

Antimicrobial agent susceptibility patterns of staphylococci isolated in urban and rural areas of Bolivia

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Summary

Staphylococcal strains obtained from cutaneous swabs of hospital staff and school students of Camiri and Boyuibe and healthy people living in Javillo, Bolivia, were tested for their in-vitro antimicrobial susceptibility. The highest percentages of resistance to the antibiotics tested were found in staphylococcal strains isolated from hospital personnel. All the *S. aureus* strains from these subjects were resistant to penicillin. Coagulase-negative staphylococci from hospital personnel evidenced a high rate of multiresistant strains, mainly to penicillin, ampicillin, tetracycline, and chloramphenicol. The staphylococcal strains isolated in the rural population of Javillo were highly susceptible to all the antibiotics tested.

Introduction

Resistance to antimicrobial drugs is a worldwide problem which may be particularly serious in developing countries where resistance is sometimes more prevalent (O'Brien *et al.* 1987).

We report here the results of a study carried out in the Santa Cruz region in south-eastern Bolivia to evaluate the in-vitro antibiotic sensitivity of staphylococci isolated in three different communities, Camiri, Boyuibe and Javillo. We studied the antibiotic susceptibility of staphylococcal strains isolated from (a) hospital staff of the Camiri Hospital and Boyuibe Hospital, (b) healthy school students in Camiri and

Boyuibe and (c) healthy individuals living in Javillo, a very small community isolated in the jungle.

Patients and methods

The samples were collected during the months November-December 1987 in three different localities: Camiri, Boyuibe and Javillo. Camiri, a city of about 25 000 inhabitants, is called the Petroleum Capital of Bolivia and the population includes a privileged group of employees of the Bolivian National Petroleum Agency (YPFB), compared with the rest of the Cordillera Province. Camiri has two hospitals, the District Hospital run by the Bolivian Ministry of Health and a private hospital which belongs to the YPFB. Boyuibe, a town of 2500 inhabitants, is situated approximately 3 h by jeep south of Camiri. This is a very poor town with no infrastructure, not even a potable water supply or sewerage system. Boyuibe has an Area Hospital run by the Bolivian Ministry of Health. The third locality, Javillo, a small community of an ethnically homogeneous group of about 100 Guaraní Indians, is situated in the jungle north-east of Camiri. The population lives in huts without any hygienic-sanitary facilities or services.

Nasal, axillary and perineal swabs were obtained from hospital staff of the Camiri District Hospital ($n=52$) and of the Boyuibe Hospital ($n=10$), from elementary and middle school students in Camiri ($n=82$) and Boyuibe ($n=135$), and from apparently healthy people living in Javillo ($n=84$).

In Camiri all the students in the sample population were children of Petroleum Agency

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Table 1. Penicillin sensitivity of staphylococci isolated in the Santa Cruz region, Bolivia, by the agar diffusion method

	<i>S. aureus</i>			Coagulase-negative staphylococci				
	<i>n</i>	S (%)	I (%)	R (%)	<i>n</i>	S (%)	I (%)	R (%)
Camiri								
hospital staff	7	0	0	100	83	15.7	10.8	73.5
school students	24	0	0	100	104	23.1	26.9	50.0
Boyuiibe								
hospital staff	2	0	0	100	12	0	8.3	91.7
school students	17	17.6	5.9	76.5	178	37.6	45.5	16.9
Javillo								
healthy subjects	—	—	—	—	92	65.2	34.8	0

S, Susceptible; I, Intermediate; R, Resistant.

employees or of local merchants and they all attended a private school. Ethnically they were either whites or mestizos. In Boyuiibe the students were of the same age groups as those of Camiri, but came from the public schools and were prevalently mestizos.

The swabs (Trans-cul, Bouty Laboratory, Milan, Italy) were put in Stuart's medium, transported to the Laboratory of the Camiri Hospital and then plated onto brain-heart infusion agar (Oxoid Limited, Basingstoke, UK). The plates were incubated 24–48 h at 37°C. A Gram's stain smear was performed on all colonies with a morphology resembling that of staphylococci. Colonies of gram-positive cocci believed to be staphylococci were preserved in cystine trypticase agar tubes (Oxoid Limited, Basingstoke, UK) at 4°C and then transported to Italy in a refrigerated box. In our laboratory in Florence isolates were plated onto blood agar (Sclavo Laboratory, Siena, Italy) and incubated for 24–48 h at 37°C. All the strains were identified by standard clinical laboratory methods (Kloos & Jorgensen 1985). The staphylococcal strains were tested for susceptibility to penicillin G using the Kirby-Bauer agar diffusion method (Bauer *et al.* 1966). For strains recorded as resistant or moderately susceptible we determined the minimum inhibitory concentrations (MICs) of nine antibiotics (methicillin, ampicillin, cephalotin, gentamicin, erythromycin, chloramphenicol, clindamycin, tetracycline and vancomycin) by the broth micro-dilution technique (NCCLS 1985). Strains isolated from the same subject,

belonging to the same staphylococcal species and with the same antibiotic resistance pattern, were recorded only once.

