from studies done in Turkey and by Meers et al together with other studies^{84,86}

e) Sampling method

All consecutive patients admitted and who fitted in the inclusion criteria during the study period were recruited.

f) Period of study

This study was carried out over a period of one year from July 2004 to July 2005.

h) Consent

Consent for participation was sought from the patients selected for the study and where this was not possible (e.g. in cases of unconscious patients) from their relatives or the

Nursing officer in charge of the ward. The participants were informed on the objectives, benefits and implications of the study.

i) Questionnaire filling

The filling of the questionnaire was done after the investigator had obtained the consent. Further information was obtained from the patients file notes, such as previous treatment records and from the patients' relatives.

LABORATORY METHODS (APPENDIX III)

a) Sample collection, transport and storage

Two urinary specimens were taken from eighty- (80) patients with indwelling urinary catheters admitted to the various wards. First and second urine specimens were taken within the first twelve (12 hours) and forty-eight (48) hours of a patient's admission. The area was cleared of all items and a sterile towel laid down. Afterwards the investigator gownned and put on sterile gloves and after disinfecting the rubber catheter with 70% alcohol five mls of urine was aspirated from the rubber catheter collecting port using a gauge 23 sterile needle and 10 ml syringe.

The samples were then transferred in a universal bottle to the laboratory and analyzed within the first two hours of collection.

In cases where it was not possible to undertake any tests within the stipulated time the specimen was refrigerated at $2 - 4^{\circ}\text{C}$ overnight in order to minimize the multiplication of organisms in the sample

b) Techniques – Specimen Analysis

Urine was cultured semi quantitatively using a calibrated loop (0.001) method on CLED media. The colony count was noted on the next day after aerobically incubating the plates overnight (18 – 24 hours) at 37°C temperature. A new appearance of bacteriuria greater than 10^3 CFU/ml was considered to represent significant bacteriuria. Further biochemical tests were done to identify the organism. (Appendix III)

Antibiotic susceptibility testing was done by standard disk diffusion by Kirby Bauers disk diffusion technique. The results were recorded as either sensitive or resistant depending on the diameter of clear zone around the antibiotic disc measured using vernier calipers. These were compared with standard strains of *E. coli* and *Pseudomonas aeruginosa*.

After preparing the culture the urine was mixed well and urinalysis done using the Bayer uristix dipstick. Results were tabulated.

Afterwards the urine was centrifuged at 3000 revolutions per minute for two minutes and a wet mount prepared on the deposit in order to record the count of RBCs, pus cells, bacterial cells, epithelial cells, crystals by microscopy

Summary

Day 1:

- Performed culture on CLED medium using standard loop technique
- Did urinalysis using Bayer urine dipsticks
- Centrifuged and examined the deposit microscopically

Day 2

- Read the cultures and comment on the microbiological findings. After calculation and finding the significant numbers of infected urine, identification tests and antibiotic sensitivity testing is done.

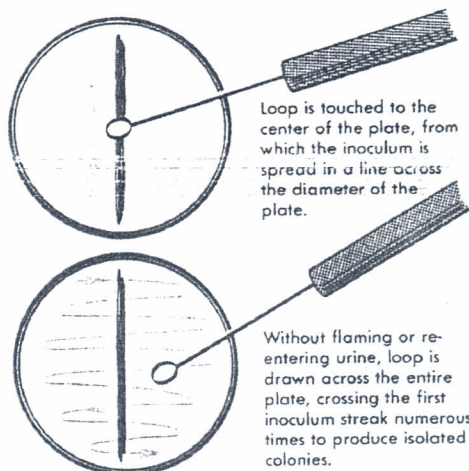
Day 3

- Read the sensitivities plates.

N/B: The organisms were identified according to standard laboratory techniques

(Appendix III)

Demonstration of spreading of microorganisms on culture plates



c) Quality Control

Internal quality control measures were undertaken in all tests done. Standard reference strains were used as controls with each set of culture media and disk diffusion tests. These were run concurrently with the tests to ensure that they gave the expected results.

The Analytical Profile Index (API) system was used to confirm the microorganisms cultured.

Control organisms included:

A) *E. Coli* ATCC 25922 for Gram negative enterics

B) *Pseudomonas aeruginosa* ATCC 25853 for antimicrobial resistant organisms

Every time a new batch of media was opened it was prepared in the standard manner and the above known microorganisms are incubated overnight at 37⁰C to see if the microorganisms grew in the expected way. A separate plate was incubated without the microorganisms to see if there was any growth and to confirm sterility. This was also done for antibiotic sensitivity media.

For urinalysis quality control involved testing known negative and positive specimens controls whenever a new bottle was first opened. An example is the CHEK-STIX Positive and Negative Control Strips from Bayer, which provide a convenient basis for a quality control Programme.

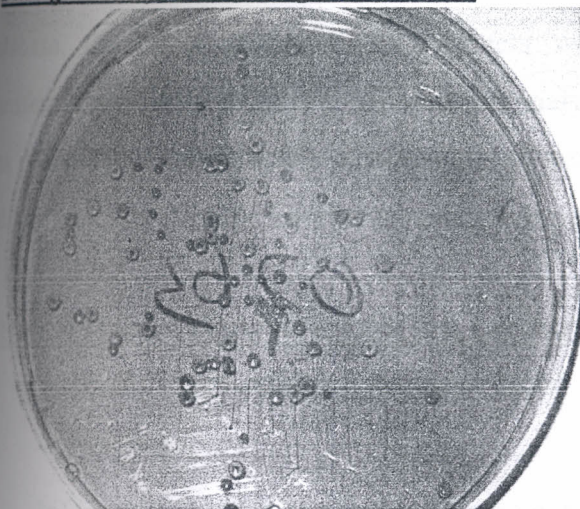
For microscopy another independent technician was given unlabelled wet preparations and asked to give his findings and this was compared with those already recorded.

N/B: *Examples of microorganisms cultured are shown below.*

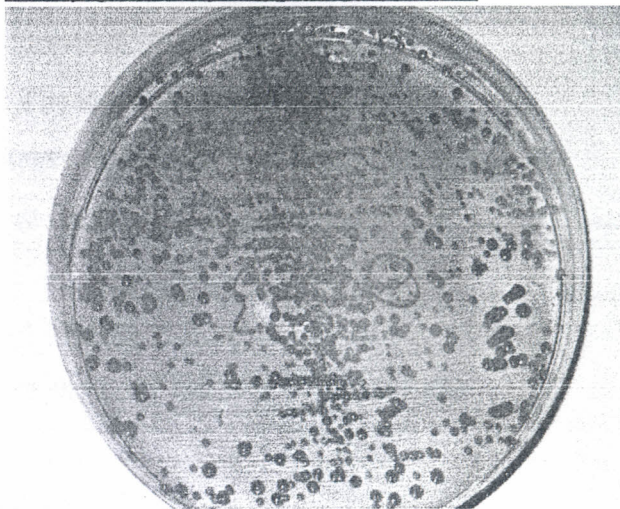
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Examples of Microorganisms isolated

