Urinary bacteria sensitivity and resistance in patients with chronic urinary catheter

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Citation

J Esquivel, A Arreguín, L Sandoval, Q Gante, I Enciso. *Urinary bacteria sensitivity and resistance in patients with chronic urinary catheter*. The Internet Journal of Infectious Diseases. 2008 Volume 7 Number 1.

Abstract

Antecedents:
Catheter-Associated Urinary Tract Infection (CAUTI) is a common infection often resulting in severe complications. The objective of this study was to identify the microorganisms present in patients with chronic urinary catheter and to determine antibiotic sensitivity and resistance.
Materials and Methods:
A cross-over study was carried out in Colima, Colima, Mexico. Patients over18 years of age with chronic urinary catheter (>30days) were included in the study. Urine samples were taken directly from the catheter and processed immediately. Qualitative-quantitative urine cultures were obtained.
Results:
A total of 38 samples were studied. The principle bacteria isolated in our study was Escherichia coli. Of the 27 isolated Escherichia coli strains, 100% were sensitive to: ampicillin/clavulanate, ampicillin/sublactam, lomefloxacine, ofloxacin, tetracycline, tobramycin, and trimethoprim/sulphametoxazole. One hundred percent of the Escherichia coli strains were resistant to ampicillin.
Conclusions:
This study can serve the community and especially health institutes in providing patients with efficient medical treatment.

INTRODUCTION

The definition of Catheter-Associated Urinary Tract Infection (CAUTI) varies among published studies and the terms “bacteriuria” and “urinary tract infection” (UTI) are frequently used indistinctly (1). Bacteriuria or funguria levels $>10^3$ colony- forming units (CFU) have been shown to be highly predictive of CAUTI, given that these levels increase to 10^5 CFU within 24 to 48 hours (2). Other specialists consider CAUTI to be present when there is predominant pathogen growth equal to or greater than 10^2 CFU, especially when associated with piuria (3). Signs and symptoms associated with CAUTI such as fever, disuria, urgency, flank pain and leukocytosis have also been shown to have a low positive predictive value for CAUTI diagnosis since 90 per cent of them are asymptomatic. This is most likely due to the fact that a urinary tract catheter continually eases bladder compression, thus avoiding urgency and pollakiuria associated with inflamed bladder distension. A catheter in the urethra also prevents continuous urethral exposure to large numbers of organisms in the infected urine, averting urethritis, and consequently, urgency and disuria (4). Millions of urinary tract catheterizations are carried out worldwide for purposes of control, repair, diagnosis and treatment. The risk of infection per procedure is from 1 to 2 per cent. This risk increases to 3 to 7 per cent per catheterization day in such a way that nearly all patients will present with bacteriuria after 30 days of urethral catheterization (5).

The risk per day average is 5 per cent. Other studies have stated that more than half the number of patients with permanent catheters will develop bacteriuria after 5 days of use and that the infection risk per day is 2.7 per cent for chronic use as opposed to 0.14 per cent for intermittent use (6, 7, 8, 9). Fifteen to twenty per cent of hospitalized patients require urinary catheter (10). Four per cent of patients receiving at-home care use permanent urinary catheters (11). It has also been reported that extra-hospitalary urinary infections are associated with the use of vesical catheters in 16.3 per cent of patients (12). Diverse studies reveal that the predominant uropathogen is E. coli (13). The conventional

cut-off point for distinguishing between short and long-term catheterization is 30 days (14).

A study carried out in Great Britain from 1996 to 2001 reported that there was a significant change in both the bacterial spectrum and antimicrobial resistance. A greater incidence of polymicrobial infection was also observed resulting in important clinical implications. CAUTIs could become more difficult to treat, especially while the catheter was in situ, since it would be necessary to determine the indicated antibiotic or antibiotics to combat the bacteria present (13).

