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BACTERIURIA DUE TO CATHETERIZATION IN HOSPITALIZED PATIENTS

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ABSTRACT

In this survey, made to determine instances of bacteriuria occurring in hospitalized patients who had undergone catheterization, 259 urine specimens were taken from 103 patients admitted to three hospitals in Tehran. Of the 73 patients who had no urinary tract infection or contamination, 40 (54.8%) developed bacteriuria at the end of catheterization. Incidence of bacteriuria in patients under age 40 was 55.5%, and 53.5% in patients over age 40. The organisms that were isolated from the urine cultures of the patients were most often gram negative bacilli of Enterobacteriaceae, among which *E. coli* (38%) and *Klebsiella pneumoniae* (17%) had the highest frequency.

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INTRODUCTION

Urinary catheters, especially the longer indwelling ones, comprise the most common predisposing cause of urinary tract infections in hospitalized patients. In 1956, Kass reported that without the use of a closed urinary drainage system, 95% of catheterized patients will develop bacteriuria rapidly within 96 hours (most of them within the first 24 hours).

The Center for Disease Control, citing the incidence of nosocomial urinary tract infection in the USA, has announced that some form of urological equipment (mostly urinary catheters) had been used by nearly 75% of patients with nosocomial urinary tract infection, before the onset of infection.[13]

Although urine drainage by catheterization is a complementary curative method for the patients and although the use of closed, rather than open, urinary drainage systems has brought about a reduction in the incidence of urinary tract infections, basic research indicates that in most patients in whom catheterization exceeds two weeks, the closed urinary drainage systems cause the emergence of bacteriuria.[1,13] Studies indicate that in spite of the use of this system, still about 15-30% of the patients become afflicted with urinary infections within five days after the start of catheterization.[2]

The present study, made to determine incidence of bacteriuria found among a number of hospitalized patients at three hospitals in Tehran, reveals that not withstanding certain care measures taken at the time of insertion, the occurrence of bacteriuria among the catheterized patients has been relatively high.

MATERIALS AND METHODS

Two hundred and fifty-nine urine specimens were collected from 103 catheterized patients (98 females and 5 males) hospitalized in nine wards of three Tehran hospitals namely the Imam Khomeini, the Dr. Shariati and the Mirza Kuchek Khan Hospitals. Most of these patients were women who had been admitted for various surgical procedures such as Caesarean section, hysterectomy, laparotomy, curettage, etc.

Methods of Collecting Specimens

From each patient, three urine specimens were collected (one before the insertion of the catheter, one while inserting the catheter, and the third was taken after removal of the catheter); all were tested. The first specimen was tested to determine the presence or absence of urinary infection in the patients before catheterization. The third specimen was tested after removal of the catheter to determine the role of catheterization in the production of bacteriuria. Both the first and the third specimens were taken by the patients themselves in sterilized (16× 125mm) tubes from midstream urine.[11,23] The second specimens were taken from the end of the catheter while the sound was being fixed in place by the ward nurse, the operating room nurse or the related physician, all under aseptic conditions.[11]

The catheter was allowed to remain in place for at least 24 hours in the majority of the patients (67%). This period for some of the patients (except in cases involving change of the catheter, which lasted from 10 to 23 days) lasted between a minimum of 12 hours (in 17.5% of the patients) and a maximum of 72 hours (in 5.8% of the patients). In other words, each patient tolerated the catheter26 hours on the average. For this reason, efforts were made to collect the midstream urine specimens at least 48 hours after the stop of prophylactic antibiotics (third day after start of catheterization).

The kind of catheters used in all the hospital wards studied was the «Foley» variety manufactured in Japan, and the sizes were most often 18F or 20F.

Prophylactic antibiotics for prevention of probable infections were prescribed for 96 patients out of 103 (93%), the type, dosage and period of use being different under various conditions. At first, parenteral ampicillin or cephalothin were given to patients (1 g/q 6 h for 1-2 days), and later was changed to an oral dosage of 500 mg/q 6 h for 5-7 days.

