Antibiotic susceptibility of *Streptococcus pneumoniae* colonizing the nasopharynx of Colombian children with pneumonia¹

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**ABSTRACT**

*Streptococcus pneumoniae* is one of the principal causal agents of acute respiratory infection (ARI) in children, and its resistance to antibiotics has increased worldwide. This study examined the patterns of susceptibility to antibiotics of *S. pneumoniae* that had colonized the upper respiratory tract of 272 children hospitalized for pneumonia in two hospitals in Santafé de Bogotá. *S. pneumoniae* was isolated from 114 patients (42%). Diminished susceptibility to penicillin was noted in 19 isolates (17%), with 12 (11%) having an intermediate level of sensitivity and 7 (6%) showing outright resistance. Only 1 of the 19 isolates resistant to penicillin also showed resistance to ceftriaxone. There was diminished sensitivity to erythromycin in 3 isolates (3%), to chloramphenicol in 6 (5%), and to co-trimoxazole (trimethoprim + sulfamethoxazole) in 46 (40%). Resistance to multiple drugs was found in 7 isolates (6%). The most commonly encountered penicillin-resistant serotype was 23F (68.4%). An association was observed between age, prior use of antibiotics, and colonization by *S. pneumoniae* with reduced penicillin sensitivity or multiple-drug resistance. This study confirmed the presence of antibiotic-resistant *S. pneumoniae* in Colombia and highlights the importance of the rational use of antibiotics and of the implementation of epidemiologic surveillance for this agent.

Every year in developing countries, some 4.5 million persons, most of them under 5 years of age, die of acute respiratory infections (ARI) (1). Most ARI episodes are caused by viral agents and are self-limiting, but the bacterial pneumonias, which occur less frequently, carry a much higher risk of complications and death (2).

*Streptococcus pneumoniae* (pneumococcus) and *Haemophilus influenzae* are the two bacterial pathogens most commonly isolated in pediatric pneumonia (3). Since these microorganisms can colonize the upper respiratory tract, aspiration of secretions may lead to pneumonia, especially if an individual’s susceptibility to a bacterial infection were increased by malnutrition, viral infection, or other factors that would change the immune response (4). Colonization of the upper airways by *S. pneumoniae* can occur during the first few days of life; early colonization is associated with living in a large family and a higher risk of suffering from the disease (5).

An etiologic diagnosis of pneumococcal pneumonia is often difficult to establish. *S. pneumoniae* is not easily cultured from blood samples, and invasive diagnostic procedures, such as lung puncture, pose too great a risk for most patients. To cover the possibility of undiagnosed pneumococcal pneumonia, World Health Organization (WHO) guidelines for the management of ARI include empirical use of antibiotics selected for their activity against *S. pneumoniae*. These guidelines recommend the initial use of penicillin (or amoxicillin) for empirical treatment because penicillin is active against most strains of *S. pneumoniae*. In areas with a high prevalence of penicillin-resistant *S. pneumoniae*, other agents with a broader spectrum of activity, such as third-generation cephalosporins (e.g., ceftriaxone), should be used. The selection of the most appropriate antibiotic regimen should be guided by the findings of ongoing surveillance of *S. pneumoniae* antibiotic susceptibility.

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of antimicrobial agents such as pro-
caine penicillin, ampicillin, and co-
trimoxazole (trimethoprim + sulfa-
methoxazole) (6, 7).

Worldwide, S. pneumoniae has dem-
strated increasing resistance to a
variety of antibiotics. Studies in Spain
and Hungary have documented resis-
tance to penicillin in 44% and 57% of
 pneumococcal isolates, respectively.
The organism is also frequently resis-
tant to co-trimoxazole and chloram-
phenicol (8, 9). The patient’s age, the
serotypes involved, the time of colo-
nization, rapid recolonization follow-
ing treatment, prior use of antibiotics,
and previous hospitalization are fac-
tors that have been found to be associ-
ated with the presence of resistant
isolates (8).