Chronic vesical catheter use is a very common condition in medical practice due to a large variety of pathologies. Infection risk in permanent catheter use is variable and depends on the population, hospital application motive and catheter placement skill on the part of medical personnel. Urinary infection is not the only problem related to catheter use. Urethral stenosis in the male, urethrorrhagia, catheter obstruction, vesicoureteral reflux, bacteremias, false pathways and even stone formation are all possible resulting problems (14, 15, 16).

Indiscriminate antibiotic use in patients with temporary or chronic urinary catheter has led to the creation of bacterial resistance to one or to multiple drugs. This has provoked the development of severe and difficult-to-treat urinary infections. Inadequate, insufficient and inopportune medical treatment can result in treatment complications for the patient.

The objective of this study was to identify the microorganisms present in patients with chronic urinary tract catheter and to determine the sensitivity and resistance of the bacteria present to diverse antibiotics.

MATERIALS AND METHODS

A cross-over study of patients from the public health sector in Colima, Colima, Mexico, was carried out. Patients over 18 years of age, with chronic urinary tract catheter (>30días), with no antibiotic intake at least 30 days prior to sample taking were included in the study. Pregnant women and those individuals under any type of immunosuppressive regimen were excluded. All participating patients signed letters of informed consent and the study was approved by the regional ethics committee.

SAMPLE OBTAINMENT

The sample was taken as follows: the line was washed with isodine shampoo and blocked with Kelly tweezers and, with the use of sterile gloves, the recollection system was disconnected so the sample could drip into a sterile container.

Once the sample was taken it was either immediately sent to the laboratory for analysis or refrigerated. If arrival to the place of study was to be delayed, the sample was kept in a cold environment of 4°C.

SAMPLE PROCESSING

In the laboratory the urine was homogenized and divided into two parts: one for sediment study and the other for urine culture.

Sediment was obtained by centrifuge at 2.500 rpm and was observed fresh which gave an indication of the number of organisms present in the urine. It was also observed in a urine smear colored by the Gram method. A qualitative-quantitative urine culture was done.

LABORATORY QUALITY CONTROL

Two fundamental types of quality control were employed:

1. Internal quality control (IQC) (intralaboratory)
2. External quality control (EQC) (interlaboratory)

IQC is applied by the laboratory once a month and consists of treating a Dade Behring pure strain of known sensitivity (E. coli. ATCC 25922 or P. aeruginosa ATCC 27853).

EQC is applied every 60 days. The sample – a pure strain of known sensitivity – is received in the Clinical Laboratory of Guadalajara Jalisco. It is processed and the result is sent by messenger service or by electronic mail. If there is any discrepancy it is made known before a period of 48 hours.

STATISTICAL ANALYSIS

Descriptive statistics based on percentages, averages and standard deviation were used. Sample size was obtained using the Kish & Leslie formula with a 90% expected prevalence and a reference population of 60.

RESULTS

A total of 38 samples from 37 men and 1 woman with an average age of 72 ±13.58 were studied. Symptoms suggestive of UTI were present in 7.89 per cent of the patients (n=3) while 92.1 per cent (n=35) were asymptomatic. All samples underwent culture and antibiogram to determine the bacterial species isolated in our

environment, their frequency and their sensitivity and resistance to 21 antibiotics commonly used in medical practice. Thirty-five of them (92.36%) developed more than 100,000 CFU.

In relation to the search for infection with single vs. polymicrobial micro-organisms 38 (100%) showed Gram-negative bacteria and only 2 (5.26%) showed mixed bacterial flora (Gram-positive and Gram-negative).

The principle isolated bacterial species found in our study was Escherichia coli (n=27, 71.05%), followed by Proteus mirabilis (n=5, 13.15%), Enterobacter cloacae (n=3, 7.89%), Staphylococcus aureus (n=2, 5.26%) and Enterobacter agglomerans (n=1, 2.63%). The behaviour of the five cultivated bacteria was classified by angiogram as sensitive (S), intermediate (I) and resistant (R). Of the 27 isolated strains of Escherichia coli, 100 % were sensitive (S) to 7 of the 21 antibiotics studied: ampicillin/clavulanate, ampicillin/sublactam, lomefloxacine, ofloxacin, tetracycline, tobramycin, and trimethoprim/sulphametoxazole. One hundred percent of the Escherichia coli strains showed resistance (R) to ampicillin. Escherichia coli sensitivity to the remaining antibiotics was variable (Table1).