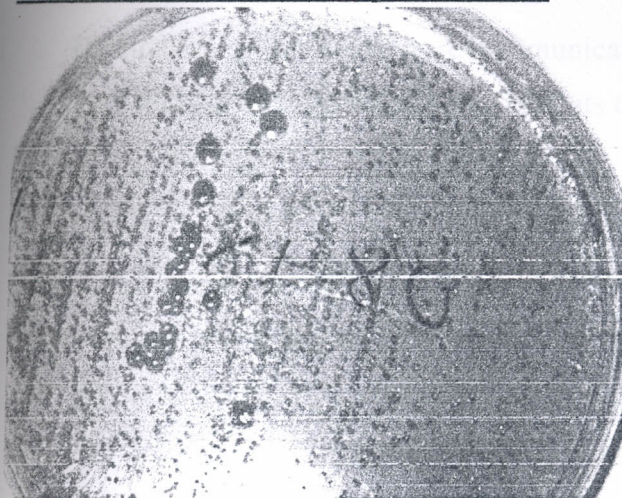
Pure growth of *Klebsiella pneumoniae*



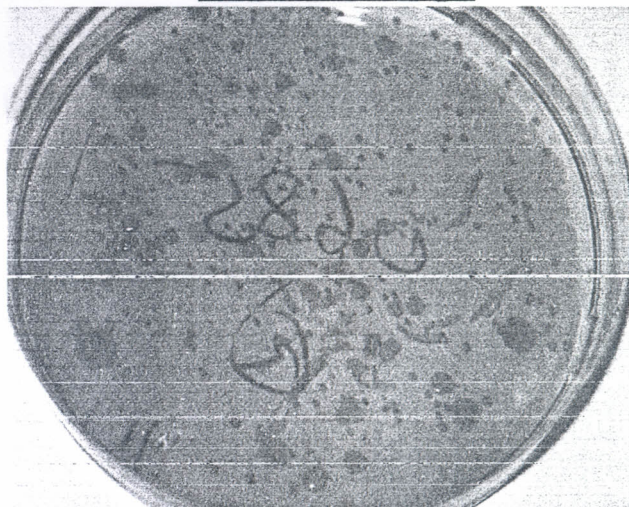
Heavy growth of 3 types of colonies



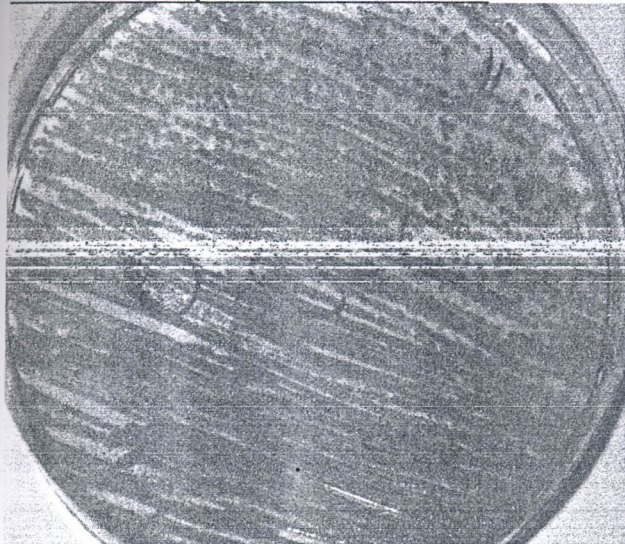
Enterococcus and *Klebsiella pneumoniae*



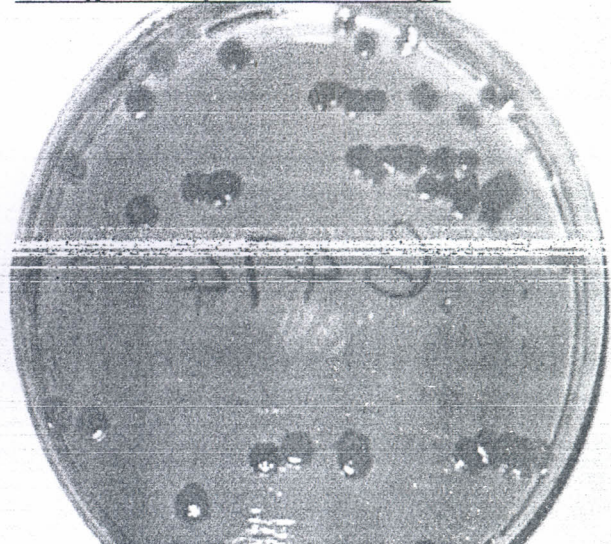
Klebsiella and Staph



Pure Growth of *E. coli* $> 10^5$ CFU/ml



Pure growth of *Enterobacter* spp



d) Statistical Analysis

The results were tabulated into coded proforma sheets and entered onto a computer database. Computer generated spreadsheets were prepared from the database and transferred to SPSS® statistical software for analysis. The descriptive summary statistics was presented as frequencies, proportions and percentages in form of tabulations, charts and graphs using SPSS®. Pearson's correlation was used for test of significance.

STUDY APPROVAL AND ETHICAL CONSIDERATIONS

- a. Authority was sought from the KNH and University ethical and research committees.
- b. Informed consent was sought from the participating subjects. (see appendix II)
- c. Confidentiality of participating subjects was maintained at all times.
- d. The findings of this study were communicated to the attending clinician for timely and continued management of the patients the future.

ANALYSIS OF RESULTS

80 patients were recruited into this study after fulfilling the inclusion criteria, 38 (43.2%)were males and 42 (56.8%) females. The oldest patient recruited into this study was 79 years while the youngest was 18 years old with a mean age of 33.43 years, standard deviation of 11.44 and a skewness of 1.704. Majority of the patients were from the ICU (40.5%) and Gynecology wards (34.2%)

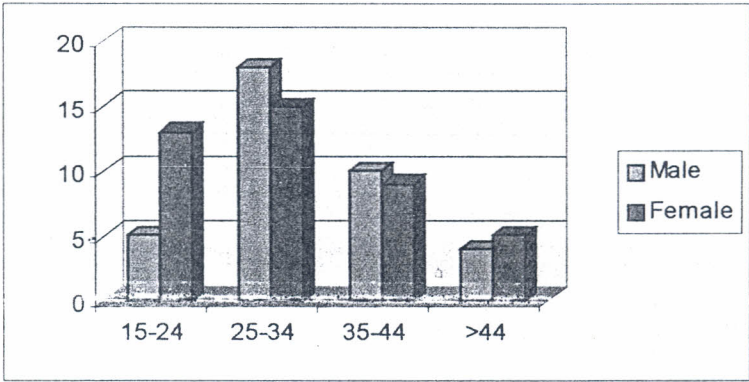
Table 1: Distribution of patients in each ward by sex

Ward	Total Patients		Males		Females	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Gyn Ward	27	34.2	0	0	27	34.2
Burns unit	7	8.9	6	7.4	1	1.5
Surgical	5	6.3	4	5	1	1.3
Medical ward	2	2.5	0	0	2	2.5
ICU	33	40.5	24	27	9	13.5
HDU	6	7.6	4	3.8	2	3.8
Total	80	100.0	38	43.2	42	56.8

Most of the patients (33) representing 41.2% were in the 25 – 34 age group with majority of both sexes being at this age. There were few patients over 44 years of age.

N/B: One patient did not give his age.