In studies in Pakistan, S. pneumoniae
serotypes found in the respiratory tract
of sick children matched the serotypes
in cultures of their blood, and the anti-
biotic sensitivities of the isolates corre-
sponded in 98% of cases (10). Thus, in
children with pneumonia, the antimi-
icrobial resistance patterns of the S. pne-
moniae that cause the invasive disease
may be reflected in the nasopharyngeal
isolates, a circumstance that would
prove useful in implementing epidemi-
ologic surveillance programs in an
area. Knowledge of resistance patterns
would also allow for better therapeutic
case management (11).

The objectives of the present study
were (a) to investigate the frequency of
nasopharyngeal colonization by S. pneu-
moniae in children hospitalized with a
diagnosis of pneumonia, (b) to
determine these isolates’ patterns of
resistance to the antibiotics recom-
meded for use in the ARI program,
(c) to identify the serotypes of the
penicillin-resistant isolates, and (d) to
document factors associated with the
resistance pattern. Analysis of these
data would give an indication of the
utility of nasopharyngeal isolates in a
surveillance program.

MATERIALS AND METHODS

Patients. The study participants were
272 children under 5 years of age
admitted to the Lorencita Villegas de
Santos Children’s Hospital or La
Misericordia Hospital in Santafé de
Bogotá between November 1993 and
October 1994. All met WHO diag-
nostic criteria for pneumonia or severe
pneumonia: a fast respiration rate (>60
breaths per minute in infants
under 2 months of age, >50 in infants
aged 2 months to 1 year, or >40 in
children over 1 year), and, for severe
pneumonia, the additional presence of
retractions of the suprasternal notch or
costal margins, indicating respiratory
distress (6). Inclusion in the study also
required a clinical evolution of less
than 15 days. Patients with symptoms
of stridor or croup (acute laryngo-
tracheobronchitis) were excluded. For
each child, age, prior use of antibiotics,
respiratory rate, presence or absence
of retractions, and clinical diagnosis
were recorded on a form.

Specimen, isolation, and identifica-
tion. A specimen of nasopharyngeal
secretion was obtained from each
patient using a flexible Dacron swab
and seeded directly onto a trypticase
soy agar supplemented with 5%
sheep’s blood and 5 µg/mL genta-
micin (12). Specimens were incubated
at 37°C for 20 to 24 hours in an atmos-
phere containing 2% to 5% CO2 (can-
dle jar method). S. pneumoniae iden-
tification was based on macroscopic
and α-hemolytic colony character-
istics, microscopic morphology by
Gram’s stain, optochin sensitivity, and
bile solubility (13).

Antimicrobial sensitivity. Suscep-
tibility to penicillin was determined
using the Kirby-Bauer disk diffusion
method, employing a Mueller-Hinton
agar containing 5% sheep’s blood and
1 µg oxacillin disks (screening test).
This same technique was used to
determine sensitivity to erythromycin
using 15 µg disks, and to chlora-
mphenicol with 30 µg disks. All pro-
cedures were performed and analyzed
according to the standards set by the
National Committee for Clinical Lab-
oratory Standards (NCCLS) of the
United States of America (14). S. pneu-
moniae ATCC 49619 was used as the
control strain.

The minimum inhibitory concentra-
tions (MIC) of penicillin and ceftriax-
one were determined in the isolates
that exhibited diminished susceptibil-
ity to penicillin (diameter of oxacillin
inhibition zone <20 mm). MICs of co-
trimoxazole were also measured to
determine the susceptibility of all iso-
lates to that treatment (15). In each
case, the microdilution method was
used with Mueller-Hinton broth con-
taining 5% horse’s blood in accordance
with NCCLS specifications (16).

Serotyping. The isolates that demon-
strated penicillin- or multiple-drug-
resistance (defined as resistance to
three or more antibiotics)3 were sero-
typed by the quellung (Neufeld’s)
reaction using a panel of 12 antisera
from the Stantens Seruminstitut in
Copenhagen (17).

Data analysis. The prevalence of each
category of S. pneumoniae resistance
and the corresponding prevalence
ratio (PR) were calculated. Confidence
intervals (CI) of 95% for the PR were
determined using Epi Info epidemiol-
ogic software (18).