Figure 1

Table 1: E. Coli Sensitivity and Resistance to 21 selected antibiotics

	Amikacin	Cefalotin	Cefazolin	Ceftazidime	Ceftriaxone	Cefuroxime	Ciprofloxacin
S	59.25%	81.48%	66.6%	96.3%	85.18%	74%	92.6%
I	37.03%	14.8%	33.3%	3.7%	14.82%	26%	7.4%
R	3.7%	3.7%	0%	0%	0%	0%	0%
	Gentamicin	**Nitrofurantoin**	**Norfloxacin**	**Piperacillin**	**Sulphametoxazole**	**Trimethoprim**	
S	7.4%	0%	37.03%	0%	0%	0%	
I	40.75%	33.3%	59.25%	25.92%	11.12%	22.23%	
R	51.85%	66.6%	3.7%	74.08%	88.88%	77.77%	

N= 27; S= Sensitive; I= Intermediate; R= Resistant

100% Resistance (Ampicillin)

100% Sensitivity (Ampicillin/Clavulanate, Ampicillin/Sulbactam, Lomefloxacillin, Ofloxacin, Tetracycline, Tobramycin y Trimethoprim/Sulphametoxazole)

Of the 5 Proteus mirabilis isolated strains, 100 % were sensitive (S) to 13 of the 21 antibiotics studied: ampicillin/clavulanate, ampicillin/sublactam, cefalotin, cefazolin, ceftazidime, ceftriaxone, cefuroxime, ciprofloxacin, lomefloxacine, ofloxacin, tetracycline, tobramycin and trimethoprim/sulphametoxazole. One hundred percent showed resistance (R) to sulphametaxole, ampicillin and trimethoprim. Proteus mirabilis sensitivity to the remaining antibiotics was variable (Table 2).

Figure 2

Table 2: P. Mirabilis Sensitivity and Resistance to 21 selected antibiotics

	Amikacin	*Gentamicin*	*Nitrofurantoin*	*Norfloxacillin*	*Piperacillin*
S	80.0%	20%	0%	60%	0%
I	20%	40%	40%	20%	60%
R	0%	405	60%	20%	40%

N= 5; S= Sensitivity; I= Intermediate; R= Resistance.

100% Sensitivity (Ampicillin/Clavulanate, Ampicillin/Sulbactam, Cefalotin, Cefazolin, Ceftazidime, Ceftriaxone, Cefuroxime, Ciprofloxacillin, Lomefloxacillin, Ofloxacin, Tetracycline, Tobramycin and Trimethoprim/Sulphametoxazole)
1
00% Resistance (Ampicillin, Sulphametoxazole and Trimethoprim)

The rest of the three identified strains showed diverse sensitivity and resistance to the drugs included in the study (Table 3).

Figure 3

Table 3: E. Cloacae, S. Aureus and E. Agglomerans Sensitivity and Resistance to 21 selected antibiotics

	100% Sensitive	*Intermediate*	*100% Resistant*
E. Cloacae N=3	Amikacin, Amps/Clavulanate, Amps/Sulbactam, Cefalotin, Cefuroxime, Ciprofloxacin, Lomefloxacillin, Ofloxacillin, Tetracycline, Tobramycin, Trimethoprim/Sulphametoxazole, Ceftazidime, Ceftriaxone.	Cefazolin, Gentamicin, Nitrofurantoin, Norfloxacin	Ampicillin, Piperacillin, Sulphametoxazole and Trimethoprim
S. Aureus N=2	Amikacin, Amps/Clavulanate, Amps/Sulbactam, Cefalotin, Cefazolin, Ceftazidime, Ceftriaxone, Cefuroxime, Ciprofloxacin, Gentamicin, Lomefloxacillin, Norfloxacin, Ofloxacin, Sulphametoxazole, Tetracycline, Tobramycin, Trimethoprim y Trimethoprim/Sulphametoxazole.	There was none	Ampicillin Nitrofurantoin Piperacillin,
E. Agglomerans N=1	Amps/Clavulanate, Amps/Sulbactam, Cefalotin, Ceftazidime, Ceftriaxone, Cefuroxime, Ciprofloxacillin, Lomefloxacillin, Ofloxacillin, Tetracycline, Tobramycin and Trimethoprim/Sulphametoxazole.	Amikacin, Cefazolin, Nitrofurantoin, Norfloxacillin	Ampicillin Gentamicin Piperacillin Sulphametoxazole and Trimethoprim