Figure 1: Distribution of patients by age



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Sixteen (16) patients representing twenty (20%) of the eighty (80) patients had culture positive growths. *E. Coli* was the most frequently isolated representing 37.5% of the total cultures. Both males and females had equal rates of infection. *Proteus spp*, *E. Coli* and *Pseudomonas aeruginosa* had equal prevalence in both sexes, *Acinetobacter spp* grew only in one male while both *Enterobacter spp* and *Klebsiella pneumoniae* were isolated from female patients only. There was no correlation between sex and the culture growth.

Table 2: Sex of the Patient versus Culture growth

Cultures	Total		Males		Females	
	Frequency	%	Frequency	%	Frequency	%
No growth	64	80	30	37.4	34	42.3
<i>Proteus mirabilis</i>	2	2.5	1	1.25	1	1.25
<i>E. Coli</i>	6	7.6	3	3.8	3	3.8
<i>Klebsiella pneumoniae</i>	2	2.5	2	2.5	0	0
<i>Enterobacter spp</i>	3	3.8	0	0	3	3.8
<i>Acinetobacter spp</i>	1	1.3	1	1.3	0	0
<i>Pseudomonas aeruginosa</i>	2	2.5	1	1.25	1	1.25
Total	80	100.0	38	47.5	42	52.5

Table 2a: Correlation between sex and culture growth

	Sex of the patient	Culture growth
Pearson Correlation	1.000	-.013
Sig. (2-tailed)	0.01	.910
N	80	80

Most of the microorganisms (87.5%) isolated were obtained in the ICU and Gynecology wards probably due to the large number of samples obtained from the two wards. *E coli* was isolated at the same frequency from both wards. *Acinetobacter* was isolated from the burns unit. All the *Pseudomonas aeruginosa* isolated were from the ICU ward. There was

no correlation noted between the type of ward and culture growths obtained.

Table 3: Type of ward versus culture growth

Ward	Culture growth obtained							Total
	NGO	Proteus	E.coli	Klebsiella	Enterobacter	Acenetobacter	Pseud	
Gyn Wd	22	0	3	0	2	0	0	27
Burns	6	0	0	0	0	1	0	7
Surgical	5	0	0	0	0	0	0	5
Medical Wd	1	1	0	0	0	0	0	2
ICU	24	1	3	2	1	0	2	33
HDU	6	0	0	0	0	0	0	6
Total	64	2	6	2	3	1	2	80

Table 3a: Correlations of ward and culture growth

	Culture growth	Type of ward
Pearson Correlation	1.000	.049
Sig. (2-tailed)	0.01	.664
N	80	80

Most of the isolates (43.7%) were in the 35 – 44 years age group followed by the 15 – 24 age group and this is despite the fact that this group was not the majority. Isolates were obtained from the other age groups. There is no correlation noted.

Table 4: Categorized age versus culture growth

Age (years)	Culture growth								
	Total Patients	NGO	<i>Proteus</i>	<i>E.coli</i>	<i>Klebsiella</i>	<i>Enterob</i>	<i>Acenet</i>	<i>Pseudo</i>	
15-24	18	14	0	3	0	1	0	0	
25-34	33	30	0	1	0	0	1	1	
35-44	19	12	2	2	1	1	0	1	
>44	9	7	0	0	1	1	0	0	
Total	79	63	2	6	2	3	1	2	

Table 4a: Correlations between the age of patient and culture growth

	Culture growth	Age of the patient
Pearson Correlation	1.000	.100
Sig. (2-tailed)	0.01.	.376
N	80	80

Sensitivity patterns

All microorganisms were exposed to Gentamicin and Amikacin, while only five were exposed to Meropenem, Ceftriaxone and Tazopiperacillin. The organisms exposed to these five drugs included those, which had grown resistance to the first line drugs and all the *Pseudomonas aeroginosa*.

The first line antibiotics consists of the following eight drugs; Augmentin, Ciprofloxacin, Cefuroxime, Gentamicin, Nalidixic acid, Amikacin, Nitrofurantoin, and Ceftazidime.

The second line antibiotics consists of the following eight drugs; Gentamicin, Amikacin, Meropenem, Ceftriaxone, Tazopiperacillin and Ceftazidime.

Augmentin (71.5%), Cefuroxime (78.8%), Nalidixic acid (64.3%), Amikacin (56.3%),

significant correlation between appearance of urine and culture growth.

Table 6: Appearance of urine and culture growth

Color of urine	Culture growths					
	Frequency	Percent	Yes		No	
			Frequency	Percentage	Frequency	Percentage
Straw coloured	29	35.4	6	7.4	23	28
Deep amber	24	30.4	4	5.1	20	25.3
Turbid	13	16.5	3	3.8	10	12.7
Brown turbid	14	17.7	3	3.8	11	13.9
Total	80	100.0	16	20.1	64	79.9

Table 6a: Correlations of urine appearance with positive culture growth

	Appearance of urine	Culture growth
Pearson Correlation	1.000	.232
Sig. (2-tailed)	0.01	.039
N	80	80

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

Urinalysis and Microscopy results

Protein:

Most of the patients (29.1%) had moderate proteinuria. There is no correlation between the severity of proteinuria and the presence of a positive culture growth.

Blood and RBC count

Most of the patients had a moderate to severe hematuria (93.7%) both by uristix and microscopically. There was no correlation between the presence of blood with culture

positive growths.

Leukocytosis

There was severe Leukocytosis (38%) in the majority of patients. There is significant correlation between level of leukocytosis and culture growth.

Pus cells

Most of the patients had mild to moderate pyuria (68.4%). All the patients who had a culture positive result also had massive pyuria. There was a positive correlation between the culture positive growths and number of pus cells at microscopy.

Nitrites:

There were only four patients (5%) with positive nitrite. Three of these patients grew *Pseudomonas aeruginosa* and only one grew *E. coli*.

Glucose

Only 11 (13.9%) had glycosuria with four having severe glycosuria. They were not known to be Diabetic. There was no correlation noted with presence of glycosuria and the presence of a positive culture growth.

Table 7: Urinalysis and Microscopy results

Urinalysis/ Microscopy	Nil		Mild		Moderate		Severe		Total	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
Protein	23	27.8	24	30.4	23	29.1	10	12.7	80	100
Blood	3	2.5	3	3.8	9	11.4	65	82.3	80	100
Leukocytes	22	27.8	9	10.1	19	24.1	30	38.0	80	100
Glucose	69	86.1	4	5.1	3	3.8	4	5.1	80	100
Pus cells	18	21.5	33	41.8	21	26.6	8	10.1	80	100
RBC count	3	2.5	32	40.5	32	40.5	13	16.5	80	100

Table 7a: Correlations of Leukocytes with positive culture growth

	Culture growth	Leukocytes
Pearson Correlation	1.000	.320
Sig. (2-tailed)	0.01	.004
N	80	80

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

Table 7b: Correlations of pus cells in urine with positive culture growth

	Culture growth	Pus cells in urine
Pearson Correlation	1.000	.535
Sig. (2-tailed)	0.01	.000
N	80	72

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

Most of the isolates were from the Accident patients in ICU.

