Plasmid-Mediated Resistance to Trimethoprim-Sulfamethoxazole in *Salmonella krefeld* Strains Isolated in the United States

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Received 9 August 1982/Accepted 3 January 1983

Two types of transmissible plasmids which encode resistance to trimethoprim-sulfamethoxazole were found among five animal isolates of *Salmonella krefeld*. This is the first report of plasmid-mediated resistance to trimethoprim-sulfamethoxazole in *Salmonella* strains isolated in the United States.

As resistance to ampicillin and chloramphenicol in *Salmonella* has increased (3), trimethoprim-sulfamethoxazole (TMP-SMX) has become an important antimicrobial agent in the treatment of systemic *Salmonella* infections. Resistance to TMP-SMX in *Salmonella* strains has been rare in the United States (11), and plasmid-mediated resistance has not been reported, although it has been described in *Salmonella* strains isolated from other parts of the world (9, 10, 12). We have recently reported TMP-SMX resistance in strains of *Salmonella krefeld* (serogroup E4) isolated from clinically ill animals in Texas (7). This serotype has been isolated from both humans and animals in the United States, although it is not common (2, 5).

The purpose of this study was to determine whether the TMP-SMX resistance found in five *S. krefeld* strains was plasmid mediated. *S. krefeld* strains were isolated from clinically ill animals: one feline, one equine, one bovine, and two canines (7). A sixth TMP-SMX-resistant *S. krefeld* strain reported earlier was lost during storage. The recipient strain for mating experiments was *Escherichia coli* K-12 J53 NaI’ Rif’.

Susceptibilities were determined by the disk diffusion method of Bauer et al. (1). Filter matings were conducted to determine whether TMP resistance was transferrable, and broth matings were done to determine the frequency of transfer. The selective medium used to obtain transconjugants was 20 μg of TMP, 100 μg of nalidixic acid, and 0.08 U of thymidine phosphorylase per ml in Mueller-Hinton agar (Difco Laboratories, Detroit, Mich.).

Crude lysates of the *S. krefeld* strains and transconjugants were prepared by the method of Kado and Liu (6) or by that of Currier and Nester (4) if cesium chloride gradients were carried out. Plasmid DNA was detected by horizontal 0.7% agarose gel electrophoresis (8). The molecular weight of plasmid DNA was estimated by comparison with plasmids of known molecular sizes.

All five *S. krefeld* strains transferred TMP resistance by filter matings. In 6-h broth matings, strains 129, 174, and 1075 transferred TMP resistance at frequencies of $1 \times 10^{-4}$ to $8 \times 10^{-4}$; strain 2164 at $1 \times 10^{-2}$; and strain 2680 at $1 \times 10^{-8}$. All strains and transconjugants were resistant to high levels of both TMP and SMX (>1,000 μg/ml). Isolates 174 and 2164 and transconjugants had a single 100-megadalton plasmid mediating resistance to chloramphenicol and kanamycin as well as to TMP and SMX. Isolates 129, 1075, and 2680 and transconjugants were resistant to the four agents mentioned above and to ampicillin, streptomycin, and tetracycline. These strains all contained a single 135-megadalton plasmid, except strain 2680, which also contained two cryptic plasmids smaller than the 135-megadalton plasmid that did not transfer to *E. coli* J53.

In 1977, large outbreaks in Britain of *Salmonella typhimurium* infections caused by strains resistant to TMP began to occur in cattle (12). By 1979, 310 human infections caused by these strains had been documented. Our description of *S. krefeld* strains in this study is the first documentation in the United States of plasmid-mediated TMP-SMX resistance in *Salmonella*. It is interesting that these strains also were isolated from animals. The potential for human infection by these strains may exist, although at present this *Salmonella* serotype is much rarer than *S. typhimurium* in both animal and human infec-
tions. The potential for the spread of these strains or plasmids or both within animal and human reservoirs exists in the United States.

This study was supported by Public Health Service postdoctoral training grant AI07128 from the National Institutes of Health.

We are grateful to Pat Kiesewetter for typing the manuscript, to R. B. Simpson for his critical review of the manuscript, and to H. L. DuPont for his support and helpful discussions.

LITERATURE CITED