In general all the bacteria were resistant to ampicillin and the majority were resistant to trimethoprim with sulphametoxazole. The bacteria were very resistant to nitrofurantoin. Quinolones and Cephalosporins continue to be a good treatment alternative with great sensitivity and low resistance for bacteria when there are high levels of quinolone concentration in urine.

CONCLUSIONS

Escherichia coli is the primary bacteria (71.05 %) in isolated bacterial species and frequency in patients with permanent urinary catheter covered by and treated at the IMSS, SSA and treated in private medical practice in the State of Colima. More than 100,000 CFU, the standard concentration used to establish Urinary Tract Infection, were found in 96 per cent of the population studied.

Polymicrobial infection frequency in our population is low (5.26%). The same holds true in relation to the presence of urinary infection symptoms, which were referred to in only

7.89 per cent of patients.

These data are congruent with those reported in other studies, such as Tambyah and Maki who found that only 6 per cent of infections were polymicrobial and more than 90 per cent of catheter-associated urinary tract infection patients were asymptomatic (17). Our study demonstrates microorganism behaviour in our environment upon coming into contact with the antibiotics commonly used in clinical practice for urinary tract infection treatment.

Of the 27 strains of Escherichia coli that were isolated, cultivated and determined to be sensitive to 21 antibiotics, 100 per cent were susceptible to only 7: ampicillin/clavulanate, ampicillin/sublactam, lomefloxacine, ofloxacin, tetracycline, tobramycin, and trimethoprim/sulphametoxazole.

It is worth noting that in our medical environment tetracycline was once frequently used but is now rarely prescribed, despite the fact that E. coli strains are uniformly sensitive to it.

On the other hand, 100 per cent of Escherichia coli is uniformly resistant (R) to ampicillin by itself, which continues to be widely used with or without medical prescription. This is not true when it is combined with one of the betalactamase blockers, such as ampicillin/clavulanate and/or ampicillin/sublactam, where sensitivity (S) increases 100 per cent. With respect to the rest of the antimicrobial drugs studied, it is striking that 7.4 per cent of E. coli is sensitive to gentamicin, which is conspicuously used in the treatment of urinary tract infections, in patients both with and without urinary catheter. It is worth noting that susceptibility is intermediate (I) in 40.75 per cent of microorganisms and there is resistance (R) in 51.85 per cent. This should make us think about how bacteria act as true ecosystems in the presence of the prescribed antibiotic load, and that it would be prudent to give gentamicin a “rest” in clinical practice in these types of infections, especially in the intrahospital environment. When antibiotics are infrequently used or kept as reserves, after a period of time germs once again become susceptible to them (18).

In serious infections, another aminoglucoside, amikacin, continues to be a good therapeutic option. Our study reported sensitivity (S) in 59.25 per cent of E. coli, intermediate sensitivity (I) in 37.03 per cent and resistance (R) in only 3.7 per cent. Keeping in mind the high concentrations this antibiotic reaches in the urinary tract, it is seen as a good alternative in these types of infections. Two quinolones deserving special attention are norfloxacin and ciprofloxacin. The former has been used continuously in these infections and our study showed it has 37.3 per cent sensitivity for bacteria and the latter, more recently introduced, has a sensitivity (S) of 92.6 per cent.