The indications for inserting an indwelling catheter included;

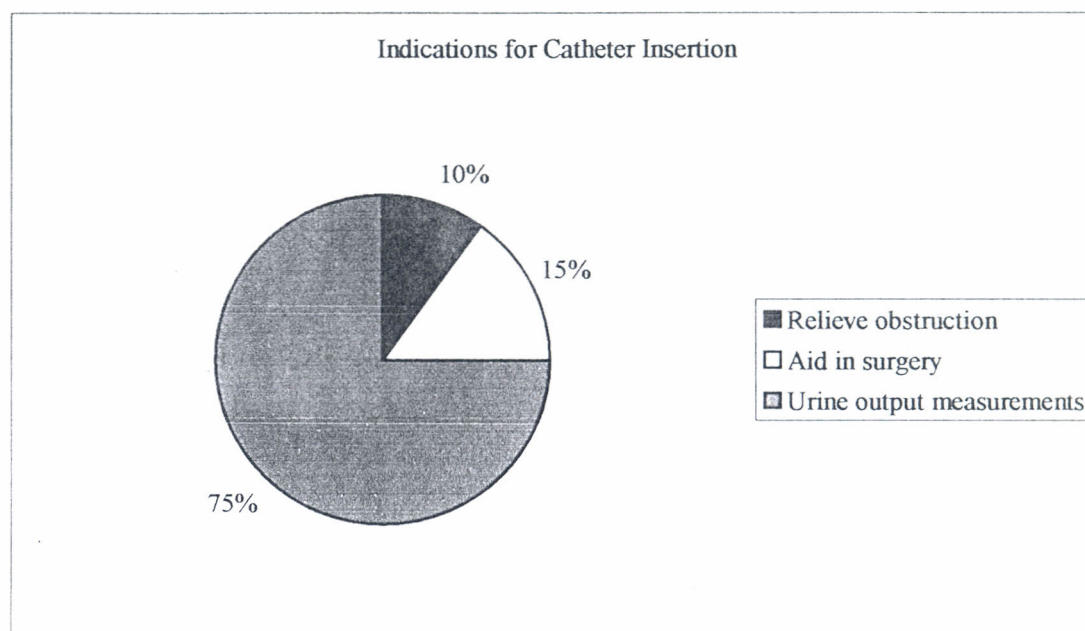
- a. Relieve urinary tract obstruction.
 - b. To aid in abdominal surgery or other surgery on contiguous structures.
and
 - c. To obtain accurate measurements of urinary output in critically ill patients.
- This was observed in ICU, HDU and in Burns unit.

All patients were on some form of antibiotics with the majority being on a combination of Penicillin (29%) and Gentamicin (23%) The stronger drugs i.e. Ceftriaxone and Augmentin were used mainly in the ICU and HDU setting. There was no statistical correlation between the antibiotics and the organisms isolated.

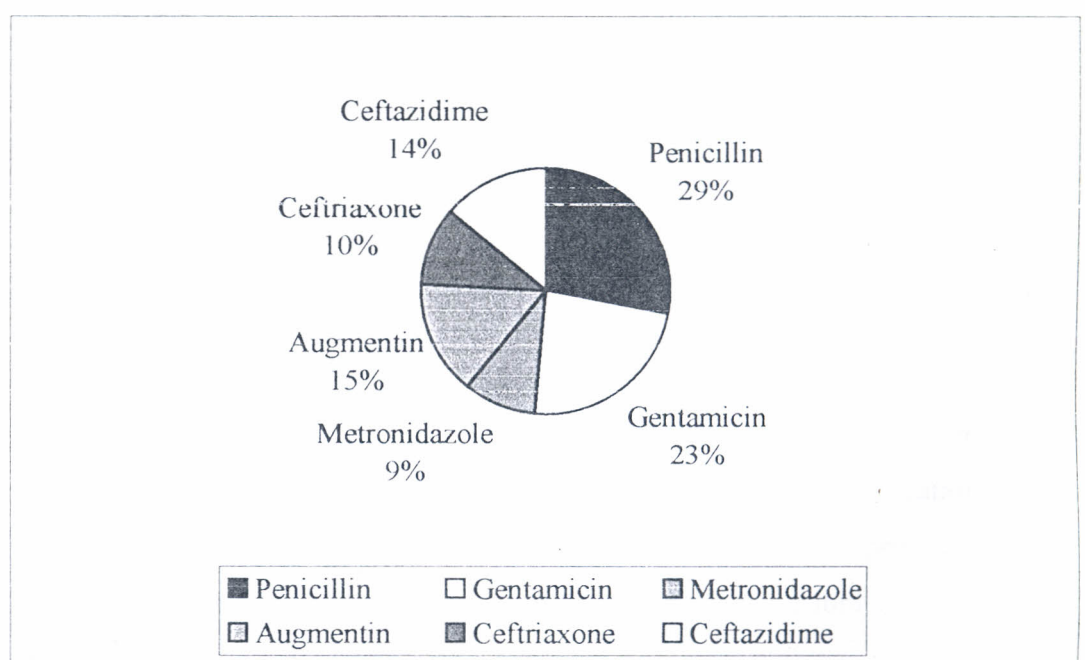
Table 8 Diagnosis versus culture growth

Diagnosis	<u>Microorganisms</u>							
	<i>Freq</i>	<i>E. Coli</i>	<i>Klebs</i>	<i>Pseud</i>	<i>Enterob</i>	<i>Acenet</i>	<i>Prote</i>	Total
Accidents	26	2	2	2			1	7
CVA	5							0
Acute coronary Syndromes	6							0
Paralysis (GBS)	4				1			1
Burns	7	1				1		2
Pre-eclampsia	8	1			2		1	4
Obstetric surgery	10	2						2
Other surgeries	14							0
Total	80	6	2	2	3	1	2	16

Pie Chart 1 Indication for catheter insertion



Pie Chart 2: Frequency of patients on antibiotics and their distribution



DISCUSSION

Introduction

Urinary tract infections (UTIs) are one of the most common bacterial infections leading to 8.3 million doctor visits and 3 million admissions yearly in the United States.^{1, 2} One million UTIs out of these are said to be Nosocomial. Urinary tract infection is a common cause of morbidity and sometimes mortality in the hospitals, though its treatment is often simple and effective. Nearly all (80%) Nosocomial UTI occurs in patients with indwelling urinary catheters⁴ and between 10 and 20% of patients who are hospitalized receives an indwelling Foleys catheter.⁴

Demographic data

Eighty- 80 patients were recruited into this study after fulfilling the inclusion criteria, 38 (43.2%) were males and 42 (56.8%) females. The oldest patient recruited was 79 years while the youngest was 18 years old with a mean age of 33.43 years. Majority of the patients were from the ICU (40.5%) and Gynecology wards (34.2%). The Surgical and Medical wards had the least number of patients recruited into this study (6.3% and 2.5% respectively). Most of the patients -33 representing 41.2% were in the 25 – 34 age group.

Prevalence rate

In this study 16 out of the 80 patients had positive cultures and this represents a prevalence of 20%. This is similar with the results of M. Shariff, MD University of Medical Sciences, Qazvin, Iran⁵⁴, Tullu MS *et al*⁵⁸ and Platt R *et al*²⁵ who all found had a prevalence of 25% in their studies. In a study at the Indian Institute of Science, Bombay under Kishore *et al* they found the incidence of UTI to be 44%.⁵⁵ This higher prevalence could be due to the follow-up of patients throughout their catheterization period. It is known that once a catheter is in place, the risk of bacteriuria is approximately 5 percent per day and approaches 100% after 30 days. Therefore with long-term catheterization, bacteriuria is inevitable.²⁴

In a study done at the Latvian hospitals the prevalence of CAUTI was found to be 5.6%⁵⁶, which is within the range reported by investigators from other European and developed

countries.^{2, 45,57} This relatively lower prevalence of CAUTI is attributed to the relatively better infection control measures employed in this centers.

