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Pattern of Nosocomial Urinary Tract Infections among Sudanese Patients

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Research Article

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ABSTRACT

Background: High incidence of nosocomial infections has led to prolonged hospitalization, leading to high morbidity and mortality. Our research was aimed at determining the prevalence as well as identification and isolation of aerobic bacteria responsible for nosocomial urinary tract infection.

Methods: Study was conducted at Gadarif Teaching Hospital, Gadarif State, Eastern Sudan, from April 2004 to March 2005. The study was designed to isolate aerobic bacteria causing urinary tract infections, and to determine the antibiograms of the isolated bacteria to commonly used antibiotics.

Results: Out of 783 specimens collected during the study, 611 (79.03%) midstream urine specimens were collected from patients after urinary catheterization. 100 (12.77%) aerobic bacterial species were isolated from these specimens, they were *P. aeruginosa* (37%), *K. pneumoniae* (23%), *P. mirabilis* (22%), *P. vulgaris* (12%) and *E. coli* (6%); The antibiograms of the isolates (n=263) shows sensitivity and resistant to S. aureus (n=103), *P. mirabilis* (n=63), *P. aeruginosa* (n=49), *K. pneumoniae* (n=23), *P. vulgaris* (n=14) *and E. coli* (n=11) bacteria to various antibiotics including Vancomycin, Fusidic acid, Gentamicin, Ciprofloxacin, Penicillin G, Ceftazidime, Methicillin, Cephelaxin, Nalidixic acid, Nitrofurantoin, Ceftazidime, Ofloxacin, Co-trimoxazole and Ciprofloxacin.

Keywords: Urinary tract; infection; antibiotic; sensitivity; resistance; bacteria.

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1. INTRODUCTION

Nosocomial infection (also known as hospital-acquired infection) refers to an infection that results from an exposure during hospitalization, even though the infection may not clinically appear until after discharge. Patients already incubating an infection and admitted to hospital may not show any clinical manifestations of the infection until a day or more after admission, in which case it is not a nosocomial infection but a community- acquired infection (Davis et al., 1989). In most cases, clinical manifestations appear more than 72 hours after admission (Wenzel and Thompson 1985). In 1985, the Centers for Disease Control and Prevention (CDC) Study on the efficacy of nosocomial infection control reported that hospitals with four key infection control components (an effective hospital epidemiologist, one infection control practitioner for every 250 beds, active surveillance mechanisms and ongoing control efforts) reduced nosocomial infection rate by approximately one third (Haley et al., 1985).

1.1 Nosocomial Urinary Tract Infections and Catheter Associated Bacteriuria

Significant bacteriuria is a statement used to describe the numbers of bacteria in voided urine >/=10^5 bacterial cells/ml., usually due to contamination from the anterior urethra (Sobel and Kaye, 1995). Infection must seriously be considered in the presence of >/=10^5 bacteria/ml urine. Urinary tract infections may be recurrent. Recurrence may be either relapses or reinfections. Recurrent urinary tract infections (UTIs) are a common clinical problem. Up to 25% of women who present with an acute UTI will have a recurrence within 6 months, despite receiving appropriate antibiotic therapy (Foxman, 1990). The development of catheter-associated bacteriuria has been associated with an increased duration and cost of hospitalization, as well as increased morbidity and mortality in catheterized patients who acquire infection (Wenzel and Thompson, 1985). In more recent epidemiologic studies in general hospital settings, where the mean duration of catheterization is 4-5 days; the overall prevalence of bacteriuria during catheterization is 25% (Wenzel and Thompson, 1985). Thus, the risk of acquiring bacteriuria approaches 5% per day of catheterization, making it extremely important from an infection control standpoint to remove indwelling catheters as soon as possible.

