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Comparison of Antibiotic Resistance Patterns of Uropathogenic *Escherichia coli* in Outpatient and Inpatient Populations from 1990 to 1996 in Bemidji, MN

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Abstract

A retrospective study of antibiotic susceptibility was conducted on data from all uropathogenic *Escherichia coli* submitted to the MeritCare Clinic-Bemidji, MN and the North Country Regional Hospital-Bemidji, MN during 1990, 1993, and 1996. The proportion of antibiotic resistant strains was generally equal or higher in *E. coli* isolates from community-acquired infections than with *E. coli* isolates from nosocomial infections. Comparison with antibiotic prescriptions during 1990, 1993, and 1996 provided no clear relation between antibiotics prescribed for outpatient urinary tract infections and the proportion of *E. coli* strains resistant to those antibiotics. This suggests that factors other than selection for resistance to antibiotics prescribed for urinary tract infections influences the spectrum of antibiotic resistance in uropathogenic *E. coli*.

Introduction

Pathogens have become increasingly resistant to antibiotics over the past four decades. This pattern of increasing resistance was initially identified in hospital settings (Finland, 1979; McGowan, 1987), but community-acquired pathogens are also showing increasing resistance to a variety of antibiotics (Cohen, 1997; Olafsson, 2000).

Urinary tract infections (UTIs) are among the most commonly diagnosed nosocomial and community-acquired infections (Hatton, et al., 1994; Ansbach, et al., 1995; Barnet and Stephens, 1997). UTIs account for approximately five to seven million outpatient infections and one million nosocomial infections annually in the United States (Childs, 1991; Stamm, et al., 1993). Uropathogenic strains of *E. coli* typically account for 80 - 95% of community-acquired infections (Munro, 1987; Perdue and Plaisance, 1995) and typically about 50% of nosocomial UTIs (Vromen, et al., 1999).

In this report, we compare prevalence of antibiotic resistance in *E. coli* isolates from community-acquired and nosocomial UTIs in Bemidji, Minnesota. The fraction of resistant strains was generally equal or higher for the community-acquired *E. coli* strains than for strains from nosocomial infections. A comparison of antibiotic prescriptions written for outpatient UTIs showed no correlation between how frequently an antibiotic was prescribed for a UTI and the proportion of *E. coli* strains resistant to that antibiotic.

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Materials and Methods

Specimens

Clinical laboratory urine specimens were primarily clean-catch, midstream collections; less than 2% were collected by catheterization. Almost 100% of hospital urine specimens were collected by catheterization. Clean-catch specimens with >100,000 *E. coli* per mL or catheterized specimens with >10,000 *E. coli* per mL were considered indicative of UTI. Specimens collected in the clinic had the following numbers of *E. coli* UTIs: 299 in 1990, 225 in 1993, and 416 in 1996. Specimens from the hospital yielded the following number of *E. coli* UTIs: 307 in 1990, 424 in 1993, and 334 in 1996.

Bacterial identification and antimicrobial susceptibility testing

E. coli was initially identified and enumerated by streaking 0.001 mL of urine on blood agar and MacConkey agar plates, followed by incubation at 37°C for 24 hours. Primary plates containing more than the threshold numbers of bacteria indicative of UTI were further tested using the Dade Microscan System (Dade Behring, Inc., Sacramento, CA) following the manufacturer's protocol to identify the organism and determine the antibiotic susceptibility pattern. For purposes of this study, any strains with intermediate susceptibility were considered resistant.

Statistical analysis

The observed frequencies of sensitive and resistant strains in each population were compared by means of the Chi-square test. Relative risk was calculated for groups that were significantly different by dividing the proportion of resistant isolates in the clinical setting by

the proportion of resistant isolates in the hospital setting.

Prescription survey

An audit was conducted of patient charts from the MeritCare Clinic-Bemidji data set for patients treating for UTI infections in an outpatient setting. Fifty patient records were randomly chosen and analyzed for each year of the study to determine prescription practices for community UTI infections. Permission to collect these data was obtained from the MeritCare Clinical Research Council, Fargo, ND.

Results

Year-to-year changes in antibiotic resistance

With the exception of cephalothin resistance in the hospital, there was a general pattern of stable or increasing resistance over time to most of the antibiotics studied (Fig. 1). The proportion of resistant *E. coli* strains was 30% or higher for several antibiotics (Fig. 1).