Culture of the Specimens

In observation of the necessary conditions for prevention of the multiplication of bacteria,[6,10] the collected specimens were transferred in the shortest possible time to Imam Khomeini Hospital/Microbiology Laboratory. There, the specimens were inoculated on a plate of chocolate agar medium for colony count (total count) and on a MacConkey agar or eosin-methylene blue agar (EMB) medium for isolation of gram-negative bacteria.[6]

The inoculated plates were placed 18 to 24 hours in the incubator at 35°C and were then studied to determine the growth of bacteria. By counting the number of colonies on the chocolate agar medium and by considering the related dilution coefficient, total count of the bacteria existing in one milliliter of urine was determined. The plates in which a maximum of two species of organisms were isolated and which contained more than 1000 developed organisms in each milliliter of urine,[9,16] were selected as criteria of «bacteriuria» and subsequent diagnostic and differentiation tests were performed on them.

After preparing smears from the colonies in the chocolate or MacConkey agar media and staining them by the Gram's stain method,[6] and after determining the gram-negative and gram-positive bacteria, differential

Table I. A summary of patient's condition after cultivation of «before and during catheterization» urine specimens

Patients' Condition	Case Number	%
Total number of patients studied	103 cases	100
Cases afflicted with urinary infection before catheterization	21	20.4
Cases contaminated before catheterization	9	8.7
Cases contaminated and infected while inserting catheter	0	0
Remaining patients whose first and second specimens were negative	73	70.9

Table II. Results obtained from incubation and haterial counts of the third specimens of the 73 patients whose first and second specimens were negative

Bacterial species	One SP.	Two SP.	Three SP.	Total/%
Numher of colonies in 1 ml urine	No pt/%	No pt/%	No pt/%	
10^3-10^4	8/11	1/1.4	4/5.5	13/17.9
10^4-10^5	2/2.8	5/6.8	0/0	7/9.6
$> 10^5$	17/23.3	7/9.6	1/1.4	25/34.3
Total	27/37.1	13/17.8	5/6.9	45/61.8

Table III. Number of casesafflicted with bacteriuria and the incidence of bacteriuria due to catheterization

Patients' condition after removal of the catheters	No pts.	Incidence of bacteriuria
Afflicted by bacteriuria due to catheterization	40	54.80
Number of contaminated cases	5	6.90
Patients with negative results of urine cultures	28	38.3
Total	73	100

Table IV. Profusion distribution of patients and the percentage of hacteriuria due to catheterization in various age groups

Age by Years	Noof Pts	# cases due to catheterization	% of 73 Patients	% of all 40 cases
10-19	4	2	2.7	5
20-29	17	8	11	20
30-39	24	15	20.6	37.5
40-49	17	9	12.3	22.5
50-59	7	4	5.5	10.0
60-69	4	2	2.7	5.0
Total	73	40	54.8	100

Table V. Number of patients studied and the percentage of bacteriuria according to the average of their ages (40 years)

Average age by years	Patients Number	studied Percent	Bacteriuria due to c.*	
			Number	Percent
< 40	45	61.6%	25	55.5%
> 40	28	38.4%	15	53.5%
Total	73	100%	40	—

*Catheter

Table VI. Types of organisms isolated in the culture of the third urine specimens of patients after removal of catheters

TYPE OF ORGANISM	Number isolated	%
E. coli	20	38
Klebsiella pneumoniae	9	17
Staphylococcus epidermidis	4	7
Enterobacter agglomerans	3	6
Diphteroid bacilli	3	6
Proteus mirabilis	2	4
Staphylococcus aureus	2	4
Pseudomonas cepacia	2	4
Candida albicans	2	4
Staphylococcus saprophyticus	1	2
Streptococcus viridans	1	2
Klebsiella ozaenae	1	2
Citrobacter diversus	1	2
Serratia rubidaea	1	2
Total	52	100

and biochemical tests to determine the identity of the related organisms were performed by standard methods.[10,17]

RESULTS

In order to evaluate the role of catheterization in the generation of bacteriuria, 259 urine specimens were taken in three stages (prior and during the insertion of catheter, and after its removal) from hospitalized patients of three hospitals and they were tested.