RESULTS

S. pneumoniae was isolated from 114
of the 272 patients’ nasopharyngeal
secretions, indicating a minimum colo-
nization rate of 42%. Of the patients in
whom colonization was detected, 76
(67%) were male and 38 (33%) female;
94 (82%) were under 3 years of age,
and 57 of the latter (61%) were under 1
year old. The average age of S. pneu-
moniae carriers was 1.4 years. The
highest prevalence of colonization was
at 6 months of age.

3 In this study, co-trimoxazole, although a combina-
tion of trimethoprim and sulfamethoxazole, was
considered to be a single antibiotic.
Isolates of *S. pneumoniae* were obtained throughout the year of the study. However, Figure 1 shows that the majority of isolates (65%) were collected between May and September 1994. Previous antibiotic treatment was documented in 36 (31%) of the 114 children with colonization. Thirty-two (89%) of this subgroup had received a β-lactam antibiotic, either amoxicillin (25), penicillin G (4), amoxicillin and penicillin G (1), or a second-generation cephalosporin (2). Seventy-five children had not received antibiotics. It was impossible to determine whether antibiotics had been administered to three children. Severe pneumonia was diagnosed in 79 patients with colonization (69%).

Reduced sensitivity to penicillin was detected in 19 *S. pneumoniae* isolates (17%) by the oxacillin screen. Oxacillin MICs indicated intermediate sensitivity in 12 isolates (11%) and resistance in 7 (6%). Only one penicillin-resistant strain was also resistant to co-trimoxazole. Sensitivity to co-trimoxazole was intermediate in two isolates (2%) and resistance was found in one (1%). Chloramphenicol resistance was seen in six isolates (5%) (Table 1).

Thirteen of the 19 *S. pneumoniae* isolates with low sensitivity to penicillin corresponded to serotype 23F, 2 to type 14, 1 to type 19F, and 3 were not typable. The most common serotype among the multiresistant isolates (those with low sensitivity to three or more antibiotics) was 23F (6 out of 7) (Table 2).

Reduced sensitivity to at least one antibiotic was found in 48 isolates (42%). All isolates resistant to penicillin were also resistant to co-trimoxazole. Multiresistance was present in seven isolates (6%), five of which were fully resistant to all of the antibiotics tested. All multiresistant isolates were resistant to penicillin and co-trimoxazole. The most common multiresistance pattern—to penicillin, chloramphenicol, and co-trimoxazole—was present in four isolates (Table 2). Of the 19 patients carrying *S. pneumoniae* with diminished susceptibility to penicillin or multiple-drug resistance, 12 were boys and 7 were girls. Five were under the age of 1 year, eight were between 1 and 2 years, and six were between ages 3 and 5.

Colonization of the nasopharynx by penicillin-resistant or multiresistant *S. pneumoniae* was found in 5 of the 57 patients under 1 year of age, 8 of the 37 between 1 and 2, and 6 of the 20 between 3 and 5. A positive association was seen between increasing age and the presence of penicillin- or multiple-drug-resistant strains. Compared with children under 1 year of age, those in the 1–2-year age group had a prevalence of resistant isolates encountered in two isolates (2%) and resistance was found in one (1%). Chloramphenicol resistance was seen in six isolates (5%) (Table 1).

<table>
<thead>
<tr>
<th>Antimicrobial agent</th>
<th>Sensitive isolates</th>
<th>Intermediate sensitivity</th>
<th>Resistant isolates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
<td>No.</td>
</tr>
<tr>
<td>Penicillin</td>
<td>95</td>
<td>83</td>
<td>12</td>
</tr>
<tr>
<td>Ceftriaxone</td>
<td>18</td>
<td>95</td>
<td>0</td>
</tr>
<tr>
<td>Co-trimoxazole</td>
<td>68</td>
<td>60</td>
<td>21</td>
</tr>
<tr>
<td>Erythromycin</td>
<td>111</td>
<td>97</td>
<td>2</td>
</tr>
<tr>
<td>Chloramphenicol</td>
<td>108</td>
<td>95</td>
<td>0</td>
</tr>
</tbody>
</table>