This study might have had a higher prevalence than that indicated if:

- Special media had been used to isolate other organisms like *Chlamydia spp*, *Borrelia spp* etc that do not normally grow in common media used and require specialized tests.
- Most patients were already on Antibiotics and this could have interfered with these results.

The ICU and Gynecology wards had the most isolated organisms at 9 (56.2%) and 5 (31.3%) respectively. This is probably due to the larger number of samples taken from these wards i.e. (40.5%) and (34.2%) respectively.

Microorganisms isolated

Microorganisms causing nosocomial infection in order of frequency include *E. coli* and other coliforms (68-80%), *Proteus mirabilis* (12%), *Klebsiella pneumoniae* (4-6%), *Pseudomonas aeruginosa* (12%), *Enterococcus faecalis* (16%) and *Staphylococcus aureus* (10%)^{26,34}

E. Coli normally lives in the colon. However, it is less important as a cause of Nosocomial infections than *Klebsiella*, *Enterobacter* and *Pseudomonas* and other antimicrobial resistant microorganisms. Studies have shown that gram-positive and gram-negative bacteria each accounts for nearly 50% of the infections (63/133 or 47%, and 70/133 or 53% of the isolated microorganism, respectively).⁹⁴

In this study *E. coli* (37.5%) was the commonest organism isolated, followed by *Enterobacter spp* (18%), *Pseudomonas aeruginosa* (12.5%), *Klebsiella pneumoniae* (12.5%), *Proteus spp* (12.5%), and *Acinetobacter spp* (6.25%) respectively. According to current medical literature, *P. aeruginosa* must be the second most common organism,² however; it was the third commonest in this study. Moreover, no Gram-positive organisms were detected.

In M. Shariff's study, the catheter colonization was predominated by *Klebsiella pneumoniae* . (46%), *S. aureus* (27%), *S. saprophyticus* (8%), *E. Coli* (12%) and *Pseudomonas aeruginosa* (8%) respectively. This is in concordance with a study performed in Thailand ⁴⁸

One-day point-prevalence survey conducted in Turkey by Leblebicioglu *et al* showed that 78.4% of UTIs were culture-proven. In this study *Escherichia coli* (32.4%) was the most common reported pathogen, followed by *Klebsiella pneumoniae* . (17.0%), *Candida spp.* (12.8%), *Pseudomonas aeruginosa* (11.7%) and *enterococci spp* 8.5%. ⁸⁶

Henry *et el* isolated *Pseudomonas aeruginosa* (21%), *E. coli* (18.2%), *Acenetobacter spp* (11.3%), *Klebsiella pneumoniae* (9.1%). *Staphylococcus saprophyticus* was isolated in 4.5% and *Staphylococcus. aureus* in 2.3%. ⁵³

In the United States, 12 of 14 UTI epidemics were due to *Proteus spp.*, *Klebsiella spp.*, and *Serratia spp* probably due to their high antibiotic resistance. ²

Chlamydia spp and *Mycoplasma spp* may also cause UTIs in both men and women, but these infections tend to remain limited to the urethra and reproductive system. Unlike *E. coli*, *Chlamydia spp* and *Mycoplasma spp* may be sexually transmitted, and infections require treatment of both partners. Other Culture negative UTIs which are not normally isolated by routine clinical laboratory and include: *Gardnerella vaginalis*, *Ureaplasma urealyticum*, *Mycoplasma hominis*, *Leptospira spp.*, *Mobiluncus spp.*, *Mycobacterium spp.* ³⁸

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Culture growth versus Age/sex

Majority (43.7%) of the patients with bacteriuria belonged to the age group 35 – 44 years age group followed by the 15 – 24 age group with both sexes having equal rates of infection. There was no significant difference in the incidence of bacteriuria in both sexes (Odds Ratio=1.07, 95% CI: 0.38-1.55). There was no statistically significant difference in the incidence of bacteriuria in all age groups and there was no association between age and the development of bacteriuria probably because there were few elderly patients included. Henry *et al* had majority of their patients at the age group 16 – 25. ⁵³ Age is a significant factor for bacteriuria with older age being associated with bacteriuria than the

younger age and without regard to the sex, the risk of catheter-associated bacteriuria increases with age.

Antibiotic sensitivity patterns

Antibiotics were considered and analyzed as possible risk factors for development of bacteriuria. All patients recruited into this study were on some form of antibiotics. However, no association between bacteriuria and prior administration of antibiotics was shown.

CAUTI comprise a huge reservoir of antibiotic resistant bacteria. From tables it can be seen that several of the isolated organisms in urine and catheter were found to be resistant to the commonly used antibiotics.

Augmentin (62.5%), Cefuroxime (68.8%), Nalidixic acid (56.3%), Amikacin (56.3%), Nitrofurantoin (50%), and Ceftazidime (68.8%) were moderately sensitive to most of the organisms isolated.

However, Ciprofloxacin (37.5%), Gentamicin (43.8%) had poor sensitivities to the microorganisms. Ceftriaxone had the poorest sensitivity at 23% with one organism being positive out of four. Two drugs Tazopiperacillin and Meropenem show 100% sensitivity.

M. Shariff, MD *et al* found that there was a total resistance of *K. pneumonia*, *E. cloacae*, and *Proteus mirabilis* to ampicillin, chloramphenicol, carbenicillin, cephaloxin, tetracyclin, and co-trimoxazole. These strains were completely sensitive to amikacin and Nalidixic acid. Their resistance to nitrofurantoin and Gentamicin was partial (16.6%, and 58%, respectively).

Regarding the antimicrobial resistance of these isolates, three categories could be identified; *P. aeruginosa* strain was sensitive to Amikacin only. *Klebsiella pneumoniae*, and *P. mirabilis* were sensitive to Amikacin and Nalidixic acid but were highly resistant to other antibiotics.

In the study from Bombay several of the isolated organisms from the catheter were found to be resistant to the commonly used antibiotics. Amikacin was the most effective amongst the antibiotic tested.

Leblebicioglu *et al* had *Klebsiella pneumoniae*, *Enterobacter cloacae*, and *Proteus mirabilis* all being sensitive to Amikacin and Nalidixic acid. The sensitivity to Gentamicin and Tobramycin was 58%. All of the isolates were resistant to all other antibiotics.

Drug resistance is generally a common and prevalent issue. It could be stated that drug resistance in this study is following its worldwide pattern and perhaps some part of the resistance could be attributed to a routine antibiotic regimen administered in this center.

In this setup Augmentin, Cefuroxime, Nalidixic acid, Amikacin, Nitrofurantoin, and Ceftazidime are still effective and can continue being administered, as they are moderately sensitive to most of the organisms isolated. Two drugs, Piperazine and Tazobactam, which show 100% sensitivity, can be used in patients who develop resistance to the other drugs commonly used. However, they are usually expensive and are not readily available. There should be frequent surveillance studies to be able to pick any development of resistance.