The essential and major criterion which is considered to define urinary tract infections is the presence of «significant bacteriuria» which is reported through urine culture and the colony count of patients' urine specimens. Although the most widely recognized indicator of urinary infections is the presence of 10^5 bacteria in each milliliter of urine[2], some studies indicate that under other conditions, this figure can be below 10^5.[6,8,11,16,23]

In this study, the presence of more than 10^3 bacteria in each milliliter of urine with one, or at most, two species of pathogens, were regarded as criterion for «significant bacteriuria» in patients. Therefore, 30 urine specimens (belonging to 30 patients) that had been infected or contaminated prior to catheterization (i.e., specimens with a colony count of over 10^3 bacteria in each milliliter of urine and/or with more than two species of pathogens) were excluded from the study.

Moreover, the results of culture of urine specimens taken during catheterization, directly from the catheters, were all negative. These results showed that the bladder urine of the studied patients had been sterile and had had no organisms.

Table I shows in summary the condition of the patients after culture of two urine specimens, before and while catheterized. Of the 73 patients whose urine specimens prior to and during catheterization had been negative, after removal of the catheters, 13 cases (17.9%) had a colony count of 10^3-10^4; 7 cases (9.6%) had from 10^4-10^5, and 25 cases (34.3%) had more than 10^5 organisms per milliliter of urine. Thus, by deleting the five cases (6.9%) of the specimens (due to growth of more than two species of bacteria[11,23]), a total of 40 cases had a colony count of more than 10^3 bacteria per milliliter of urine. The results of urine culture of these 73 patients are shown in Table II.

Thus, it can be noted that 40 patients became afflicted with bacteriuria after a period of catheterization, in fact, incidence of bacteriuria has been 54.8% in this study (Table III).

The distribution of prevalence and percentage of bacteriuria (according to the age of patients) was studied in 73 patients, also with respect to total number of afflictions. Results show the highest prevalence of bacteriuria to be in the 30-39 year age group; the lowest percentage was noted among the 10-19 year and in the 60-69 year age groups (Table IV). Thus, considering the average age of the patients in this study, the percentage of bacteriuria in patients under 40 years of age was 55.5% and in those above 40 years of age, it was 53.5% (Table V).

Organisms Isolated by Culture of Urine Specimens

The bacteria that were isolated in urine culture were mostly gram-negative bacteria and belonged to the

Enterobacteriaceae. In fact, they were the same pathogens that are regarded responsible for the majority of urinary tract infections.[6,19,23]

Of the 52 bacterial strains that were isolated in the culture of the third specimens (specimens taken after removal of the catheters), *E. coli* in 20 cases (38%) was the most common and *Klebsiella pneumoniae* in nine cases (17%) was the second most frequent. The lowest percentage of isolated organisms belonged to *Klebsiella ozaenae, Staphylococcus saprophyticus, Streptococcus viridans, Citrobacter diversus* and *Serratia rubidaea*, each yielding one instance (2%) of isolation (Table VI).

DISCUSSION

The extent of the prevalence of bacteriuria due to catheterization of nosocomial patients or other patients who are maintained under this system, indicates that catheterization is the most predisposing factor to bacteriuria and urinary tract infections among these patients, so much so that 75 to 80% of urinary tract infections are said to be caused by catheterization.[5,13,18]

Although scientific data has established that the use of a closed urinary drainage system in aseptic conditions, together with proper care, has been able to reduce the incidence of bacteriuria to 15-30% of patients five days after catheterization,[2,20] yet the results of the present study, in spite of the use of closed urinary drainage systems, shows that bacteriuria arising from catheterization (after deleting the 30 cases who were contaminated or afflicted with bacteriuria prior to catheterization), developed in 54.8% within 12 to 72 hours after catheterization. In other words, one out of every two cases under study became afflicted by bacteriuria in a short time after receiving catheters.

As the performed studies indicate that prolongation of the period of catheterization causes an increase in bacteriuria among the patients,[7] therefore one may claim that if the catheterization period in the studied patients had lasted longer, the percentages of resultant bacteriuria would be more than the 54.8% figure already obtained. However, if the results are considered on the basis of the average age of these patients (40 years), then no appreciable difference would be observed, from the bacteriuria point of view, between the patients less than 40 years old (55.5%) and patients above 40 years (53.5%)[20].

