Streptococcus pneumoniae isolated from the nasal carriage and its antibiotic susceptibility profiles in children

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Abstract

Background and objective: The prevalence of Streptococcus pneumoniae and resistance to antibiotics have become a public health problem in different countries of the world. This study aimed to investigate the occurrence of Streptococcus pneumoniae nasal carriage among children, and their antibiotics susceptibility profiles.

Methods: A nasal swab was obtained from 1092 healthy children aged from 6 to 13 years in Erbil Parks, Kurdistan region, Iraq. The swabs were cultured on appropriate culture media to isolate Streptococcus pneumoniae and to examine their susceptibility to antibiotics. The antibiotic susceptibility testing was performed using the standard disk-diffusion method.

Results: Streptococcus pneumoniae was isolated from 224 (20.51%) of the specimens; 57.59%, and 56.25% of isolates were resistant to penicillin and ampicillin, respectively, while 3.57% and 4.46% were resistant to clarithromycin and moxifloxacin, respectively. None of the isolates had resistant to vancomycin.

Conclusion: There is a high prevalence of penicillin and another β-lactam drug resistance among isolates of Streptococcus pneumoniae from the nasal carriage of children in our region.

Keywords: Streptococcus pneumoniae; Antibiotic susceptibility; Nasal carriage; Penicillin resistance.

Introduction

Streptococcus pneumoniae (S. pneumoniae) is a significant bacterial pathogen worldwide, causing serious illness, such as meningitis, bacteremia, acute otitis media, and pneumonia. An estimated one million children less than 5 years old die each year from S. pneumoniae caused pneumonia. S. pneumoniae is a part of the normal microbial flora of the nose and pharynx, particularly among young children, and are easily transmitted, usually by droplet secretions, from person to person. The nasal mucosa is the first line of defense against pathogenic bacteria and permits a large and diverse community of bacterial species to asymptomatically colonies the upper respiratory tract. The colonization of S. pneumoniae in the nasopharynx is believed to be an important reservoir for community spread of this pathogen and a key factor preceding pneumococcal diseases. S. pneumoniae asymptptomatically colonizes nasal of children and it is a frequent cause of otitis media. S. pneumoniae is a common nasal colonizer capable of causing life-threatening human diseases worldwide. In the individual host, the colonization mainly depends on age. Several studies have shown that age younger than two years is associated with the highest carriage rate. The rate declines thereafter to a stable and low prevalence in adolescents. There were few data focused on pneumococcal carriage in both pediatric and adult population. For many

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A total of 1092 healthy children were enrolled in this study, of whom 612 (56.04%) were boys, and the majority of the children (67.03%) were living in urban environments (Table 1). The percentage of S. pneumoniae carriage among total children was 20.51%. According to age groups, the high percentage of S. pneumoniae carriage was 30.36% (68 children out of 291) among children in the age group 6 to 7 years (Table 2). The rate of S. pneumoniae carriage was 21.73% among boys, and it was 18.96% among girls (Table 3).
Table 1: Characteristics of studied children.

| Characteristics | No. | %  |
|-----------------|-----|----|
| Age (years)     |     |    |
| 6-7             | 291 | 26.65 |
| 8-9             | 297 | 27.20 |
| 10-11           | 245 | 22.44 |
| 12-13           | 259 | 23.72 |
| Gender          |     |    |
| Boys            | 612 | 56.04 |
| Girls           | 480 | 43.96 |
| Residency       |     |    |
| Urban           | 732 | 67.03 |
| Rural           | 360 | 32.97 |
| Total           | 1092| 100 |

Table 2: Distribution of children with *S. pneumoniae* carriage according to age.

| Age (years) | Number of children examined | *S. pneumoniae* carriage | P value |
|-------------|-----------------------------|--------------------------|---------|
|             |                             | No.                      | %       |         |
| 6-7         | 291                         | 68                       | 30.36   |         |
| 8-9         | 297                         | 63                       | 28.13   |         |
| 10-11       | 245                         | 50                       | 22.32   | 0.265   |
| 12-13       | 259                         | 43                       | 19.20   |         |
| Total       | 1092                        | 224                      | 20.51   |         |