* Minimum inhibitory concentration (MIC) <0.06 μg/mL in sensitive isolates, between 0.1 and 1 μg/mL in those with intermediate sensitivity, and >2 μg/mL in resistant isolates.
* MIC <0.25 μg/mL in sensitive isolates, between 0.5 and 1 μg/mL in those with intermediate sensitivity, and >2 μg/mL in resistant isolates.
* MIC of trimethoprim/sulfamethoxazole <0.5/9.5 μg/mL in sensitive isolates, between 1/19 and 2/38 μg/mL in those with intermediate sensitivity, and >4/76 μg/mL in resistant isolates.
* Disk diffusion interpretation (Kirby-Bauer): more than 21 mm in sensitive isolates, from 16 to 20 mm in those with intermediate sensitivity, and less than 15 mm in resistant isolates.

* Disk diffusion interpretation (Kirby-Bauer): more than 21 mm in sensitive isolates, from 16 to 20 mm in those with intermediate sensitivity, and less than 17 mm in resistant isolates.
2.4 times higher (95%CI: 0.9 to 7.0), while 3–5-year-olds experienced a prevalence 3.4 times higher (95%CI: 1.2 to 10.0). In the latter case, the tendency for the percentage of resistant isolates to increase with age was statistically significant ($P = 0.02$) (Table 3).

Nine of the 36 patients known to have received previous antibiotic treatment were colonized by strains of penicillin-resistant *S. pneumoniae*. In contrast, only 9 of the 75 patients who had not received antibiotics were carriers of resistant isolates. Consequently, the risk of carrying resistant *S. pneumoniae* was 2.1 times greater (95%CI: 0.9 to 4.8) in children with previous antibiotic exposure (Table 3).

In the children who were colonized by penicillin-resistant or multiresistant *S. pneumoniae*, the most common clinical diagnosis was severe pneumonia (17 of 19 cases). The frequency of resistant isolates was 3.8 times higher in cases of severe pneumonia (95%CI: 0.9 to 15.4) (Table 3).

### DISCUSSION

Colonization of the upper respiratory tract by *S. pneumoniae* is common, especially in children, but the prevalence rates of colonization found in different studies have varied widely. In some cases the similarity between invasive disease agents and the nasopharyngeal isolates has been confirmed (10, 11). Given the difficulties of establishing the etiology of pneumonia, these isolates could prove useful in determining patterns of antimicrobial susceptibility in a specific area, allowing the behavior of the serotypes responsible for invasive disease in the same area to be predicted (19).

The colonization rate documented in the present study is similar to rates reported in Uruguay (20) and in a community in the State of Virginia (U.S.A.) (21). In contrast, studies conducted in other countries have found a higher prevalence of colonization in children with pneumonia, for example, 51% in the Philippines and 98% in Pakistan (11, 22). In Papua New Guinea, colonization rates of 100% have been reported in 3-month-old infants (23). Although no previous study has reported colonization rates in Colombian children with pneumonia, one recent investigation found *S. pneumoniae* in 46% of children in a day-care center in Santafé de Bogotá (24). In that study, the proportion of pneumococcal carriers was highest among children under 2 years of age.

Isolates of *S. pneumoniae* resistant to penicillin and other antibiotics are becoming increasingly frequent. In Spain, Hungary, and South Africa, very high rates of penicillin resistance have been found in both colonizing and invasive isolates (9, 25). The 17% frequency of diminished sensitivity to penicillin documented in this study is significantly higher than rates reported in Uruguay (3%) (20), Pakistan (12%) (11), and South Africa (12%) (26).

Serotypes 6, 14, 19, and 23 have been associated with resistance to penicillin and other antibiotics. These serotypes represent 60% of isolates found in children under 2 years old (5, 21). A clone of serotype 23F with resistance to penicillin and other antibiotics was first discovered in Spain; later, it was found in South Africa and the United States (27, 28). In the present study, 68% of

