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URINARY TRACT INFECTIONS IN THE CITY OF FLORENCE:  
EPIDEMIOLOGICAL CONSIDERATIONS OVER A  
TWENTY-YEAR PERIOD

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**Key words:** Urinary tract infection - Gram-negative - Gram-positive - Domiciliary bacteriuria - Nosocomial bacteriuria

Our study of significant bacteriurias indicated that the worldwide shift in the etiology of infections also holds true for the Florence area. In a twenty-year period (1970-1990), we noted a decreased frequency of Gram-negative bacilli, particularly of the family *Enterobacteriaceae*, and a significant increase of Gram-positive cocci in urinary patients. This finding was observed both in hospital and in community-acquired cases in the male sex and only in nosocomial bacteriurias in the female sex. There was a reduced isolation of "classic" urinary pathogens such as *Proteus mirabilis*: its prevalence in hospital-acquired urinary tract infection (UTI) decreased from 16% in 1970 to 5% in 1990 both in males and in females. On the other hand, we noted an increase of "difficult" microorganisms such as enterococci and methicillin-resistant staphylococci, particularly in the male sex; in 1970 enterococci were occasionally isolated in males both from hospital and from community-acquired UTIs (3% and 5%, respectively), whereas in 1990, on the contrary, they were encountered much more frequently (19% in both cases).

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INTRODUCTION

Acute urinary tract infection (UTI) is a major health problem (2); it was calculated that about 20-30% of adult women experience some type of UTI during their life (11), generally an uncomplicated cystitis caused by *Escherichia coli* (12). UTIs are also very frequent in the hospital environment, accounting for approximately 40% of all nosocomial infections; they are caused by *E. coli* to a lesser extent than community-acquired cases, where important pathogens are *Proteus* spp., *Pseudomonas aeruginosa* and the *Klebsiella-Enterobacter-Serratia* (K-E-S group)

group. During the last decade, Gram-positive microorganisms are reemerging as potential pathogens for nosocomial UTIs, especially enterococci and staphylococci (1).

UTIs are sometimes responsible for protracted symptoms or serious complications (i.e., Gram-negative sepsis), accounting for an adjunctive morbidity and an increased mortality. It has been estimated that 30% and 3% of asymptomatic bacteriurias develop a manifest infection and a bacteremia, respectively (4, 10). In the latter case, mortality risk is multiplied by three (13). Particularly, Gram-negative bacilli (GNB) other than *E. coli* (*Proteus* spp., *P. aeruginosa*, K-E-S group bacilli) are more likely to cause serious bacteremia and sepsis in hospitalized patients (8).

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We carried out a retrospective study to compare the prevalence of urinary pathogens isolated from urine cultures in the Florence area by the Laboratory of Microbiology of Careggi Hospital, Florence, in years 1970 and 1990.

**MATERIALS AND METHODS**

**Study area**

In 1970, the Laboratory of Microbiology of Careggi Hospital covered the city of Florence (about 450,000 inhabitants) and part of the neighboring area, for a total of more than half a million persons served. In 1990, the area served by the same Laboratory was restricted to the right bank of the river Arno, with approximately 300,000 inhabitants and relative hospitals.

**Bacterial identification**

Our study is based on monomicrobial significant bacteriurias; we consider a bacteriuria significant when urine in the bladder contains  $\geq 10^5$  bacteria/ml, a sufficient number to denote infection rather than contamination (9). Our decision to exclude polymicrobial significant bacteriurias from our study depends on their being due, in certain cases, to contamination during collection, particularly in subjects at risk (the elderly, patients of urological wards).

In 1970, the bacterial counts of the urine cultures analyzed at the Laboratory was determined by a plate serial dilution technique; bacterial species were identified by enzymatic methods. 529 monomicrobial significant bacteriurias were identified, 136 from a domiciliary source (83 from males and 53 from females), and 393 from a nosocomial source (190 from males and 203 from females).