Table 3: *S. pneumoniae* carriage and gender.

| Genders   | Number of children examined | *S. pneumoniae* carriage | P value |
|-----------|-----------------------------|--------------------------|---------|
|           |                             | No.                      | %       |         |
| Boys      | 612                         | 133                      | 21.73   |         |
| Girls     | 480                         | 91                       | 18.96   | 0.359   |
| Total     | 1092                        | 224                      | 20.51   |         |
The high percentage of antibiotics resistance was 57.59% to penicillin and 56.25% to ampicillin, followed by cefuroxime (48.21%), cefotaxime (46.88%), and ceftriaxone (45.09%). All \textit{S. pneumoniae} were sensitive to vancomycin (Table 4). Children from the rural area were more likely to carry \textit{S. pneumoniae} isolates resistance to penicillin (62.30%), ampicillin (60.66%), and cefotaxime (62.30%) but less likely to carry an isolate resistance to moxifloxacin and azithromycin (1.64%) and clindamycin (3.28%). All \textit{S. pneumoniae} isolated were sensitive to clarithromycin in the rural area, whereas only 4.91% were resistant in urban (Table 5).

Table 4: Antibiotics susceptibility of \textit{S. pneumoniae} isolated from nasal carriage.

| Antibiotics (concentrations) | Total number of isolated tested=224 | Sensitive | Resistance | $P$ value |
|------------------------------|-------------------------------------|-----------|------------|-----------|
|                              | No.       | %         | No.        | %         |           |
| Penicillin G (10 units)      | 95        | 42.41     | 129        | 57.59     | 0.107     |
| Ampicillin (10 µg)           | 98        | 43.75     | 126        | 56.25     | 0.185     |
| Cefuroxime (30 µg)           | 116       | 51.79     | 108        | 48.21     | 0.705     |
| Cefotaxime (30 µg)           | 119       | 53.13     | 105        | 46.88     | 0.508     |
| Ceftriaxone (30 µg)          | 123       | 54.91     | 101        | 45.09     | 0.298     |
| Ciprofloxacin (5 µg)         | 192       | 85.71     | 32         | 14.29     | <0.001    |
| Moxifloxacin (5 µg)          | 214       | 95.54     | 10         | 4.46      | <0.001    |
| Erythromycin (15 µg)         | 189       | 84.38     | 35         | 15.63     | <0.001    |
| Azithromycin (15 µg)         | 197       | 87.95     | 27         | 12.05     | <0.001    |
| Clarithromycin (15 µg)       | 216       | 96.43     | 8          | 3.57      | <0.001    |
| Clindamycin (2 µg)           | 209       | 93.30     | 15         | 6.70      | <0.001    |
| Vancomycin (30 µg)           | 224       | 100       | 0          | 0         | ND        |

ND = Not done

Table 5: Antibiotics resistance of \textit{S. pneumoniae} isolated from urban and rural.

| Antibiotics (concentrations) | Urban ($n=163$) | Rural ($n=61$) | Total ($n=224$) | $P$ value |
|------------------------------|-----------------|----------------|-----------------|-----------|
|                              | No.             | %              | No.             | %         |           |
| Penicillin G (10 units)      | 91              | 55.83          | 38              | 62.30     | 129       | 57.59     | 0.654     |
| Ampicillin (10 µg)           | 89              | 54.60          | 37              | 60.66     | 126       | 56.25     | 0.669     |
| Cefuroxime(30 µg)            | 81              | 49.69          | 27              | 44.26     | 108       | 48.21     | 0.666     |
| Cefotaxime (30 µg)           | 67              | 41.10          | 38              | 62.30     | 105       | 46.88     | 0.986     |
| Ceftriaxone (30 µg)          | 75              | 46.01          | 26              | 42.62     | 101       | 45.09     | 0.777     |
| Ciprofloxacin (5 µg)         | 24              | 14.72          | 8               | 13.11     | 32        | 14.29     | 0.790     |
| Moxifloxacin (5 µg)          | 9               | 5.52           | 1               | 1.64      | 10        | 4.46      | 0.227     |
| Erythromycin (15 µg)         | 23              | 14.11          | 12              | 19.67     | 35        | 15.63     | 0.388     |
| Azithromycin (15 µg)         | 26              | 15.95          | 1               | 1.64      | 27        | 12.05     | 0.007     |
| Clarithromycin (15 µg)       | 8               | 4.91           | 0               | 0         | 8         | 3.57      | 0.856     |
| Clindamycin (2 µg)           | 13              | 7.98           | 2               | 3.28      | 15        | 6.70      | 0.237     |
| Vancomycin (30 µg)           | 0               | 0              | 0               | 0         | 0         | 0.00      | ND        |