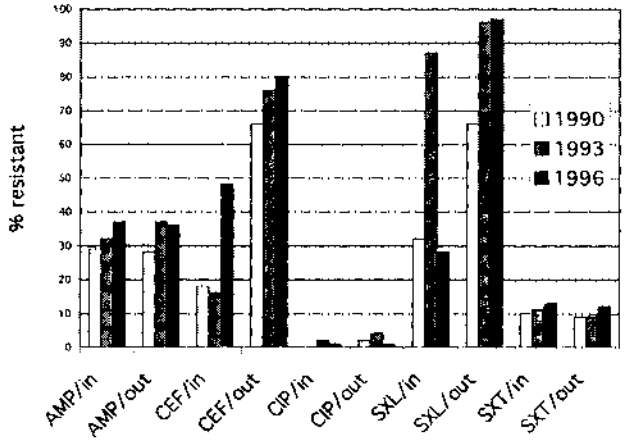

Figure 1. Proportion of uropathogenic *E. coli* isolates resistant to various antibiotics, 1990 to 1996. "In" refers to inpatient *E. coli* isolates from the North Country Regional Hospital-Bemidji, MN. "Out" refers to outpatient *E. coli* isolates from MeritCare Clinic-Bemidji MN. aAbbreviations: AMP, ampicillin; CEF, cephalothin; CIP, ciprofloxin; SXL, sulfasoxazole; SXT, trimethoprin-sulfasoxazole.

Prevalence of antibiotic resistance in community and hospital-acquired infections

The proportion of antibiotic-resistant, uropathogenic *E. coli* was higher, in many cases, for the community-acquired *E. coli* strains (Fig. 1). These differences were statistically significant (by Chi-square analysis) for sulfasoxazole ($p < 0.001$) and cephalothin ($p < 0.001$). Using relative risk analysis, the likelihood of encountering cephalothin-resistant *E. coli* was 2.78 times greater and encountering sulfasoxazole-resistant *E. coli* was 1.45 times greater in the community-acquired infections compared to hospital-acquired infections.

Antibiotic prescription habits

Trimethoprim/sulfasoxazole and ciprofloxin were prescribed for over 70% of the UTIs diagnosed in the clinic for all three years (Fig. 2). Yet the proportion of *E. coli* strains resistant to those drugs remained low and stable during the study period (Fig. 1). In contrast, large fractions of uropathogenic *E. coli* strains were resistant to cephalothin and sulfasoxazole (Fig. 1) even though these drugs were rarely prescribed for UTIs during the study period (Fig. 2).

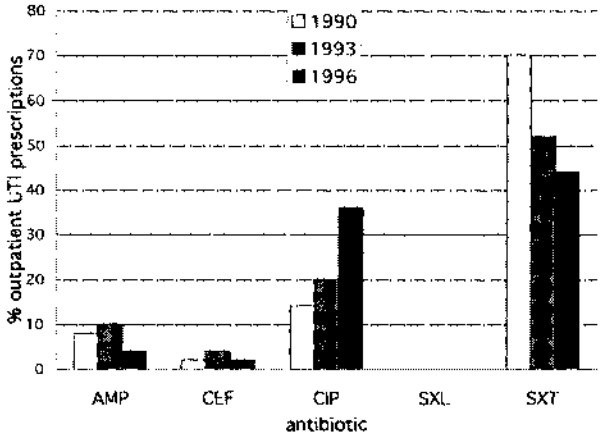

Figure 2. Prescriptions written for outpatient urinary tract infections at MeritCare Clinic-Bemidji, MN, 1900-1996. Abbreviations: AMP, ampicillin; CEF, cephalothin; CIP, ciprofloxin; SXL, sulfasoxazole; SXT, trimethoprin-sulfasoxazole.

Discussion

Substantial percentages of uropathogenic strains of *E. coli* that we studied showed resistance to one or more antibiotics that are commonly used in clinical practice. In several cases, the proportion of uropathogenic strains was higher in an outpatient population than a population of hospitalized patients. Although other studies have found a relation between increasing antibiotic resistance and antibiotic prescription patterns (Neu, 1992; Thornsberry, 1995), we found little correlation between the proportion of strains of *E. coli* resistant to an antibiotic and prescription of that antibiotic to treat UTIs.

There are several possible explanations for the lack of correlation between prescription patterns for urinary tract infections and resistance patterns. For example, the current resistance patterns might reflect selection due to past antibiotic use. In this vein, the high levels of sulfasoxazole resistance we found in uropathogenic *E. coli* might reflect selection caused by

high prescription rates for this drug in treating UTIs in the years prior to our study, since sulfasoxazole alone was not prescribed for UTIs during our study period (Figs. 1 and 2). Another possible explanation, which we think merits further study, is that antibiotics prescribed for other purposes can cause high proportions of uropathogenic *E. coli* strains to become resistant to those drugs. Some of these drugs, like ampicillin, are widely prescribed for a variety of bacterial infections even though they were rarely prescribed for UTIs during the years of our study. The selective pressure that led to a high proportion of uropathogenic *E. coli* being resistant to ampicillin might, therefore, be an unintended side effect of antibiotic prescription for non-UTIs. If this is supported by further analysis, our study would suggest the need for broad review of antibiotic usage in order to ensure continued efficacy of antibiotics used to treat UTIs.

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