### TABLE 2. Serotypes of *Streptococcus pneumoniae* associated with various patterns of resistance

<table>
<thead>
<tr>
<th>Serotype</th>
<th>No. of strains isolated</th>
<th>Pattern of resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>23F</td>
<td>1</td>
<td>Penicillin, ceftriaxone, chloramphenicol, co-trimoxazole</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Penicillin, erythromycin, co-trimoxazole</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Penicillin, chloramphenicol, co-trimoxazole</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>Penicillin, co-trimoxazole</td>
</tr>
<tr>
<td>14</td>
<td>2</td>
<td>Penicillin, co-trimoxazole</td>
</tr>
<tr>
<td>19F</td>
<td>1</td>
<td>Penicillin, erythromycin, co-trimoxazole</td>
</tr>
<tr>
<td>Nonserotypable</td>
<td>3</td>
<td>Penicillin, co-trimoxazole</td>
</tr>
<tr>
<td>Total</td>
<td>19</td>
<td></td>
</tr>
</tbody>
</table>

### TABLE 3. Characteristics of patients, prevalence, and prevalence ratio (with 95% confidence intervals) for colonization by strains of *Streptococcus pneumoniae* with low sensitivity to penicillin

<table>
<thead>
<tr>
<th>Groups of patients</th>
<th>Prevalence of resistant strains</th>
<th>Prevalence ratio with 95%CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex: M</td>
<td>12/76</td>
<td>0.9</td>
</tr>
<tr>
<td>F</td>
<td>7/38</td>
<td>1.0</td>
</tr>
<tr>
<td>Age: &lt;1 year</td>
<td>5/57</td>
<td>1.0*</td>
</tr>
<tr>
<td>1 to 2 years</td>
<td>8/37</td>
<td>2.5</td>
</tr>
<tr>
<td>3 to 5 years</td>
<td>6/20</td>
<td>3.5</td>
</tr>
<tr>
<td>Prior antibiotic administration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>9/36</td>
<td>2.1</td>
</tr>
<tr>
<td>No</td>
<td>9/75</td>
<td>1.0</td>
</tr>
<tr>
<td>Undetermined</td>
<td>1/3</td>
<td></td>
</tr>
<tr>
<td>Clinical diagnosis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pneumonia</td>
<td>2/35</td>
<td>1.0</td>
</tr>
<tr>
<td>Severe pneumonia</td>
<td>17/79</td>
<td>3.8</td>
</tr>
</tbody>
</table>

* a The category in which the prevalence ratio is 1.0 is the reference category.
* b $P<0.05$.
* c $P = 0.02$. 

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isolates resistant to penicillin belonged to serotype 23F. In Mexico, serotype 23F has also been found to be common among multiresistant isolates, accounting for 27% (29).

Marked differences have been recorded between the colonization rates and serotypes of *S. pneumoniae* isolates in healthy children compared to children with pneumonia. In Uruguay, healthy children were found to have a 15% colonization rate, while children with pneumonia had a 42% rate (20). In another study, isolates from healthy carriers were more frequently resistant than invasive isolates (29). The 17% rate of resistance to penicillin in nasopharyngeal isolates reported in the present study is higher than the 12% rate observed in invasive pneumococcal isolates analyzed using the Colombian National Serotyping Protocol (Protocolo Nacional de Serotipificación) for *S. pneumoniae* (unpublished data). However, this difference could be artefactual, since blood cultures—the technique used in the National Protocol—are much less sensitive than cultures of nasopharyngeal secretions (1, 3). Very likely, the resistance rate in the nasopharyngeal isolates is the better indicator of the behavior of circulating *S. pneumoniae*.

Noteworthy among the results of this study is the high percentage (40%) of colonizing *S. pneumoniae* with diminished susceptibility to co-trimoxazole; a substantial proportion (22%) showed complete resistance and, frequently, simultaneous resistance to co-trimoxazole and penicillin. In the past 15 years, resistance rates of *S. pneumoniae* to co-trimoxazole have been found to range from 18% to 40% in various countries (20, 25, 30, 31). This level of resistance necessitates a reconsideration of the WHO recommendation, in its ARI guidelines, that this agent be used as the treatment of choice for pneumonia.

Few isolates in this study exhibited resistance to erythromycin or chloramphenicol. Therefore, resistance to these two agents seems not to be a problem in Colombia at present. In this respect the Colombian situation resembles those of the United States and Australia, where pneumococcal resistance to macrolides is low (32, 33), and it contrasts with those of France, where such resistance reaches 29% (34), and Spain, where 30% resistance to chloramphenicol has been found (35). In Colombia, erythromycin and chloramphenicol are probably the treatments of choice in childhood pneumonia.

