Oropharyngeal colonization by *Streptococcus pneumoniae* among HIV-infected adults in Uganda: assessing prevalence and antimicrobial susceptibility

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**KEYWORDS**

Streptococcus pneumoniae; Pneumococcus; Oropharyngeal colonization; Antibiotic resistance; Uganda; HIV

**Summary**

**Objectives:** To evaluate characteristics of *Streptococcus pneumoniae* associated with oropharyngeal colonization in the Ugandan adult HIV population.

**Methods:** We conducted a cross-sectional study at the outpatient HIV clinic at the Joint Clinical Research Centre in Kampala, Uganda between July 2004 and February 2005. Six hundred HIV-infected individuals were interviewed and had oropharyngeal specimens collected. Pneumococci were isolated from these specimens and antimicrobial susceptibility patterns determined using standard microdilution methods. Serotypes of the pneumococcal isolates were evaluated by capsular swelling reaction with commercial antisera.

**Results:** The prevalence of oropharyngeal colonization with pneumococci was 18% (108/600). Thirty-two different pneumococcal serotypes were identified, and the most common were serotypes 3 (14.7%), 19F (6.4%), 23F (6.4%), and 16 (5.5%). Seventy-two percent of the isolates were penicillin (PCN) intermediate (MICs 0.12–1 μg/mL), the remainder all being PCN susceptible, and

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Oropharyngeal colonization by S. pneumoniae among HIV-infected adults

Introduction

Streptococcus pneumoniae is a major cause of acute otitis media, sinusitis, pneumonia, bacteremia, and meningitis throughout the world. In the pre-treatment era, approximately 80% of patients hospitalized with pneumococcal bacteremia died of their infections. For over a half-century in the developed world, however, patients with pneumococcal disease have benefited from penicillin and other antimicrobial agents. With effective antibiotics, the overall mortality has decreased to 33% in adults with bacteremic disease. This reduction in mortality is a considerable medical success, but there is concern that these improvements may be short-lived. Over the past 25 years there has been the emergence and continued spread of S. pneumoniae with antimicrobial resistance. Although there is no evidence yet to suggest that antibiotic resistance has resulted in increased mortality in hospitalized patients with pneumococcal pneumonia, there is concern that in the near future it may do so.

People who are immunocompromised are at particularly high risk of invasive pneumococcal infections. For example, persons infected with human immunodeficiency virus (HIV) are estimated to be >100 times more susceptible to invasive pneumococcal disease than age-matched controls. The reason for the higher rate of disease in this population has not been clearly delineated. Some believe that immunocompromised patients are less able to eliminate pathogens once bacteremia has occurred. Others think that their increased susceptibility to infection is related to decreased mucosal surveillance allowing persistent colonization. This notion is supported by the fact that HIV patients have been shown to be persistently colonized by the same strain of S. pneumoniae and the characteristics of nasopharyngeal isolates are similar to those of subsequent invasive strains. Regardless, the frequency of severe pneumococcal disease in the immunocompromised is concerning because the HIV epidemic coincides with the emergence and global spread of antibiotic-resistant pneumococcal strains. This is particularly true in Sub-Saharan Africa where the prevalence of HIV infection is high and antibiotic alternatives to penicillin are limited.

Because antibiotic choices are significantly governed by cost rather than effectiveness in Uganda, there is an urgent need to know the specific trends of antimicrobial resistance in pneumococci in HIV patients. This cross-sectional study addresses this issue by evaluating the prevalence of oropharyngeal colonization, the distribution of serotypes, and the resistance patterns to antimicrobials of pneumococci at an adult HIV clinic in Kampala.

Materials and methods

Setting

The study was conducted at the HIV clinic at the Joint Clinical Research Centre (JCRC) located in Kampala, Uganda. Kampala is the capital city of Uganda covering an area of 169 square kilometers with a population of approximately one million people. The JCRC was established in 1989 and has become recognized as a center for excellence in HIV care in Uganda and throughout Africa. The JCRC has state-of-the-art laboratories, outpatient clinics, a pharmacy, and a 16-bed inpatient ward. There is an HIV clinic that evaluates more than 40 HIV-infected patients each day.

Participants

HIV-infected Ugandan adults (age 18 years or older) presenting to the JCRC for clinical evaluation were invited to participate in this cross-sectional study. The medical officers that care for patients at the JCRC HIV clinic were responsible for recruiting eligible HIV-infected men and women. Individuals were excluded if they were over 55 years old, had received pneumococcal vaccine within the past five years, were being treated for active tuberculosis, or were taking antibiotics for an acute infection at the time of enrollment. Patients who were eligible and taking prophylactic antibiotics to prevent opportunistic infections (OI), such as trimethoprim—sulfamethoxazole (TMP—SMX), were not excluded. A standardized questionnaire seeking data on demographics, recent antibiotic treatment and prophylaxis, chronic medical conditions, HIV treatment, prophylaxis for OIs, and hospitalization was used. Between the months of July 2004 and February 2005, a total of 600 HIV-infected adults were entered in the study. Confirmation of HIV positive status and most recent CD4 count were determined by chart review. Ethical approval to conduct this study was obtained from the institutional review board of Case Western Reserve University (CWRU)/University Hospitals of Cleveland and the National Council of Science and Technology in Kampala, Uganda. Written informed consent was obtained from each patient prior to study entry.