Urinalysis/Microscopy

Most of the patients (29.1%) had moderate proteinuria. However, there was no correlation between the severity of proteinuria seen and the presence of a positive culture. Most of the patients had a moderate to severe hematuria (93.7%). There was no correlation between the presence of blood with culture positive growths. In this study it is postulated that the presence of the significant hematuria was due to the traumatic procedure during catheter insertion.

Thirty -30% of patients with active UTI do not have pyuria. Henry *et al* found a direct relationship between the number of pus cells in the urine and bacteriuria ($p < 0.01$) was observed in this study ⁵⁸.

There was severe Leukocytosis (38%) in the majority of patients and a significant correlation between level of leukocytosis and culture growth was observed in this study. Part of the reason postulated for the fact that despite some patients having severe leukocytosis and moderate pus cells in urine no microorganisms were isolated, could be due to the fact that:

- The patients were already on antibiotics.
- That the culture media used in this study was not able to grow some microorganisms.
- There are slow growing microorganisms that need more time than conventional time and this was not followed to its conclusion in this study.

No correlation was noted between glycosuria and a positive culture growth. Glycosuria in this study may be explained by the fact that all the patients who had glycosuria were on intravenous fluids such as 5% dextrose.

Condom catheter drainage may be useful for incontinent male patients without outlet obstruction and with an intact voiding reflex. Its use, however, requires meticulous nursing care if local complications such as skin maceration or phimosis are to be avoided. In addition, frequent manipulation of the condom catheter drainage system (e.g., by agitated patients) has been associated with an increased risk of urinary tract infection⁵⁹.

For patients who require indwelling urethral catheterization, adherence to the sterile continuously closed system of urinary drainage is the cornerstone of infection control. For short-term catheterization, this measure alone can reduce the rate of infection from an inevitable 100% when open drainage is employed to less than 25%.⁵⁵

Other efforts to reduce the incidence of catheter-associated infections have been directed toward

- 1) Preventing microorganisms at the meatus from entering the bladder and
- 2) Eradicating microorganisms that gain entry into the urinary tract before they can proliferate

Measures directed toward the first objective include aseptic catheter insertion, daily meatal cleansing, and daily application of antimicrobial ointments or solutions.²⁸

Infection control measures for purposes of eradicating microorganisms in the urinary tract before they can proliferate and cause infection include irrigation of the bladder and

the use of prophylactic systemic antibiotics. In one controlled study, continuous irrigation of the bladder with non-absorbable antibiotics was associated with frequent interruption of the closed drainage system and did not bring about a reduction in the frequency of catheter-associated infections ²⁷ It is not known, however, whether such irrigation would be effective if the integrity of the closed drainage system could be maintained. Several recent studies have shown that prophylactic systemic antibiotics delay the emergence of catheter-related infection ^{10,60}

When cross-infection is likely to be responsible for the spread of catheter-associated infections, additional measures have been proposed ¹². In several outbreaks of nosocomial urinary tract infections, catheterized patients with asymptomatic infections served as unrecognized reservoirs of infecting organisms, and the mechanism of transmission appeared to be carriage on the hands of patient-care personnel ^{47,48}. In these outbreaks, the implementation of control measures to prevent cross-infection, including renewed emphasis on hand washing and spatial separation of catheterized patients, particularly infected from uninfected ones, effectively ended the outbreak. In the absence of epidemic spread or frequent cross-infection, spatial separation of catheterized patients is probably less effective in controlling catheter-associated infections.

Regular bacteriologic monitoring of catheterized patients has been advocated to ensure early diagnosis and treatment of urinary tract infections ⁵⁰ Its possible value as an infection measure lies in its potential usefulness in detecting and initiating treatment of clinically in-apparent infections, which may serve as reservoirs of hospital pathogens, and thus, reducing the likelihood of cross-infection. However, the potential benefit of bacteriologic monitoring for such a purpose has not been adequately investigated.

CONCLUSION

A: There are two distinct differences between this study and other studies:

- 1) *P. Aeruginosa* (2.5%) was rare in our center.
- 2) In different reports Gram-positive cocci do have a considerable role, which was not evident in this study as no Gram-positive cocci, were isolated.

B This study confirms most findings of studies carried out elsewhere as quoted in the literature. From this study it is appropriate to conclude the following:

- a) The prevalence rate at KNH is high at 20%. This however is comparable to other third world countries e.g. Iran (25%)⁵⁴ and Asia (44%)⁵⁵.
- b) The commonest CAUTI Nosocomial microorganisms are enteric bacteria including *E coli* and *Klebsiella pneumoniae*.
- c) Most organisms isolated show considerable resistance to the commonly used antibiotics including Gentamicin, Ciprofloxacin and Ceftriaxone.
- d) Tazopiperacillin and Meropenem seem to be the most effective antibiotics for Nosocomial catheter-associated UTIs.
- e) The most affected wards are the ICU and Gynecology wards. This could be due to the fact that this is where most of the patients came from and also because this is the largest concentration of patients with indwelling catheters.
- f) Most of the samples were traumatic as reflected by presence of blood/RBCs in both microscopy and Urinalysis.
- g) Massive pyuria correlates well with the presence of microorganisms in the specimens from catheterized patients.
- h) The goal of preventing nosocomial CAUTI is predicted in part on the assumption that the infection adversely affects the patient to acquire them and they increases the cost of the hospitalization.

RECOMMENDATIONS

- 1) The Infection control measures should be put in place especially in the ICU and the Gynecology wards to help reduce the incidence of Nosocomial CAUTI at KNH.
- 2) Surveys such as this one should be carried out regularly so that to determine the infection control measures in the hospital and in the event make the necessary adjustments.
- 3) Personnel should be trained on how to insert the indwelling urinary catheters especially in regard to observing aseptic techniques of catheter insertion.
- 4) Where possible-indwelling catheters should be avoided and only used where it is of absolute necessity. Such other methods like condom catheters should be used instead.
- 5) Antibiotic usage should be excised more judiciously in order to reduce the development of resistance. Gentamicin, Ciprofloxacin and Ceftriaxone should be avoided as they have the highest resistance. Tazopiperacillin and Meropenem seem to be the most effective antibiotics for Nosocomial catheter-associated UTIs and should be used more.
- 6) An indwelling urinary catheter should not be left in place for more than necessary.
- 7) Frequent inspection to maintain free downhill flow must be done, making sure that no obstruction to free urine flow is present

STUDY LIMITATIONS

- a) Time allocated for the study was inadequate.
- b) The investigator would have wished to be present and to take the history and first specimen whenever a new patient was admitted but this was not feasible.
- c) Unavailability of other advanced tests that would have enabled for the identification of the culture negative pyuria.
- d) Financial constraints.

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APPENDIX I Questionnaire

A study of the Prevalence of Nosocomial Urinary Tract Infections in patients with urinary catheters at Kenyatta National Hospital

Name:

Sex: 1. Female ☐ Male ☐

Ward No:

Bed No.:

Diagnosis: Provisional:

Final:

Study Number:

Age:

Date:

I/P No:

Date Admitted:

List of antibiotics patient is on:	Name of drug	Date given	Dosage
1.			
2.			
3.			