1.2 Causative Agents

The most frequent cause of nosocomial urinary tract infections, are aerobic gram-negative bacilli (Pezzlo, 1989). *E. coli* is isolated less frequently from hospitalized patients and its account decreased to < 50% among hospitalized patients. Proteus Species is the second most common gram-negative microorganism isolated from hospitalized patients (Pezzlo, 1989). *P. mirabilis* is a common cause of urinary tract infections in the elderly and young males and often following catheterization. Infections are also associated with the presence of renal stones (Cheesbrough, 2000). *P. aeruginosa* is responsible for up to 20% of hospital-acquired urinary tract infections (Dennis et al., 2001). *K. pneumoniae* is an important nosocomial pathogen accounting for up to 10% of hospital-acquired urinary tract infections. The significance of nosocomial urinary tract infections with Staphylococci has been recognized in recent years. *S. aureus* is not a common nosocomial pathogen causing urinary tract infections; however, there is an increased incidence of infection with this organism in association with urinary tract obstruction. Elderly men undergoing urologic procedures are also at risk (Pezzlo, 1989). Staphylococcus epidermidis is a bacterium commonly present on human skin that sometimes causes human illness. Infection caused by *S. epidermidis* is usually associated with medical devices, such as indwelling catheters (Goldmann and Pier,

1993) and often occurs in people with weakened immune systems. The organism is typically resistant to multiple antibiotics and has become an important cause of serious infections in hospitalized patients (von Eiff, 2002). Enterococcus is a common cause of nosocomial urinary tract infections; especially in men and it is associated with renal transplant rejection (Pezzlo, 1989). Increasing incidence of nosocomial infections lead to prolonged hospitalizations, increased costs and increased use of antibiotics, thus, increasing morbidity and mortality of hospitalized patients. No formal studies have been conducted in Sudan to evaluate or estimate the prevalence and the infecting bacterial strain types causing nosocomial infections. Our objectives in this single institution study were to identify local bacteria strains responsible for nosocomial urinary tract infections, determine their prevalence and evaluate antibiotic efficacy in treating these infections.

2. MATERIALS AND METHODS

2.1 Study Design

The study was conducted in Gadarif Teaching Hospital (800-beds), Gadarif State, Sudan from April, 2004 to March, 2005. The targeted population (611) hospitalized and subjected to urinary catheterizations were recruited for the project. Age, gender, location of the patient in the hospital, duration of hospital stay, clinical condition and antibiotics received before and during hospitalization were recorded.

2.2 Analytical Profile Index (API) System

All isolated bacteria were subjected to API system identification to confirm primary and secondary identification. API-Staph was used to identify *S. aureus* whereas API-20E was used to identify members of the enterobacteriaceae family and associated organisms according to manufacturer's directions.

2.3 Urine Specimens

Urine specimens were collected from all patients subjected to urinary catheterization. Two specimens were collected from the patient after informed, written and verbal consent. The first one was collected on the first day of admission and before the insertion of the urinary catheter. The second specimen was collected from the patient after removal of catheter (48 hours or more). Urine specimen (10-20 ml) of mid-stream urine (MSU) was collected from each patient in a sterile plastic container and transported to laboratory on ice.

2.3.1 Identification of the isolated bacteria

Primary identification was performed by Gram's stain (Lockhart et al., 1995) to see the shape, arrangement and Gram's reaction. Secondary identification was done by biochemical tests. They were indole test, citrate utilization test, V.P, methyl red, urease test, nitrate reduction, and sugar fermentation test (sugars involved were glucose, lactose, sucrose, maltose and mannitol), in addition to motility test.

2.4 Antibiotic Susceptibility Test

The susceptibility was determined by the disc diffusion technique (Kirby-Bauer method) (Bauer et al., 1966). Antibiotics used included Penicillin G, Gentamycin, Ciprofloxacin, Ceftazidime, Cephalexin, Nitrofurantoin, Nalidixic acid, Ofloxacin and Co-trimoxazole. β-

Lactamase Test: β-lactamase test strips were used to examine β-lactamase production of the isolated bacteria.

2.5 Statistical Analysis of the Data

Statistical Package for Social Sciences (SPSS) version 9.05 software was used for data analysis.