With the help of the medical staff and nurses responsible for the delivery of drugs we collected information about the pattern of use of antimicrobial agents in the two hospitals. Moreover, we obtained data concerning the distribution of antibiotics by the pharmacies of Camiri ($n=10$) and Boyuiibe ($n=1$). The data were collected in a questionnaire distributed to the pharmacists by the Inspectoría Distrital de Farmacia y Laboratorio.

Results

The results are shown in Tables 1 and 2. A total of 519 staphylococcal strains (50 *S. aureus* and 469 coagulase-negative) were isolated in the three localities. Seven strains of *S. aureus* and 83 strains of coagulase-negative staphylococci, mainly *S. epidermidis* (55 strains), were recovered from the cultures of the staff of the Camiri Hospital. All the seven *S. aureus* strains tested resistant to penicillin G by the agar diffusion method. Of the 83 coagulase-negative staphylococcal strains, 73.5% resulted resistant and 10.8% moderately susceptible to penicillin by the same technique. Two strains of *S. aureus* (both resistant to penicillin) and 12 coagulase-negative staphylococcal strains (11 of which were resistant to penicillin) were recovered from hospital staff in Boyuiibe. None of the *S. aureus* strains isolated from the two hospital staffs, and recorded as moderately

Table 2. Percentage of antibiotic resistance of staphylococci isolated in the Santa Cruz region, Bolivia, by the micro dilution method

	Meth		Ampi		Ceph		Genta		Eryth		Chlor		Clind		Tetra		Vanco	
	SA	CNS	SA	CNS	SA	CNS	SA	CNS	SA	CNS	SA	CNS	SA	CNS	SA	CNS	SA	CNS
Camiri	0	2.9	85.7	32.8	0	1.4	0	8.6	14.3	18.6	42.9	38.6	0	7.1	14.3	45.7	0	0
hospital staff	0	1.2	66.7	18.7	0	0	0	2.5	20.8	16.3	25.0	22.5	0	0	16.7	52.5	0	0
school students	0	8.3	100	58.3	0	0	0	8.3	0	0	100	16.7	0	8.3	0	33.3	0	0
Boyube	0	0	71.4	20.7	0	0	0	0.9	0	9.0	14.3	22.5	7.1	1.8	14.3	38.7	0	0
hospital staff	—	0	—	0	—	0	—	0	—	0	—	6.3	—	0	—	9.4	—	0
school students																		
Javillo																		
healthy subjects																		

Meth, methicillin; Ampi, ampicillin; Ceph, cephalotin; Genta, gentamicin; Eryth, erythromycin; Chlor, chloramphenicol; Clind, clindamycin; Tetra, tetracycline; Vanco, vancomycin; SA, *Staphylococcus aureus*; CNS, coagulase-negative staphylococci.

susceptible or resistant to penicillin using the agar diffusion technique, was methicillin resistant. Cephalotin, gentamicin, clindamycin and vancomycin were active against all the strains. No statistically significant differences were observed between the resistance patterns of the two populations studied ($P > 0.05$).

Vancomycin was the only drug found effective against all the coagulase-negative staphylococcal strains isolated from both hospital staffs and recorded as moderately susceptible or resistant to penicillin. Cephalotin, clindamycin and gentamicin were the other most active drugs. Two strains (2.9%) isolated in Camiri and one (8.3%) isolated in Boyube were resistant to methicillin. We did not observe any statistically significant differences between the resistance patterns of the coagulase-negative staphylococcal strains isolated from the two hospital staffs ($P > 0.05$).

All the 24 strains of *S. aureus* isolated from the students in Camiri were recorded as resistant to penicillin by the agar diffusion test. Using the same technique we found that 13 (76.5%) of the 17 strains isolated from the Boyube students were penicillin resistant and 1 (5.9%) was moderately susceptible to the drug. None of the *S. aureus* strains was recorded as methicillin resistant. Cephalotin, gentamicin and vancomycin were the most active drugs (100% of the strains were susceptible). We note that the Camiri school children evidenced a significantly higher *S. aureus* carrier rate (29.3%) than that of the Boyube school children (12.6%) ($P < 0.005$).

