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Evolution of Transferable Antibiotic Resistance in Coliform Bacteria from Remote Environments

SHARON J. BURT AND D. R. WOODS*
Department of Microbiology, Rhodes University, Grahamstown, 6140, South Africa

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The influence of a mission hospital on the evolution of antibiotic resistance in coliform bacteria from a remote antibiotic-free Xhosa community and environment is described.

An initial study of the incidence of antibiotic resistance and R plasmids in urban and remote Xhosa communities and their environments was undertaken in 1973 (2). The study of the remote population and environment was initiated at a recently established mission hospital in a very remote area of the Transkei, East Coast, South Africa, among a Xhosa population and environment that had not previously been exposed to antibiotics. Since further investigations should provide a useful opportunity for the study of the evolution of resistance among populations and their environments, a second study of antibiotic resistance and R plasmids was carried out after 3 years among the same populations.

The urban population studied was a Xhosa community living in a crowded, modern township near East London, South Africa. These people have easy access to hospitals and doctors and are thus exposed to antibiotics. A total of 102 human stool specimens were obtained from hospitalized patients. The remote population was a Xhosa community from the Eastern Transkei. These rural people live in thatched mud huts that are clustered in groups of 5 to 10, each with its own cattle pen. This particular community is a "Red Blanket" community that is particularly reluctant to accept western customs and modern medicine. The isolated community is served by only one mission hospital, and the majority of the people have not been exposed to antibiotics. A total of 91 human stool specimens were obtained only from "first time" patients at the mission hospital, that is, those with no record of previous contact with a doctor or hospital. Forty-three environmental samples were obtained from the soil, dams, huts, cooking areas, and cattle pens.

The fecal and environmental samples were incubated in brilliant green bile broth (Difco) at 37°C before streaking on MacConkey purple agar. Isolated, yellow nonmucoid colonies, which were indole positive and formed gas in brilliant green bile lactose broth, were regarded as coliforms. The methods for determining antibiotic resistance and its transfer have been previously described (3).

During the 3 years between 1973 and 1976, the incidence of resistance to antibiotics of coliform bacteria from the remote community increased from 19 to 48%, but the transferable resistance remained the same (12 and 11%) (Table 1). The remote environment also showed an increase in resistance from 26 to 36% and a striking increase in transferable resistance from 0 to 7%. The urban population showed an increase in resistance from 69 to 83%, but a decrease in transferable resistance from 48 to 33%.

The difference in R plasmid-mediated resistance of the individual antibiotics in the remote population and environment over the 3 years is significant. In 1973 the transferable resistance of the remote population was due to ampicillin R plasmids, and no R plasmid strains were isolated from the environment. During the present study, strains harboring R plasmids for ampicillin, chloramphenicol, kanamycin, streptomycin, tetracycline, and septrin (23.5 μg of septrin-sulfamethoxazole plus 1.5 μg of trimethoprim) were isolated from the remote population. R plasmids for ampicillin, chloramphenicol, and tetracycline were isolated from coliform bacteria from the environment. Particularly interesting is the isolation from both the urban and remote populations of R plasmids for septrin, which has only been used over the last few years in South Africa. The highest degree of resistance in bacteria from both the urban and remote populations and the remote environment was for streptomycin, and the present study showed a marked increase in streptomycin resistance as compared with our 1973 results. Streptomycin is extensively used to combat the high incidence of tuberculosis among the Xhosa community.

The striking differences between the resist-

TABLE 1. *Resistance and transferable resistance in coliform bacteria from urban and remote communities*

Antibiotic	Urban population				Remote population				Remote environment			
	1973 study[a] (67)[b]		Present study (102)		1973 study (90)		Present study (91)		1973 study (51)		Present study (43)	
	R[c]	TR	R	TR	R	TR	R	TR	R	TR	R	TR
Ampicillin	49	45	62	25	7	17	8	7	4	0	3	5
Cephaloridine	7	0	2	0	6	0	11	0	16	0	8	0
Chloramphenicol	19	31	29	5	1	0	4	2	2	0	3	5
Kanamycin	18	42	24	13	0	0	1	1	0	0	0	0
Nalidixic acid	2	0	0	0	0	0	0	0	0	0	0	0
Nitrofurantoin	0	0	0	0	0	0	0	0	0	0	2	0
Streptomycin	46	10	81	18	11	0	38	7	6	0	12	0
Tetracycline	22	27	34	8	1	0	15	8	0	0	3	2
Septrin	9	0	22	8	0	0	10	1	0	0	1	0
Total[d]	69	48	83	33	19	12	48	11	26	0	36	7

[a] Results are from reference 2.
[b] Numbers in parentheses indicate the total number of strains.
[c] R, Percentage of resistant strains; TR, percentage of resistant strains that transfer resistance.
[d] Total of all the antibiotics studied.

ance in bacteria between the urban and remote communities demonstrate the selective force of antibiotics. The influence of the mission hospital and the selective force of antibiotics are further illustrated by the evolution of R plasmids in the remote population and environment.

We conclude that it is the influence of the use of antibiotics among the human population since there are no veterinary services in the area and the addition of antibiotics to animal feeds is not practiced (1). Continued monitoring of transferable drug resistance in these communities is important if the full benefit of modern antimicrobial therapy is to be derived.

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