Ecology of R Factors

A STUDY OF URBAN AND REMOTE COMMUNITIES AND THEIR ENVIRONMENTS

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SUMMARY

The resistance to antimicrobial drugs and the incidence of R factors were determined in coliform bacteria, isolated from stool and environmental (soil, water) specimens from an urban Xhosa community, as well as from a remote drug-free Xhosa community in the Transkei. The significant reservoir of R factors in the urban environmental and stool specimens indicates the strong selective force of antimicrobial drugs. This contrasts with the low frequency of R factors from the remote community and its environment.

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In a recent study[1] it was shown that the incidence of R factors in bacteria from an urban Xhosa population was strikingly high. This high incidence was attributed to the use of drugs among an overcrowded, poor and uneducated population, with inadequate domestic hygiene facilities and sewage treatment. It was also postulated that the unhygienic neighbourhood could serve as a reservoir for resistant strains.

The present study was undertaken to test this hypothesis and to determine whether the incidence of R factors in the environment would reflect a similar pattern of resistance to that shown by bacteria from the inhabiting population. A comparative study was thus carried out between an urban Xhosa population and a remote Xhosa population, and their respective environments.

MATERIALS AND METHODS

Bacterial Strains

The urban population studied was a Xhosa community living in a crowded, modern township near East London. These people have easy access to hospitals and doctors, and are thus exposed to antimicrobial drugs.

Human stool specimens (67) were obtained from hospitalized patients, and environmental specimens (83) from the soil, water, sewage and drains in the township.

The remote population was a Xhosa community from the eastern Transkei. These primitive, rural people live in thatched, mud huts which are clustered in groups of 5 to 10, each with its own cattle pen. This vast area of the Transkei is served by only one mission hospital, and the majority of the people have not been exposed to antimicrobial drugs. Human stool specimens (90) were obtained only from 'first time' patients at the mission hospital, with no record of previous contact with a doctor or hospital. Environmental samples (51) were obtained from the soil, water, rivers, huts, cooking areas and cattle pens.

Faecal or environmental samples were incubated in sterile, brilliant-green bile broth (Difco) at 37°C before streaking on MacConkey purple agar. Isolated yellow non-mucoid colonies were tested for their ability to form gas at 37°C in brilliant-green bile lactose broth within 48 hours. Those which formed gas were regarded as coliforms. Strains which were also indole-positive were classed as *Escherichia coli*.

Resistance Spectra and Transfer

The methods for determining drug resistance and its transfer have been previously described.[1] Selective media were prepared as before, except that Wellcotest agar was used in the case of trimethoprim and Septrin (Septrin—sulphamethoxazole 23,5 μg + trimethoprim 1,5 μg).

RESULTS

The results shown in Table I indicate the striking difference between the incidence of resistance and R factors among bacteria from urban and from remote communities and their environments. Only 2 strains from the remote population were found to transfer resistance, while no strains isolated from the environment

TABLE I. INCIDENCE OF RESISTANCE AND R FACTORS IN COLIFORM BACTERIA FROM URBAN AND REMOTE COMMUNITIES

	No. of strains tested	R*	TR†
Remote population	90	18,9	11,8
Remote environment	51	25,5	0
Urban population	67	68,6	47,8
Urban environment	83	66,3	23,1

*R = % resistant strains.
†TR = % resistant strains which carry R factors.

TABLE II. RESISTANCE AND TRANSFER PATTERNS FOR INDIVIDUAL DRUGS

Drug	Remote—first admission mission hospital (90 strains)		Remote environment (51 strains)		Urban Xhosa hospital patients (67 strains)		Urban Xhosa environment (83 strains)	
	R*	TR†	R	TR	R	TR	R	TR
Ampicillin (25 μg)	**6,7**	**16,7**	**3,9**	—	**49,3**	**45,4**	**20,5**	**29,4**
Cephalorexin (15 μg)	**8,9**	—	**15,7**	—	**5,9**	—	**41,0**	**15,6**
Cephaloridine (15 μ)	**5,5**	—	**15,7**	—	**7,3**	—	**31,3**	**16,0**
Chloramphenicol (30 μg)	**1,1**	—	**2,0**	—	**19,4**	**30,7**	**3,6**	**66,7**
Kanamycin (30 pg)	—‡	—	—	—	**18,0**	**41,7**	**3,6**	—
Naladixic acid (30 μg)	—	—	—	—	**1,5**	—	—	—
Nitrofurantoin (200 μg)	—	—	—	—	—	—	—	—
Streptomycin (25 μg)	**11,0**	—	**6,0**	—	**46,3**	**9,7**	**24,1**	—
Tetracycline (50 μg)	**1,1**	—	—	—	**22,4**	**26,7**	**7,2**	**16,7**
Trimethoprim (1,5 μg)	—	—	**6,0**	—	**8,9**	—	**4,8**	—
Septrin (25 μg)	—	—	—	—	**8,9**	—	**1,2**	—

*R = % resistant strains. †TR = % resistant strains which transfer resistance. ‡ = 0%.

contained R factors. The incidence of resistance in bacteria from the urban Xhosa and their environment was high (68,6% and 66,3%, respectively). Of these resistant strains, 47,8% from the urban Xhosa and 23,6% from the environment showed transferable resistance.

The resistance and transfer patterns for each drug are shown in Table II.

The percentage of resistance was lower in *E. coli* than in the other coliform strains from both communities (Table III). However, the percentage of these *E. coli* strains which were able to transfer resistance (43,7% urban; 11,1% remote) was higher than that of the other coliform strains (19% urban; 0% remote).

TABLE III. INCIDENCE OF RESISTANCE AND R FACTORS IN *E. COLI* AND OTHER COLIFORMS FROM URBAN AND REMOTE COMMUNITIES

Area	*E. coli*			Other coliforms		
	No.	R*	TR†	No.	R	TR
Urban	**106**	**60,4**	**43,7**	**44**	**84,1**	**19**
Remote	**125**	**14,4**	**11,1**	**16**	**75,0**	**0**

*R = % resistant strains.
†TR = % resistant strains with R factors.

DISCUSSION

The high incidence of resistance and R factors in the human stool specimens from the urban Xhosa agrees with our previous results regarding R factors in urban Xhosa communities.[1] These results also indicate that R factors exist and survive in bacteria from the environment, and that the crowded township studied is serving as a reservoir for R factors.

The detection of only 2 R factors in 141 specimens from the remote community suggests that R factors have a low incidence in drug-free communities. This agrees with the findings of Gardner *et al.*[2] and Davis and Anandan.[3] The striking differences between the urban and remote communities demonstrate the selective force of antimicrobial drugs.

The resistance and transferable resistance patterns for cephalosporins are interesting. A higher percentage of resistance to cephalosporins was obtained in bacteria isolated from the environment than from stool specimens. Only bacteria from the urban environment, particularly those from sewers, were found to transfer resistance to cephalosporins. The cephalosporins are at present not used extensively in either this urban community or the mission hospital studied. Cephalosporin was first obtained from the fungus *Cephalosporium* isolated from a sewer in Sardinia.[4] If this fungus is present in the environment, it may have resulted in the selection of cephalosporin-resistant strains.

This study indicates that careful monitoring of transferable drug resistance in overcrowded, unhygienic and underdeveloped communities is essential if the full benefit of modern antimicrobial therapy is to be derived. The increasing introduction of antimicrobial drugs in this remote area of the Transkei should provide a useful opportunity for the study of the evolution of R factors.

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