Regarding the coagulase-negative staphylococcal strains isolated in the Camiri and Boyube school groups, 50 and 16.9%, respectively, were recorded as resistant and 26.9 and 45.5% as moderately susceptible to penicillin. Comparison of the resistance patterns for coagulase-negative staphylococci isolated from the two groups of students did not show any statistically significant difference ($P > 0.05$). Only one strain isolated in Camiri was recorded as methicillin resistant, and vancomycin, cephalotin, gentamicin and clindamycin were all very effective.

Regarding the samples collected from the healthy population of Javillo, 92 strains of

coagulase-negative staphylococci were recovered. None of these was resistant to penicillin with the agar diffusion method; 34.8% were recorded as moderately susceptible and 65.2% sensitive to penicillin. All the strains showed a high susceptibility to all the other antibiotics tested. No *S. aureus* strains were recovered in any of the Javillo subjects ($P < 10^{-6}$).

The limited data concerning the pattern of use of antimicrobial agents in the Camiri and Boyuibe Hospitals show that the drugs most used are penicillin and ampicillin while the use of chloramphenicol, co-trimoxazole, tetracycline and gentamicin is notably lower. An investigation through the Camiri pharmacies showed that the drugs most used, with or without medical prescription, were penicillin and ampicillin and, less commonly, co-trimoxazole and chloramphenicol. The distribution of other drugs such as erythromycin, amoxicillin, tetracycline and gentamicin was much more limited. In all cases we noted that the cycles of treatment were short, from 3 to 5 days.

Discussion

Staphylococcal strains obtained from nasal, axillary, and perineal swabs of hospital personnel and school students of Camiri and Boyuibe and the healthy people living in Javillo were tested for their sensitivity to different antimicrobial agents. The highest percentages of resistance to the antibiotics tested were recorded for the staphylococcal strains isolated from the two groups of hospital personnel. Furthermore, all the *S. aureus* strains isolated from the hospital personnel were found resistant to penicillin. The penicillin resistance prevalences of the coagulase-negative staphylococci in the Camiri and Boyuibe hospital staffs were 73.5 and 91.7%, respectively. Moreover, the coagulase-negative staphylococci isolated in these two groups of hospital personnel evidenced a high rate of multiresistant strains.

As far as the staphylococcal strains isolated in the schools were concerned we found no significant differences between the patterns of susceptibility encountered in the Camiri and Boyuibe school children. The penicillin resistance of the *S. aureus* strains was 95.8% in the Camiri group

and 76.5% in Boyuibe, while the coagulase-negative staphylococcal strains registered penicillin resistance of 50% in the Camiri children and 16.9% in Boyuibe.

The staphylococcal strains isolated from the rural population of Javillo were highly susceptible to all the antibiotics tested. None of the strains was resistant to penicillin. It is important to note that we did not find any *S. aureus* strains at all in this group, in the children or the adults. This finding is all the more striking when compared to the relatively high rate of such strains found in the Camiri school children (29.3%), while the Boyuibe children had a rate of 12.6%. It is very difficult to comment on these findings since we do not have any specific information that would allow us to explain them.

The above results confirm, if it were necessary, the remarkable capacity of staphylococci to adapt to antimicrobial agents and show a close correlation between use of antibiotics and development of resistance to them. In the rural community of Javillo, visited by a doctor approximately once a year, but sometimes even less often, antibiotics are not used and consequently the staphylococcal strains are still highly susceptible to antimicrobial agents. In Camiri and Boyuibe, where antibiotics are commonly used, we found various antibiotic-resistant strains. The sensitivity patterns of staphylococci isolated in urban areas seems directly related to the selective pressure of antibiotic usage as demonstrated by the high rate of antibiotic-resistant strains in the hospital personnel. Projections into the future on the basis of these data indicate that in Javillo the pattern of resistance to antibacterial agents is destined to remain as it is now for some time to come because the community is isolated, while in Camiri and Boyuibe we will probably witness a rapidly increasing prevalence of resistant staphylococci in line with the trends of antibiotic resistance typical of developed countries.

We wish to emphasize the need for efforts to limit and control antimicrobial resistance in this area as well as in other developing countries. Restrictions against over-the-counter sale of antimicrobial drugs without the authorization of a qualified physician, together with the

establishment of general guidelines for the appropriate use of antimicrobials are important ways of limiting antimicrobial resistance (Stein *et al.* 1984). Moreover, the availability and use of laboratory facilities for diagnosing infectious diseases rapidly and for performing sensitivity tests is essential for optimal antimicrobial therapy.

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