3. RESULTS AND DISCUSSION

3.1 Nosocomial Urinary Tract Infections

Within the study period (April, 2004 to March, 2005) there were 2546 admissions in Gadarif Teaching Hospital. Out of the 611(76% male and 24% female) admissions subjected to urinary catheter, hospital-acquired urinary tract infections were identified in 100(16.37%) patients. The mean age of the patients was 54.08 (14-90) years.

3.2 Aerobic Bacteria Isolated from Patients with Nosocomial Urinary Tract Infections

Aerobic bacteria found responsible for nosocomial urinary tract infections were *E. coli* (6.0%), *K. pneumoniae* (23%), *P. mirabilis* (22%), *P. aeurginosa* (37%) and *P. vulgaris* (12%) (Fig. 1).

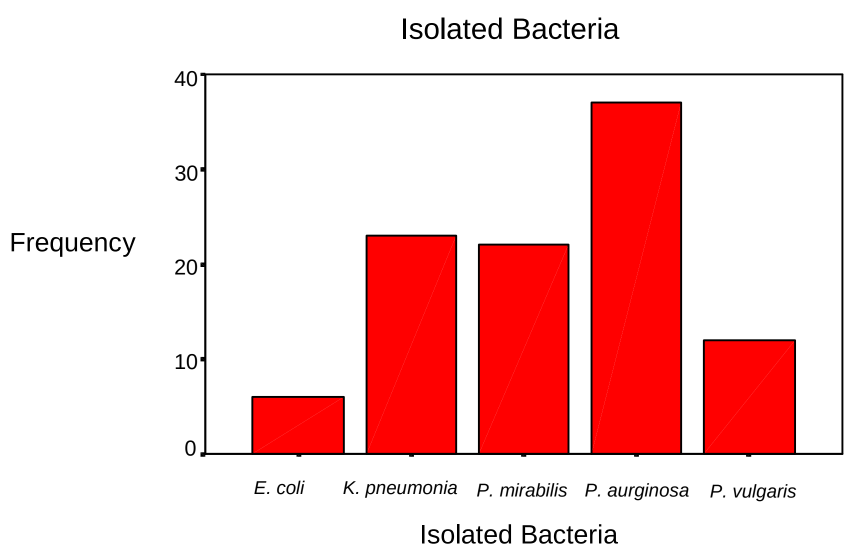

Fig. 1. Frequency of aerobic bacteria isolated from patients with nosocomial urinary tract infections

3.3 Susceptibility of the Isolated Bacteria to Antibiotics

The isolated bacteria were subjected to in vitro antimicrobial susceptibility test using the disc diffusion technique (Kirby-Bauer method) (Bauer et al., 1966). Tables 1 and 2 show sensitivity, intermediate and resistance response of the isolated bacteria to antibiotics.

Table 1. Susceptibility test to aerobic bacteria isolated from patients with nosocomial urinary tract infection

Isolates	N	Antibiotics														
		Penicillin G (%)			Gentamicin (%)			Ciprofloxacin (%)			Ceftazidime (%)			Cephalexin (%)		
		S	I	R	S	I	R	S	I	R	S	I	R	S	I	R
E. coli	6	-	-	100	33.3	-	66.7	16.7	-	83.3	83.3	-	16.7	66.7	-	33.3
K. pneumonia	23	-	-	100	30.4	-	69.6	69.6	-	30.4	39.1	-	60.9	52.2	-	47.8
P. mirabilis	22	68.2	-	31.8	13.6	-	86.4	95.5	-	4.5	40.7	-	59.1	72.7	-	27.3
P. Aeruginosa	37	29.7	-	70.3	51.4	-	48.6	89.2	-	10.8	35.1	5.4	59.5	24.3	2.7	73.0
P. vulgaris	12	-	-	100	50.0	-	50.0	100	-	-	25.0	-	75.0	41.7	-	58.3
Total	100	26.0	-	74.0	37.0	-	63.0	83.0	-	17.0	39.0	2.0	59.0	46.05	1.0	53.0
P=value		P=0.01			P=0.04			P=0.01			P=0.02			P=0.03		