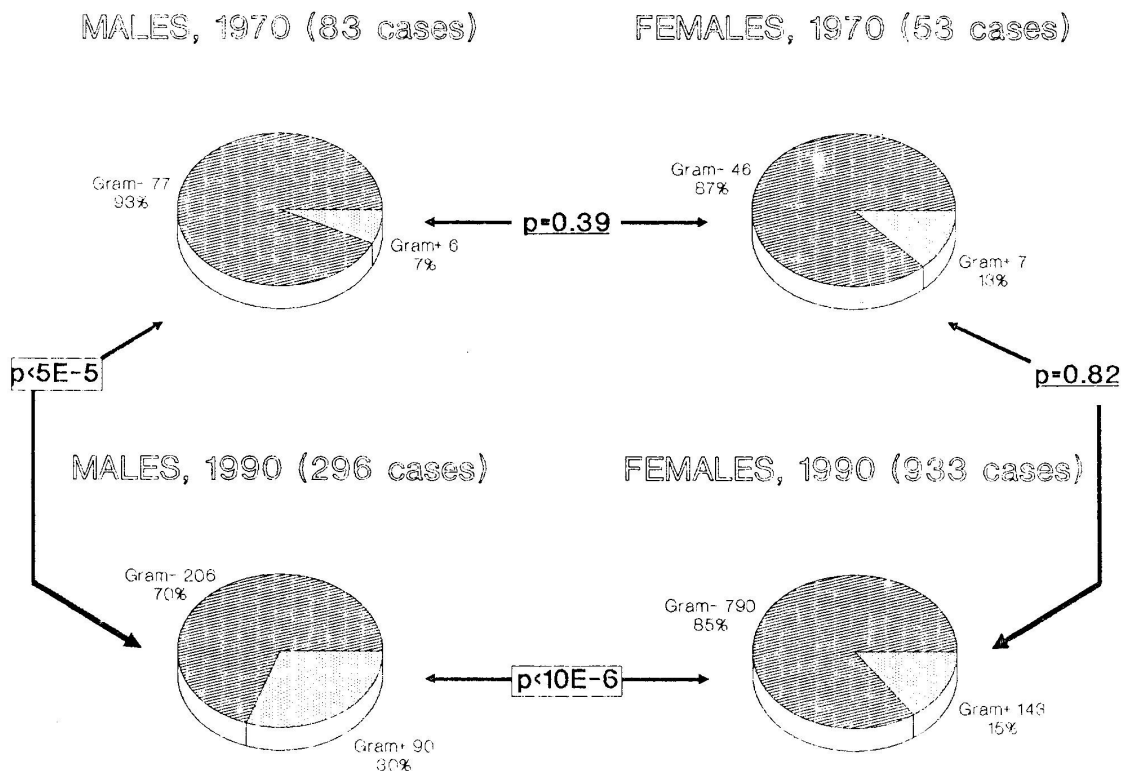


Figure 1. - Urinary pathogens isolated from domiciliary monomicrobial significant bacteriurias (I).

In 1990, the bacteria present in the urine were quantified by a 1- $\mu$ l calibrated loop technique and bacterial identification was carried out by enzymatic methods. 2576 monomicrobial significant bacteriurias were found, 1229 from a domiciliary source (296 from males and 933 from females), and 1347 from a nosocomial source (488 from males and 859 from females).

**Statistical analysis**

Statistical analysis was performed by the chi-square test with the Yates's correction for small numbers and by the Fisher's exact test. The differences were considered statistically significant for  $p < 0.05$ .