ND = Not done
Colonization of nasal is a dynamic process with a turnover of new strains of S. pneumoniae. The percentage of nasal carriage of S. pneumoniae in children as reported in this study was lower than the study reported in Vietnamese children. The percentage of nasal carriage of S. pneumoniae varied from 9% in Singapore to 43% in India among children. Accordingly, it has been reported that the anterior nasal swabs are easier to do in younger children and the method was to be as sensitive as a nasopharyngeal aspiration but, might affect lower carriage rates in some countries. In the present study, the high rate of nasopharyngeal carriage of S. pneumoniae was observed among children aged 6 to 7 years than other age groups. The immunological developments of cellular and humoral responses to S. pneumoniae capsular polysaccharide contribute towards a much lower incidence of pneumococcal disease in older children than in young children. On the other hand, the study was observed that the rate of S. pneumoniae carriage more common in boys compared to the girls; this may be due to the boys in our culture is more exposed to the external environment. The prevalence of antibiotics resistance has been studied in different countries in the world. In the present study, the high rate of penicillin and ampicillin resistance was observed among S. pneumoniae nasal carriage isolates that lower than reported in Taiwan, Korea, Sri Lanka, Vietnam, and Saudi Arabia (50%). Moreover, it has been detected that S. pneumoniae is a naturally transformable organism, selective pressure of any antibiotic may facilitate incorporation of extrachromosomal DNA encoding various antibiotic resistance mechanisms. Therefore, penicillin resistance in clinical isolates of S. pneumoniae has become an important problem, and strategies to prevent the emergence of clinically significant diseases caused by S. pneumoniae resistance to antibiotics in this region will be needed. Penicillin and ampicillin are widely used in our region and are available over the counter at a suitable price, particularly in subclinical pharmacy that used randomly without physician prescription may contribute to increasing penicillin resistance among S. pneumoniae strains. Furthermore, it has been found that the S. pneumoniae strains with both penicillin and other β-antibiotics resistance appear to be increasing worldwide, although rates may vary depending on the location. With limited use of new antibiotics such as azithromycin, clarithromycin, clindamycin, and vancomycin for treatment of S. pneumoniae, the study reported a low level of resistance to these antibiotics. The rate of urban children to penicillin and ampicillin resistance of S. pneumoniae isolates was significantly lower than the rate obtained in children of the rural area; this was in agreement with a study has been reported in Southern Vietnam of which the use of the antibiotic in rural children was lower than in urban children. The increase of antibiotic resistance in S. pneumoniae is attributed to several factors, including socio-cultural and economic factors and differences in regulatory practices, particularly antibiotic consumption. European studies have shown that variations of antibiotic consumption are well correlated to S. pneumoniae rates at the country level. Therefore, antibiotic consumption should be considered according to the volume and the pattern use. It has been found that the emergence of antibiotics resistant clones of S. pneumoniae appears to be delayed in rural areas compared with urban areas, but clonal spread, combined with the use of antibiotics, is likely to account for carriage rates of antibiotics resistant strains that were similar to urban areas.

**Conclusion**

The high rate of S. pneumoniae nasal
carriage among children that could serve as reservoirs for the transmission to the community and cause disease. Meanwhile, the high rate of *S. pneumoniae* antibiotics susceptibility was observed for vancomycin, clarithromycin, moxifloxacin, and clindamycin. There are still a number of other factors contributing to the spread of resistant *S. pneumoniae*. Therefore, further studies of antibiotics resistance will be needed.

### Competing interests

The authors declare no competing interests.

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