N- Number of isolates, S- Sensitive, I- Intermediate, R- Resistant

Table 2. Susceptibility test to aerobic bacteria isolated from patients with nosocomial urinary tract infection

Isolates	N	Antibiotics											
		Nitrofurantoin (%)			Nalidixic Acid (%)			Ofloxacin (%)			Co-trimoxazole (%)		
		S	I	R	S	I	R	S	I	R	S	I	R
E. coli	6	50.0	-	50.0	33.3	-	66.7	66.7	-	33.3	83.3	-	16.7
K. pneumonia	23	69.6	-	30.4	82.6	-	17.4	82.6	-	17.4	47.8	-	52.2
P. mirabilis	22	52.2	4.5	40.9	59.1	-	40.9	72.7	4.5	22.7	77.3	-	22.7
P. aeruginosa	37	83.8	2.7	13.5	56.8	-	43.2	70.3	2.7	27.0	64.9	-	35.1
P. vulgaris	12	33.3	-	66.7	58.3	-	41.7	75.0	8.3	16.7	58.3	-	41.7
Total	100	66.0	2.0	32.0	62.0	-	38.0	74.0	3.0	23.0	64.0	-	36.0
P=value		P=0.03			P=0.01			P=0.04			P=0.02		

N- Number of isolates, S- Sensitive, I- Intermediate, R- Resistant

3.4 β-lactamase Production of the Isolated Bacteria

β-lactamase production test was performed to the isolated bacteria, the results were as follows: all strains of *E. coli* (100.0%) were positive, *K. pneumoniae* 11(47.8%) strains positive and 12(52.2%) negative, *P. mirabilis* 8(36.4%) strains positive and 14(63.6%) negative, all strains (n=37, 100.0%) of *P. aeruginosa* were positive and also all strains (100.0%) of *P. vulgaris* were positive, Table 3.

Table 3. Beta-lactamase production of aerobic bacteria isolated from patients with nosocomial urinary tract infections

Isolated Bacteria	Count and Percentages	Positive	Negative	Total
E. coli	% within Isolated Bacteria	6	0	6
	% within Beta-lactamase	100	0	100
	% of Total	8.1	0	8.1
	Count	6.0	0	6
K. pneumonia	% within Isolated Bacteria	11	12	23
	% within Beta-lactamase	47.8	52.2	100
	% of Total	14.9	46.2	61.1
	Count	11.0	12	23
P. mirabilis	% within Isolated Bacteria	8	14	22
	% within Beta-lactamase	36.4	63.6	100
	% of Total	10.8	53.8	64.6
	Count	8.0	14	22
P. aeurginosa	% within Isolated Bacteria	37	0	37
	% within Beta-lactamase	100	0	100
	% of Total	50	0	50
	Count	37	0	37
P. vulgaris	% within Isolated Bacteria	12	0	12
	% within Beta-lactamase	100	0	100
	% of Total	16.2	0	16.2
	Count	12	0	12
Total	% within Isolated Bacteria	74	26	100
	% within Beta-lactamase	74	26	100
	% of Total	100	0	100

Hospital-acquired infections have increased worldwide, contributing considerably to morbidity and mortality of the hospitalized patients (Bryan and Reynolds, 1984). Therefore, prolonging hospital stay can add significantly to the economic burden of underlying disease. Hospitalized patients acquire nosocomial infections due to important risk factors including advancing age, intravenous lines, indwelling urinary catheter and surgical wounds in intensive care units (ICU) and/or medical specialties wards. In this study we tried to evaluate and detect the prevalence of aerobic bacteria responsible for nosocomial infections in patients suffering from catheter-related urinary tract infections among hospitalized patients at Gadarif Teaching Hospital, Gadarif State, Sudan. Out of 611, 100(16.37%) patients had developed catheter-related urinary tract infections in the period from April, 2004 to March,