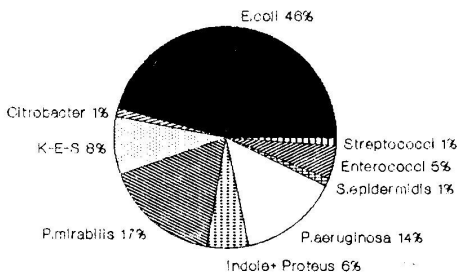
**RESULTS**

**Domiciliary UTIs**

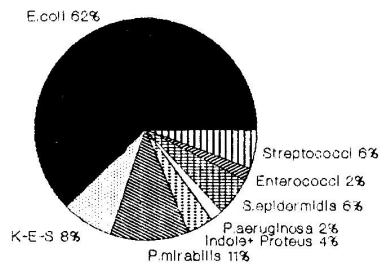
In 1970, GNB were isolated from the vast majority of specimens both in males and in females (93% and 87%, respectively;  $p = 0.39$ ). In 1990, the female sex confirmed this datum (85%;  $p = 0.82$ ), whereas the male sex manifested a highly significant increase of Gram-positive microorganisms (from 7% to 30%;  $p < 5^{\circ}$ ). In 1990 the difference between males and females was highly significant ( $p < 10^{\circ}$ ). No fungi were isolated either in 1970 or in 1990 (Fig. 1).

In 1970, *E. coli* was isolated most frequently both in males and in females (46% and 62%, respectively;  $p = 0.089$ ), followed by *Proteus mirabilis* (17% and 11%;

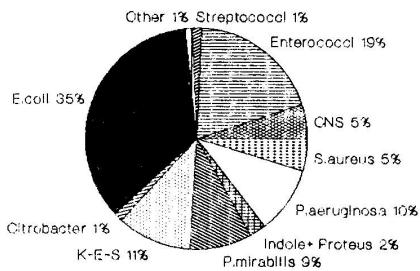
MALES, 1970 (83 cases)



FEMALES, 1970 (53 cases)



MALES, 1990 (296 cases)



FEMALES, 1990 (933 cases)

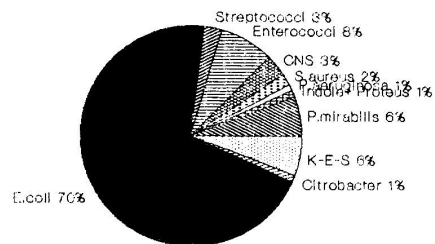


Figure 2. - Urinary pathogens isolated from domiciliary monomicrobial significant bacteriurias (II).

$p = 0.52$ ). The only significant difference between males and females was found for *P. aeruginosa* (14% and 2%;  $p = 0.011$ ). In 1990, *E. coli* was again the leading cause of bacteriuria, but with twice the prevalence among females compared with males: 70% against 35% ( $p < 10^{-6}$ ). In the male sex "difficult" microorganisms were well represented, such as enterococci (19% vs 8% of the female sex;  $p < 10^{-6}$ ), bacteria of the K-E-S group (11% vs 6%;  $p = 0.0047$ ), and *P. aeruginosa* (10% vs 1%;  $p < 10^{-6}$ ) (Fig. 2).

Among females, there were no significant differences in the etiology of bacteriuria between 1970 and 1990. On the contrary, in 1990 males evidenced a significantly greater prevalence of enterococci (19% vs 5%;  $p = 0.00054$ ) and *Staphylococcus aureus* (5% vs 0;  $p = 0.029$ ) than in 1970.

**Nosocomial UTIs**

In 1970, GNB were isolated from the vast majority of the specimens, both in males (96%) and in females (94%;  $p = 0.28$ ). In 1990, as opposed to domiciliary

infections, there was a highly significant ( $p < 10^{-6}$ ) increase of Gram-positive microorganisms not only in males (from 4% to 34%) but also in females (from 4% to 24%). Fungi of the genus *Candida* were isolated under all circumstances, although in low percentage (under 4%); their incidence increased significantly in males from 1% in 1970 to 3% in 1990 ( $p = 0.027$ ) (Fig. 3).

In 1970 *E. coli* was isolated frequently in the female sex (43% vs 24% in male sex;  $p = 0.00021$ ); among males *P. aeruginosa* was the primary species (26% vs 11%;  $p = 0.00012$ ). Another significant difference between males and females was found for indole-positive *Proteus* (17% and 6%, respectively;  $p = 0.001$ ). In 1990, *E. coli* was the primary species in both sexes (54% in females and 29% in males;  $p < 10^{-6}$ ), followed by enterococci (13% and 19%;  $p = 0.0017$ ), and K-E-S group bacilli (8% and 14%;  $p = 0.0037$ ). Other significant differences were seen in *P. aeruginosa*, isolated in 9% of the male and in 3% of the female specimens ( $p < 10^{-6}$ ), and methicillin-resistant (MR) coagulase-negative staphylococci (4% and 2%, respectively;  $p = 0.042$ ) (Fig. 4).