Do you have the following symptoms indicating a urinary infection :

	Yes	No
1) Dysuria	☐	☐
2) Flank pains	☐	☐
3) Frequency of urine	☐	☐
4) Pus discharge	☐	☐
5) Others	☐	☐

Do you have or have you been told that you suffer from any of this disease?

	Yes	No
1) Diabetes	☐	☐
2) Hypertension	☐	☐
3) Any cancer	☐	☐
4) HIV Aids	☐	☐
5) Benign Prostatic Hypertrophy	☐	☐
6) Others	☐	☐

Table 1: Specimen collection and reporting:

	<i>Date collected</i>	<i>Time Collected</i>	<i>Date reported</i>	<i>Time reported</i>
<i>Specimen I</i>				
<i>Specimen II</i>				

RESULTS

Table 2: Urinalysis results (Dipstix)

	Protein	Blood	Leucocytes	Nitrite	pH
Sample 1					
Sample 2					

Culture and sensitivity results

Table 3: Specimen 1

<u>Microorganism present</u>	<u>Sensitivity</u>
1.	
2.	
3.	

Table 4: Specimen 2

<u>Microorganism present</u>	<u>Sensitivity</u>
1.	
2.	
3.	

APPENDIX II

PATIENT INFORMATION AND CONSENT FORM

A study on hospital acquired infections in catheterized patients at KNH

INFORMATION SHEET

This is a study aimed at determining the prevalence and type of infections acquired by patients with indwelling urinary catheters at this hospital. Some of these infections can lead to serious complications with long-term health implications. The specimen that will be collected for analysis will be urine. This will be collected twice from you thus; within the first 12 hours after admission and on the third day. There are no obvious risks anticipated. The benefits include early identification of any infection if present and subsequent quick intervention to avert any disease process by aggressively treating the disease and any complications that may occur.

The Ethical and Research Committee of this hospital has approved this study. It is aimed at directly improving the care of your condition and others by assessing the presence and sensitivity of microorganisms (bacteria) in your urine. The results of this test will be sent back to you through your doctor.

The urine sample, as well as the results from this study, will only be used for the above purposes and no other. Your identity will be kept strictly confidential throughout the study as well as during the publication of the study findings. Your decision to participate or not to participate in this study will not affect the quality of your care.

Kindly fill in this consent form below:

CONSENT FORM

I Mr/Mrs/Ms_____agree to enroll myself into this study being fully aware of its purpose as explained to me by _____and consent to the investigations of a) Urine analysis

Signatures:

1) Self:_____Date:_____

2) Guardian/Relative: _____Date:_____

3) Witness: _____Date:_____

Please contact Dr P.M. Maturi, the principal investigator of this study on mobile No.: 0722400128 in case of any questions arising.

For any concerns that you may have about the conduct of this study, you may contact any of my consultant supervisors below, or Professor Bhatt, chairperson of the Ethical and Research Committee at Kenyatta National Hospital.

Supervisors

- Dr Revathi Microbiologist, KNH/UoN
- Professor Ngumi Chairman Dept of Surgery UoN
- Professor Wamola Microbiologist KNH/ University of Nairobi

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APPENDIX III

Laboratory procedures/methods

Examination of urine

In all urine examination microscopy of the urine is essential as well as analysis of other biochemical abnormalities in urine.

Quantification of bacteria in urine can be performed by:

- Calibrated loop: The loop has been calibrated in such a manner that it takes and transfers a certain volume of urine, which is then spread without flaming in between. After overnight incubation colonies are counted and calculation made based on the volume of urine transferred by the loop. Thus reported as number of colony forming units (CFU) per ml. Usually with infection they are more than 10^4 /ml but this depends on the specimen collected.

Culture media for urine can be either CLED (Cysteine Lactose Electrolyte deficient agar) used on its own or blood agar and MacConkey agar used together.

Day 1:

- Perform culture on CLED medium using standard loop technique
- Do urinalysis using urine dipsticks
- Centrifuge and examine the deposit microscopically

Day 2

- Read the cultures and comment on the microbiological findings. After calculation and finding the significant numbers of infected urine, identification tests and antibiotic sensitivity testing is done.

Gram Stain:

Procedure

1. Make a smear (2.5cm in diameter), allow to air dry and fix by passing through a Bunsen Burner flame three times
2. Allow to cool, and cover smear with Methyl Violet for 15-30 seconds
3. Drain off stain, wash with gentle tap water

4. Cover with Gram's iodine for 15-30 seconds
5. Wash off with water, and holding the slide at an angle, add acetone-alcohol drop by drop for about 5-10 seconds only.
6. Immediately rinse in water and stain with neutral red for 1-2 minutes.
7. Wash in water, blot dry on clean filter paper, then examine under a microscope using immersion oil lens.

Results: Gram +ve organisms an fibrin-----dark violet

Gram -ve organisms (Pus and tissue cells)-----pink

Catalase Test

Procedure:

Take a tiny drop of 3% Hydrogen peroxide on an absolutely clean glass slide; touch a colony with an applicator stick into this drop.

Results

Production of gas bubbles indicates a positive test.

N/B: Blood agar may contain enzymes and give false positive results.

Coagulase test

Procedure:

Slide test

- A loopfull of staphylococci is emulsified fully in a drop of normal saline on a glass slide.
- One loopfull of undiluted human plasma is added.

Results: Positive test indicated by clumping within seconds of the *Staphylococci*

Tube Test

To 1ml of 3 hours old broth culture *staphylococci* 5 – 10 drops of plasma is added. It is then incubated at 37⁰C for up to 4 hours.

Results: Positive test- a clot appears within 3-4 hours. If necessary, further incubation may be carried out depending on whether the positive control, the “*Oxford Staphylococcus*” set up at the same time, has coagulated.

N/B If carried out for too long the clot dissolves due to another enzyme (staphylokinase) produced by some strains.

Oxidase test

Pseudomonas aeruginosa, *Neisseria spp.*, *Campylobacter* and *Vibrio* all give a positive purple color when they come into contact with oxidase reagent – a 1% aqueous solution of tetramethyl-para-phenylene diamine.

Methods:

- Dried filter paper method.

Results: A positive result is seen when the culture being tested turns a deep purple Color within seconds.

Identification tests for *Enterobacteriaceae*

They are so called because they are commensal flora in the Gastro-intestinal tract of man and animals. These are gram-negative bacilli that are either motile or non-motile and grow both aerobically and anaerobically. They are capable of growing on simple laboratory media and MacConkey's bile salt lactose media.

They are usually oxidase positive and catalase positive; reduce nitrites to nitrite and ferment glucose-producing acid with or without gas. In Hugh and Leiffson test they are both fermentative and oxidative.

IMViC is a simple way of differentiating *E. coli*, *Proteus spp.* and *Klebsiella* growing

IMVIC	Indole	MR	V/P	Citrate
<i>Proteus spp</i>	+	+		
<i>Klebsiella pneumoniae</i>	–	–	+	+

Analytical Profile Index (API)

Is a computerized that is used to identify microorganisms.

Procedure

- Colonies are inoculated in peptone water and adjusted for turbidity to 0.5 mF
- A few drops are then inoculated on API strips and incubated overnight for 18 – 24 hours.
- The results are read and generated by the computer.