2005. Catheter-associated urinary tract infections is the most common nosocomial infection, and studies suggest that patients with such infections have an increased institutional death rate and is the second most common cause of nosocomial bloodstream infections (Dennis et al., 2001). In our study, the prevalence of such infections among the recruits for the period of study in Gadarif Teaching Hospital was 16.37%. Study by Dennis et al., 2001 also found that catheter-associated bacteriuria developed in about 25% of patients who required urinary catheter. Study added, patients required ≥7 days to develop nosocomial bacteriuria. In our study aerobic bacteria were isolated from patients in 3 days up to 7 days, thus agreeing with the previous study in the maximum number of 7 days (Dennis et al., 2001).

Nosocomial urinary tract infections are the largest institutional reservoir of nosocomial antibiotic-resistant pathogens (Jarvis and Martone, 1992). The aerobic gram-negative bacteria isolated in our study from patients who suffered nosocomial urinary tract infections included *E. coli* (6%), *K. pneumoniae* (23%), *P. mirabilis* (22%), *P. vulgaris* (12%). The highest incidence was due to *P. aeruginosa* (37%). Studies in the United States Acute-care hospitals reported *E. coli* (26%), *K. pneumoniae* (12%), *P. mirabilis* (6%), *P. vulgaris* (10%) and *P. aeruginosa* (16%) as the most important nosocomial antibiotic-resistant pathogens, causing catheter-related bacteriuria (Davis et al., 1989). Another supporting research to this study was that conducted in Saudi Arabia to evaluate the prevalence of gram-negative bacteria implicated in urinary tract infections due to Foley's urinary catheter. The research showed that 30.3% of *E. coli* isolates were extended spectrum β lactamase (ESBL) producers, which is higher than reported figures of *E. coli* in Canada (2.7-6.2%) and USA (2.2-6.6%) and is lower than those reported in India (41-40%) (Baby and Appla, 2004).

The increasing antimicrobial resistance among aerobic bacteria causing urinary tract infections makes therapy of this type of infections difficult and leads to more use of extensive broad-spectrum drugs.

In our study, antimicrobial susceptibility of aerobic bacterial isolates from urinary tract infections showed different patterns. E. coli was susceptible in higher percentage to Ceftazidime (83.3%) and Co-trimoxazole (83.3%), but resistant to penicillin G (100%), while *K. pneumoniae* was susceptible to Nalidixic acid (82.6%) and Ofloxacin (82.6%) but completely resistant to penicillin G (100%). Ciprofloxacin (95.5%) emerged as the most effective drug against *P. mirabilis* strains, but resistance to Gentamicin (86.4%) was obvious. *P. vulgaris* was completely susceptible to Ciprofloxacin (100%) and remarkably resistant to penicillin G (100%) with different patterns to other drugs. *P. aeruginosa* showed susceptibility to Ciprofloxacin (89.2%) and Nitrofurantoin (83.8%).

4. CONCLUSION

Strains of *S. aureus* including methicillin-resistant *S. aureus*, beside gram-negative aerobic bacteria represented by *E. coli, P. mirabilis, P. vulgaris* and *P. aeruginosa* were the most frequent cause of nosocomial urinary tract infection**.** Both *S. aureus* strains and gram-negative bacteria appeared resistant to Penicillin G and to some extent to Gentamicin. Vancomycin and Fusidic acid were effective against strains of *S. aureus* and Ciprofloxacin exhibited effectiveness against gram-negative bacteria.

The findings of this study demonstrated an increase in the prevalence of resistance to a number of used antimicrobial agents up to alarming levels. This increased rate is an expanding global health crisis that threatens the live of many individuals. In view of the emerging drug resistance, bacterial therapy should only be advocated, as far as possible after culture and sensitivity has been performed. This would not only help in the proper treatment of the patient but also prevent further development of bacterial drug resistance.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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