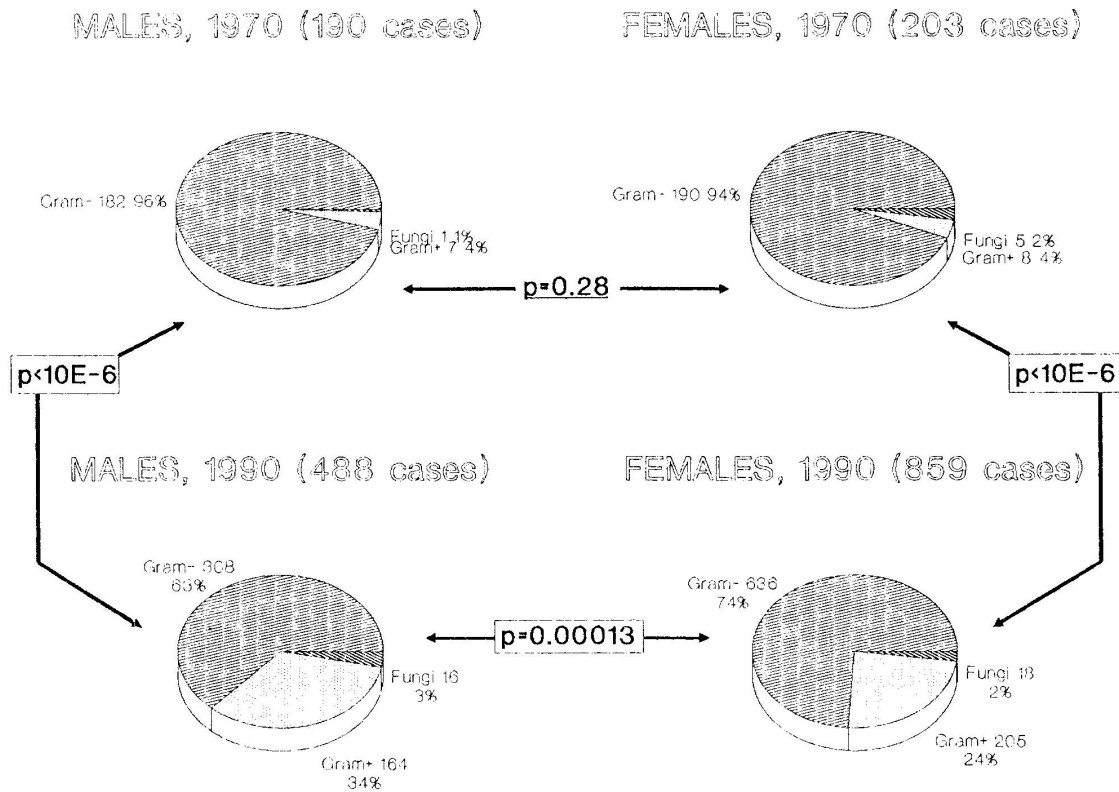
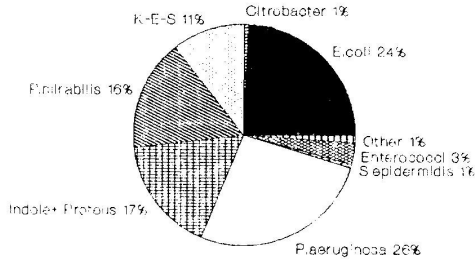
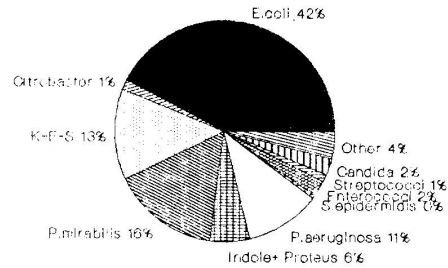


Figure 3. - Urinary pathogens isolated from nosocomial monomicrobial significant bacteriurias (I).

