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Transmission of *Streptococcus pneumoniae* in an urban slum community[☆]

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Summary *Background:* Inhabitants of slum settlements represent a significant proportion of the population at risk for pneumococcal disease in developing countries.

Methods: We conducted a household survey of pneumococcal carriage among residents of a slum community in the city of Salvador, Brazil.

Results: Among 262 subjects, 95 (36%) were colonized with *Streptococcus pneumoniae*. Children <5 years of age (OR, 8.0; 95% CI, 3.5–18.6) and those who attended schools (OR, 2.7, 95% CI, 1.2–6.0) had significantly higher risk of being colonized. Of 94 isolates obtained from colonized individuals, 51% had serotypes included in the seven-valent pneumococcal conjugate vaccine. Overall, 10% (9 of 94 isolates) were nonsusceptible to penicillin and 28% (27 of 94 isolates) were resistant to cotrimoxazole. BOX-PCR, PFGE and MLST analyses found that 44% of the carriage isolates belonged to 14 distinct clonal groups. Strains of the same clonal group were isolated from multiple members of 9 out of the 39 study households. Nineteen carriage isolates had genotypes that were the same as those identified among 362 strains obtained from active surveillance for meningitis.

[☆] This work has not been presented previously in a meeting.

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Conclusions: The study's findings indicate that there is significant intra- and inter-household spread of *S. pneumoniae* in the slum community setting. However, a limited number of clones encountered during carriage among slum residents were found to cause invasive disease.

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Introduction

Streptococcus pneumoniae is a major cause of severe infections such as meningitis, septicemia and pneumonia worldwide. Risk groups for invasive pneumococcal disease are young children under the age of 2 years, elderly people, and immunocompromised patients.¹ Nasopharyngeal carriage of pneumococci is likely to occur in all individuals at least once during infancy.² Infants are an important reservoir for community-wide transmission, which for the most part produces asymptomatic carriage.³ Invasive pneumococcal disease is a relatively rare outcome and originates from colonization with a homologous strain.⁴ Although a genetically diverse population of pneumococcal clones is found in carriage, a limited number of clones appear to produce invasive disease.^{5,6} To distinguish between clones that are capable of producing carriage or invasive disease, both clinical and nasopharyngeal isolates from the same geographic region and time period need to be characterized.

Several studies have compared carriage and invasive disease isolates from the same epidemiological setting.^{5–8} A study performed in Oxford, England found that clones with the same serotype had similar invasive potential indicating that serotype may be more important than genotype in the ability of pneumococci to cause invasive disease.⁷ In contrast, a study from Sweden identified clones that belonged to the same serotype but had different abilities to cause invasive disease. In addition, this study found that clones with different serotypes, which were presumably generated due to capsular switch phenomenon, had the same disease potential.⁸

At present, 1 billion of the world's population resides in urban slums, most of which are situated in developing countries.⁹ Much of this marginalized population has not benefited from the advances in prevention afforded by immunization with pneumococcal protein-capsular conjugate vaccines.¹⁰ Although underlying conditions of poverty presumably lead to high rates of pneumococci carriage and invasive disease, little information is available with respect to disease burden and transmission of *S. pneumoniae* within these communities. Salvador is the third largest city in Brazil (population, 2.8 million inhabitants) in which more than 60% of the population resides in slum settlements. Active surveillance in Salvador found that the annual incidence for pneumococcal meningitis was 31.7 and 8 cases per 100,000 person-years in children under one and five years of age, respectively.¹¹ The large majority (>80%) of meningitis cases in the city were residents of slum communities (*favelas*). Children <2 years had a significantly increased risk of acquiring penicillin-nonsusceptible (PNSP) isolates than children >2 years. Furthermore, 50% of all the PNSP meningitis cases were caused by a single serotype 14 clone, which has disseminated throughout Brazil.^{11,12} We herein report the findings of a cross-sectional study conducted in a slum community in Salvador, where on-going surveillance

for pneumococcal meningitis has been conducted, to identify the prevalence and risk factors for *S. pneumoniae* nasopharyngeal carriage among community residents. Furthermore, genotyping methods were used to determine the contribution of clones in the transmission of *S. pneumoniae* within households and the community.

Methods

Study site and population

The survey was carried out in the slum community (*favela*) of Nordeste de Amaralina in the city of Salvador, Brazil between July 2000 and May 2001. According to the national census bureau,¹³ 60% of the 2.6 million inhabitants of Salvador resides in slums such as Nordeste de Amaralina. In 2000, the study community had a population of 23,980 inhabitants, distributed within 18 census district in an area of 0.5 km².¹⁴ A representative census district was selected as the study within this community. We randomly selected 39 (13%) of the 296 households (1338 inhabitants) which were identified during a census of the study site. The study team performed house visits to identify eligible subjects, who were defined as residents living continuously in the selected household during the month prior to recruitment. Subjects were enrolled into the study according to written informed consent procedures approved by the Oswaldo Cruz Foundation, Brazilian Ministry of Health.

Data collection

Interviews were performed during the house visits to obtain information on demographics, underlying medical conditions, hospitalizations, occurrence of an upper respiratory tract infection (URTI) in the previous month, antibiotic therapy in the last month, childcare arrangements, school attendance and habits such as smoking. Information for children was obtained by interviewing the parent or legal guardian.

Isolation of pneumococci

Nasopharyngeal specimens were collected with calcium alginate swabs (Calgiswab type 1, Spectrum USA) and immediately streaked onto agar plates with 5% sheep blood and 5.0 µg/mL of gentamicin. Plates were incubated at 35 °C in 5% CO₂-enriched atmosphere for up to 48 h. Three to five colonies exhibiting morphologic characteristics of *S. pneumoniae* were isolated. Pneumococci were identified according to Gram-stain morphology, optochin sensitivity and bile solubility.

Antimicrobial susceptibility testing

The disk-diffusion method was performed according to CLSI recommendations¹⁵ to determine susceptibility of isolates

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