Among the factors associated with harboring or becoming infected with resistant strains of *S. pneumoniae* is a history of antimicrobial use (26, 36). In South Africa, for example, individuals who received penicillin and chloramphenicol were significantly more likely to carry strains resistant to these antibiotics (30). In this study, prior antibiotic use was significantly associated with the presence of resistant *S. pneumoniae*. β-lactam antibiotics were found to be administered most commonly. These data agree with other reports in the literature (26, 30).

In summary, the data from this study are consistent with findings reported in other published works and indicate important associations between age, prior use of antibiotics, and colonization by *S. pneumoniae* with diminished antimicrobial sensitivity. An association between nasopharyngeal carriage of resistant pneumococcal isolates and the diagnosis of severe pneumonia was also indicated, but the size of the sample was not very large and the association was not statistically significant in all cases.

The performance of similar studies in other regions of Colombia would clarify the scope of the problem posed by *S. pneumoniae* resistance to antibiotics, provide a basis for a true program of surveillance of pneumococcal resistance, and guide the rational use of common antimicrobial agents against this important pathogen.

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**REFERENCES**


12. Converse GM, Dillon HC Jr. Epidemiological studies of Streptococcus pneumoniae in infants: methods of identifying pneumo-
13. Facklam RR, Washington JA II. Streptococcus and related catalase-negative gram-
15. Jorgensen JH, Swenson JM, Tenover FC, Ferraro MJ, Hindler JA, Murray PR. Development of interpretive criteria and quality control limits for broth micro-
16. National Committee for Clinical Laboratory Standards. Methods for dilution antimicrobial susceptibility tests for bact-
19. Smith T, Lehmann D, Montgomery J, Gratten M, Riley JD, Alpers MP. Acquisition and invasiveness of different sero-
20. Mogdasy M, Camou T, Fajardo C, Hortal M. Colonizing and invasive strains of Streptococcus pneumoniae in Uruguay:
24. Muñoz N, Sanin J, Monroy F. Portadores nasofaringeos de Haemophilus influenzae, Streptococcus pneumoniae, Neisseria meningitidis y Moraxella catarrhalis en una po-
enti
28. Klugman KP, Coffey TJ, Smith A, Wasas A, Meyers M, Spratt BG. Cluster of an eury-
31. Sessegolo JF, Levin AS, Levy CE, Asensi M, Facklam RR, Teixeira LM. Distribution of serotypes and antimicrobial resistance of Streptococcus pneumoniae strains isol-

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Streptococcus pneumoniae es uno de los principales agentes causales de infección respiratoria aguda (IRA) en niños y su resistencia a antibióticos se ha incrementado en todo el mundo. En este estudio se determinaron los patrones de susceptibilidad a antimicrobianos de S. pneumoniae colonizante de las vías respiratorias altas en 272 niños hospitalizados por neumonía en dos hospitales de Santafé de Bogotá. Se aisló S. pneumoniae en 114 pacientes (42%). Se observó susceptibilidad disminuida a la penicilina en 19 aislamientos (17%), con sensibilidad intermedia en 12 (11%) y franca resistencia en 7 (6%). Solo 1 de los 19 aislamientos resistentes a penicilina mostró también resistencia a la ceftriaxona. Se observó sensibilidad disminuida a la eritromicina en 3 aislamientos (3%), al cloranfenicol en 6 (5%) y al cotrimoxazol (trimetoprima + sulfametoazol) en 46 (40%). Se encontró multirresistencia en 7 aislamientos (6%). El serotipo con sensibilidad disminuida a la penicilina que se halló con mayor frecuencia fue el 23F (68.4%). Se observó una asociación entre la edad, el uso previo de antibióticos y la colonización con S. pneumoniae con susceptibilidad disminuida a la penicilina o multirresistencia. Este estudio confirma la presencia de resistencia antimicrobiana de S. pneumoniae en Colombia y resalta la importancia del uso racional de los antibióticos y de la implementación de la vigilancia epidemiológica sobre este agente.