Antibiotic susceptibility tests:

Disc diffusion technique

This is a routine convenient method of performing antibiotic sensitivity tests. A solid sensitivity-testing medium is evenly inoculated with the organism to be tested and blotting paper discs containing the antibiotics in certain concentration are put on the surface. During incubation, the antibiotic diffuses radially from the disc into the medium. If the organism is sensitive to the drug in the concentrations achieved, its growth is inhibited in a circular zone around the disc.

The controls used control organism is *Oxford Staphylococcus aureus*, which is kept in the laboratory and is known to be sensitive to nearly all commonly used antibiotics. Other control organisms, which may be used, are: -

E.coli ATCC/NCTC 25922

Pseudomonas Aeruginosa ATCC/NCTC

Staph. Aureus ATCC/NCTC

Stoke's method

Stoke's method is another technique used for performing antibiotic tests. In the other method, control organisms may be tested on a different plate and the inhibition zone of the test organism compared with that of the control. But in Stoke's method, both the test and control organisms are in the same plate. This is convenient because all factors related to the medium are same for both test and control organisms.

ANTIBIOTICS USED AND THEIR CONCENTRATIONS

KNH 1 *Enterobacteriaceae* – *E. Coli* STD ATCC 25922

ANTIBIOTIC	DISC CONTENT (µg)	ZONE DIAMETER (mm)	
		Resistance	Sensitive
Augmentin	30	13	18
Ciprofloxacin	5	15	21
Cefuroxime	30	14	23
Nitrofurantoin	300	14	17
Nalidixic acid	30	13	19
Gentamicin	10	12	15
Amikacin	30	14	17
Ceftazidime	30	14	18

KNH 4: *Pseudomonas Aeruginosa*

ANTIBIOTIC	DISC CONTENT (µg)	ZONE DIAMETER (mm)	
		Resistance	Sensitive
Piperacillin	100	17	18
Pipril/Tazobactam	110	17	18
Meropenem	10	13	16
Gentamicin	10	12	15
Amikacin	30	14	17
Ceftazidime	30	14	18
Ceftriaxone	30	13	21

Urinalysis

The reagent strips for Urinalysis include test pads for protein, blood, leucocytes, nitrite, glucose, ketones, pH, specific gravity, bilirubin, and urobilinogen. The reagent strips are usually ready for use upon removal from the bottle. The strips may be ready visually or by a special instrument using the CLINITEK family of urine Chemistry analyzers.

Urine must be collected in a clean and dry container. The sample must be mixed before testing and it should be tested within two hours after voiding, or sooner for bilirubin.

Procedure

1. Dip all the test pads of the strip into the urine and remove immediately.
2. Drag the edge of the strip against the container rim to remove excess urine.
3. Compare each test pad to the color blocks on the bottle label. Read each pad at the time shown on the label, starting with the shortest time. Color changes that occur after 2 minutes are of no diagnostic value. Discard the used reagent strip.

Interpretation:

Protein

Less than 0.15g of total protein is normally excreted per day. Clinical proteinuria is indicated at greater than 0.5g of proteins/24 hrs. It is less sensitive to mucoproteins and globulins.

Blood:

Normally, no hemoglobin is detectable in urine. Test is also sensitive to myoglobin. A hemoglobin concentration of 150-620 micrograms/liter is approximately 5-20 intact red cells per microlitre.

Leucocytes:

A strip result of small or greater is a useful indicator of infection. Elevated glucose concentrations 3g/dl may cause decreased test results.

Pus cells

In adults significant pyuria is > 10 pus cells/hpf, 7-8 pus cells is borderline pyuria. In children > 5 is significant pyuria while 4 is borderline. 20 – 30 or numerous is massive pyuria.

Nitrite:

This test depends upon the conversion of nitrite from diet to nitrite by the action of Gram-negative bacteria in the urine. Many enteric gram negatives organisms give positive results when their number is greater than 10^5 /ml. False negative results are seen may occur in shortened bladder incubation of the urine (<4 hours), in absence of dietary nitrite

or the presence of non-reproductive pathological microbes. A negative result does not rule out significant bacteriuria.

N/B: The methodology above were compiled from

1. District Laboratory Practice in Tropical Countries Part 2 by Monica Cheesbrough page 105 – 115,
2. Standard Operating Procedure (SOP) Manuals from the Microbiology department Kenyatta National Hospital,
3. Bailey and Scott's textbook of Diagnostic Microbiology
4. Practical Laboratory manual from the Medical students UoN (2nd edition)

Appendix IV

Dictionary

Bacterimea	Presence of bacteria in blood
Bacteriuria	Presence of bacteria in blood
Commensals	Microorganisms that constitute the normal flora of the healthy body
Cross-infection	Results from bacterial derived from other patients or healthy staff carriers.
Iatrogenic	Physician-induced disease through medical intervention and procedures.
Inoculum	A population of microbes which has the potential of multiplying and consequently causing disease.
Microbes	Microorganisms that have a potential to cause disease
Nosocomial	Refers to infections that are acquired as a result of being hospitalized
Reservoir	An organism that harbors a disease-causing organism without it being affected by that invading organism
Vectors	An organism or material that transmits an infective organism from affected organism to another.

Appendix V

Aug	Augmentin
Amk	Amikacin
API	Analytical Profile Index
CAUTI	Catheter associated urinary tract infections
Cef	Cefuroxime
Ceftr	Ceftriaxone
Cip	Ciprofloxacin
CFU	Colony Forming Units
CLED	Cysteine Lactose Electrolyte Deficient Agar
CPC	Center for Disease control and prevention
CPG	Clinical Practice Guidelines
Cefta	Ceftazidime
CVA	Cardiovascular accident
ENT	Ear, Nose and Throat
E.coli	<i>Escherichia coli</i>
GBS	Guillen-Barre Syndrome
Gen	Gentamicin
GIT	Gastro-intestinal tract
Gyne	Gynecology ward
HIV	Human Immune Virus
HDU	High Density Unit
ICARE	Intensive Care Antimicrobial Resistance Epidemiology
ICP'S	Infection Control Personnel
ICU	Intensive care unit
ISS	Immunosuppression
KEMRI	Kenya Medical Research Institution
KNH	Kenyatta National Hospital
NI	Nosocomial infections
NICU'S	Neonatal Intensive Care Units

NNIS	National Nosocomial Infection Surveillance System
Mer	Meropenem
MRSA	Methicillin resistant <i>Staphylococcus aureus</i>
Pip	Piperazine
RSV	Respiratory Syncytial Virus
STI	Sexually Transmitted Infections
<i>Spp</i>	Species
Taz	Tazobactam
TSI	Triple Sugar Iron
UoN	University of Nairobi
USA	United States of America
UTI	Urinary tract infections
Nal	Nalidixic acid
Nit	Nitrofurantoin
WBC	White blood count

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NNIS	National Nosocomial Infection Surveillance System
Mer	Meropenem
MRSA	Methicillin resistant <i>Staphylococcus aureus</i>
Pip	Piperazine
RSV	Respiratory Syncytial Virus
STI	Sexually Transmitted Infections
<i>Spp</i>	Species
Taz	Tazobactam
TSI	Triple Sugar Iron
UoN	University of Nairobi
USA	United States of America
UTI	Urinary tract infections
Nal	Nalidixic acid
Nit	Nitrofurantoin
WBC	White blood count

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