Knowing which bacteria are present in chronic urinary catheter patients is of great importance due to the high prevalence of infection associated with catherization and its complications. Knowing which bacteria are present will give us the opportunity to offer patients a more efficient and opportune treatment. Because of its descriptive epidemiological quality, this study can serve the community, especially the health institutions in which it was carried out, by improving the quality of treatment of patients. Even though the extrapolation of this study to other entities in Mexico would produce differences for the particular existing variables of each entity, it would serve as an incentive to motivate researchers and institutions to carry out this type of study.

References

1. Kunin CM. Care of the urinary catheter. Urinary Tract Infections: Detection, Prevention and Management. 5th ed. Philadelphia, Pa: Lippincott Williams & Wilkins; 1997:227-279.
2. Stark RP, Maki DG. Bacteriuria in the catheterized patient: what quantitative level of bacteriuria is relevant? N Engl J Med. 1984; 311:560-4.
3. Stamm WE. Urinary tract infections. In: Bennett JV, Brachman PS, eds. Hospital Infections. 4th ed. Philadelphia, Pa: Lippincott-Raven; 1998:477-485.
4. Tambyah PA, Maki DG. Catheter-Associated Urinary Tract Infection is rarely symptomatic: A prospective study of 1497 catheterized patients. Arch Intern Med. 2000; 160:678-682.
5. Nagy EM. Prevention and treatment of catheter associated infections: myth or reality? EUA Updates series 2004; 160:678-682.
6. Blumstein H. Infection in the patient with indwelling devices and ostomies. Emerg Med Clin North Am. 2001; 19(3):709-21.
7. Stamm WE. Catheter-associated urinary tract infections: epidemiology, pathogenesis and prevention. Am J Med. 1991; 91(suppl 3B):65S-71S.
8. Warren JW. Catheter-associated urinary tract infections. Infect Dis Clin North Am. 1997; 11:609-22.
9. Esclarin De Ruz A, Garcia Leoni E, Herruzo Cabrera R. Epidemiology and risk factors for urinary tract infection in patients with spinal cord injury. J Urol. 2000. 164:1285-9.
10. Liedberg H, Lundeberg T, Ekman P. Refinements in the coating of urethral catheters reduces the incidence of catheter-associated bacteriuria. An experimental and clinical study. Eur Urol. 1990; 17:236-40.
11. Zimakoff JD, Pontoppidan B, Larsen SO, Stickler DJ. Management of urinary bladder function in Danish hospitals, nursing homes and home care. J Hosp Infect. 1993; 24:183-99.
12. Carranza MA, Rodríguez D, Días J. Etiología y

resistencia bacteriana de las infecciones urinarias en pacientes hospitalizados en el Centro Médico Naval entre enero y diciembre del 2003. Rev Soc Per Med Inter. 2003; 16(3):5-13.
13. Saint S, Veenstra DL, Sullivan SD, Chenoweth C, Fendrick AM. The potential clinical and economic benefits of silver alloy urinary catheters in preventing urinary tract infection. Arch Intern Med. 2000;160:2670-5
14. Wazait HD, Patel HR, Veer V, Kelsey M, Van Der Meulen JH, Miller RA, Emberton M. Catheter-associated urinary tract infections: prevalence of uropathogens and pattern of antimicrobial resistance in a UK hospital (1996-2001). BJU Int. 2003; 91:806-809.
15. Daifuku R, Stamm WE. Bacterial adherence to bladder uroepithelial cells in catheter-associated urinary tract infection. N Engl J Med: 1986; 314(19):1208-1213.
16. Owen EM, Bream AS. A Prospective Comparison of Urinary Tract Infections in Patients Treated with Either Clean Intermittent Catheterization or Urinary Diversion. Pediatrics.1982; 70 (5): 665-9.
17. Bass PF, Jarvis JA, Mitchell CK. Urinary tract infections. Primary Care. 2003; 30(1): 41-61.
18. Gupta K, Hooton TM, Stamm WE. Increasing Antimicrobial Resistance and the Management of Uncomplicated Community-Acquired Urinary Tract Infections. Ann Intern Med. 2001; 135:41-50.

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