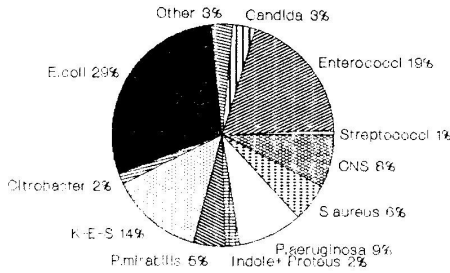
MALES, 1970 (190 cases)



FEMALES, 1970 (203 cases)



MALES, 1990 (488 cases)



FEMALES, 1990 (859 cases)

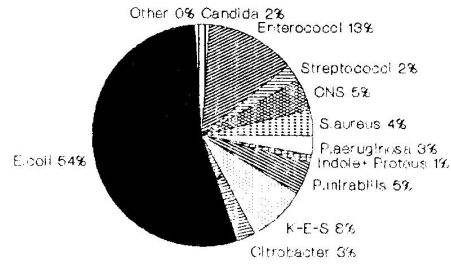


Figure 4. - Urinary pathogens isolated from nosocomial monomicrobial significant bacteriurias (II).

DISCUSSION

The etiology of infections, especially if hospital-acquired, has been changing over the past twenty years: while GNB show a reduced frequency as causes of infections, Gram-positive cocci (GPC), prevalent in the pre-antibiotic age and then falling in importance, have come back to play an important role (5). This pattern is confirmed by our study on bacteriurias both in the domiciliary (primarily in the male sex) and in the hospital environments.

Similarly to the results obtained by other authors (6), in a twenty-year period we noted in community-acquired UTIs a significantly lower prevalence of *P. mirabilis* (from 15% in 1970 to 7% in 1990;  $p = 0.0013$ ) and an equally significant increase of enterococci (from 4% to 10%;  $p = 0.017$ ), and, only in the male sex, a greater frequency of *S. aureus* strains (from 0 to 5%;  $p = 0.029$ ). We obtained even more striking results from nosocomial bacteriurias, where the prevalence of some Gram-negative species, in particular *P. aeruginosa* and indole-positive and indole-negative

*Proteus*, fell dramatically in both sexes (these three species represented 45% of the urinary pathogens isolated in 1970 and only 11% in 1990) while, conversely, GPC such as staphylococci and enterococci increased from 3% to 25%.

*E. coli* is the microorganism that more frequently causes an UTI. It is responsible for more than two-thirds of community-acquired bacteriurias (16) and for percentages varying from 20% to 60% of nosocomial UTIs (3, 14). In our study, *E. coli* reached these levels of prevalence only in the female sex. Among males, in whom *E. coli* was isolated with highly significant lower frequency than in females, both in community - and in hospital-acquired bacteriurias, "difficult" bacteria were important urinary pathogens as well: *P. aeruginosa* both in 1970 and in 1990, K-E-S group bacilli, enterococci, and MR staphylococci in 1990.

This etiologic pattern in the male sex is particularly surprising as far as domiciliary specimens are concerned. One possible explanation is that some of the male urine cultures may come from subjects with risk factors for an UTI caused by "difficult"

microorganisms, i.e., old age, frequent hospitalization, presence of indwelling urinary catheters. Another hypothesis takes into account the fact that some of the male specimens may come from subjects with a recurrent or relapsing UTI; in these conditions the prevalence of those microorganisms increases considerably, especially in the presence of congenital or acquired abnormalities of the urinary tract (15).

It is not surprising that we did not find fungi in domiciliary specimens. These organisms are a relatively frequent cause of UTIs only in the hospital environment, especially in patients exposed to short-term indwelling catheterization and to antibiotic therapy (7).

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