The following may be regarded as some of the most important factors that contributed to the increase of bacteriuria incidence among the catheterized patients studied:

1. Violation of aseptic and/or sterility conditions during catheterization and absence or inadequacy of the necessary care after insertion of catheters by the personnel responsible for catheterization.

Table VII. Relationship between the professional status of the person inserting the urethral catheter with the risk of acquiring bacteriuria as a result of it. (22)

Person performing catheterization	No of pts catheterized	Pts with bacteriuria within 48 hours
Practiced nurses	35	12 (34.3%)
Graduate nurses	62	13 (21%)
Physicians	99	10 (10.1%)

2. Changes in persons assigned to the task of catheterization and/or lack of adequate proficiency in catheterization. As some of the studies indicate, a relation exists between the professional training of the person responsible for catheterizing and risk of bacteriuria[7,20,22] (Table VII).

3. The influence of the situation and place in which catheterization takes place; the level of contamination can be different from one ward to another, and from one hospital to another.[7]

4. Excessive patient referrals and overcrowded hospital conditions, insufficient supplies, equipment and personnel of hospital wards, which in some instances entailing long delays before a patient is assigned to a hospital bed.

5. The sex of patients. As studies indicate, the prevalence of bacteriuria due to catheterization among women is greater and at times may even be double that of men.[7,12] Therefore considering that 95% of the patients in this study were female, on the basis of the anatomic situation of the urinary tract, these patients were exposed to greater risk.[3,4]

Organisms Isolated

Of the organisms that were isolated from culture of patients' urine, the highest percentage belonged to *E.coli* (38%) and *Klebsiella pneumoniae* (17%) and minor percentages associated to other organisms including *Enterobacter agglomerans, Staphylococcus epidermidis, Proteus mirabilis* and others (Table VI). As can be noticed, these organisms are mostly the gram-negative bacilli and belong to the family of Enterobacteriaceae, whose sources are in the patients' feces. Since the majority of patients in this study were women, the isolated organisms may well have arisen from the patients' own GI flora that migrated upwards to the urinary tract, as is confirmed by studies as well.[21,24] Also, in this study, 7% of the isolated organisms belong to *Staphylococcus epidermidis*, which in itself can be an evidence of the increasing role of this bacterium in generating urinary tract infections among catheterized patients.[2] *Staphylococcus saprophyticus*, which is now recognized as a urinary pathogen among

young women and *Staphylococcus aureus*, which is regarded as a urinary pathogen in patients who have used some sort of urologic instrument (such as a catheter)[19] were isolated in a lesser percentage from the surveyed patients.

Prescription of Prophylactic Antibiotics

About 93% of the studied patients received prophylactic antibiotics either orally or parenterally. Although certain studies indicate that the use of prophylactic antibiotics does reduce incidence of bacteriuria, however, this effect is confined only to the first few days of catheterization[18], therefore, it must be admitted that:

-The use of prophylactic antibiotics by patients in this study did, to some extent, cause a reduction in the incidence of bacteriuria among them and, had they not used these prescribed antibiotics, we would surely witness a higher percentage (more than 54.8%) of such incidence.

-Considering that the purpose of prescribing prophylactic regimes is, generally, to prevent secondary infections, therefore if such antibiotics as nitrofurantoin, nalidixic acid or trimethoprim-sulphamethoxazole (sxt), which are all passed in the urine with considerable density, be prescribed along with the prophylactic regimes, these can, while preventing the occurrence of secondary infections at the site of injury, also prevent the occurrence of bacteriuria by catheterization.

It is necessary to emphasize this point regarding the use of care and precaution in prescribing prophylactic antibiotics, and differentiation must be made between patients with indwelling urinary catheters who are exposed for longer periods to infection, and patients who are catheterized for a short period, especially in respect of therapeutic regimes.

Without a doubt, the significant use of the urinary catheters in nosocomial patients and others, the side-effects arising from their use, especially the role of these catheters in relation to bacteremia and sepsis and its accompanying mortality,[3,14] demand that the prevention of such side-effects and occurrences of bacteriuria from catheterization be accorded the necessary priority.

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