Specimen collection and processing

Throat swabs were collected by the medical officers at the JCRC from the posterior pharynx by inserting a BBL culture swab plus (Becton Dickson Microbiology Systems, Cockeysville, MD, USA) through the oral cavity. The swabs were kept at room temperature until being transported to a −70 °C freezer at the JCRC later on the same day the swab was collected. On a monthly basis, the swabs were transferred from the freezer.
immediately into liquid nitrogen carriers and shipped by air-freight to the laboratories at CWRU in accordance with local and international shipment regulations.

At CWRU, the swabs were transferred from the liquid nitrogen carriers into −70 °C freezers, where they were stored until further analysis. The swabs were then thawed and streaked onto trypticase soy agar (TSA) plates with 5% whole sheep blood (Becton Dickson Microbiology Systems, Cockeysville, MD, USA). An optochin disk (Becton Dickson Microbiology Systems, Cockeysville, MD, USA) was placed in the first streak area and plates were incubated overnight in 5% CO₂ at 35 °C.

Identification, serotyping, and antimicrobial susceptibility testing

Pneumococcal isolates were identified by a zone of inhibition around the optochin disk and the presence of smooth, grey, α-hemolytic colonies with depressed centers. Typical colonies were then subcultured on fresh TSA blood plates and incubated as previously outlined. The serogroups and serotypes of the S. pneumoniae isolates were determined by capsular swelling reaction, using antisera from Statens Serum Institute of Copenhagen, Denmark. Antimicrobial susceptibility patterns were determined by broth microdilution minimum inhibitory concentration (MIC) determination, according to Clinical and Laboratory Standards Institute (CLSI) recommended procedures,6 using custom frozen microdilution trays containing cation-adjusted Mueller—Hinton broth supplemented with 5% lysed horse blood (TREK, Westlake, OH, USA). The following agents were tested: penicillin (PCN), amoxicillin, azithromycin, ceftriaxone, cefuroxime, cefdinir, cefpodoxime, clindamycin, levofloxacin and TMP—SMX. Trays were inoculated using an automatic inoculator (TREK) to deliver 100 µL/well, incubated under ambient conditions at 35 °C for 20–24 h and the lowest concentration of each agent showing no growth read as the MIC. MICs were interpreted according to current CLSI interpretative standards.6,7 PCR for mefA and ermB was performed on azithromycin resistant isolates.8

Statistical analysis

Statistical analysis was performed using SAS software, version 9.1 (SAS Institute Inc., Cary, NC, USA). Differences between categorical variables were evaluated using χ² analysis, or, where appropriate, Fisher’s exact test. Differences between continuous variables were evaluated using Student’s t-test. A two-sided p value <0.05 was considered significant for all comparisons.

Results

Study population

A total of 600 HIV-infected adults were sampled over a seven-month period in 2004–2005. The age of the participants ranged from 20 to 55 years old with a mean of 38.15 years and a standard deviation of 7.5 years. There were 162 men and 438 women included in the study. Out of the 554 participants with known CD4 counts, 476 of them had CD4 counts less than 200 cells/µL. Seventy-eight percent (372/476) of patients with a CD4 count <200 cells/µL and 2.6% (2/78) of patients with a CD4 count >200 cells/µL were receiving highly active anti-retroviral therapy (HAART). The most common regimen was zidovudine/lamivudine/tenofovir with 71.9% (269/374) of patients receiving HAART on this combination because of an ongoing clinical trial at the facility. Additionally, 75.2% (358/476) of patients with a CD4 count <200 cells/µL and 12.8% (10/78) with CD4 >200 cells/µL were taking TMP—SMX for prophylaxis against opportunistic infections.

Prevalence of pharyngeal pneumococcal carriage

Overall, 18.0% (108/600) of participants were colonized with pneumococci. The mean age of subjects who were colonized

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Baseline characteristics by pneumococcal colonization status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Colonizationa (N = 108)</td>
</tr>
<tr>
<td>Age</td>
<td>36.8 (7.5)</td>
</tr>
<tr>
<td>Male</td>
<td>28 (25.9)</td>
</tr>
<tr>
<td>Current smoker</td>
<td>3 (2.8)</td>
</tr>
<tr>
<td>Drinks alcohol</td>
<td>18 (16.7)</td>
</tr>
<tr>
<td>Child in household</td>
<td>89 (82.4)</td>
</tr>
<tr>
<td>Child age 1–2 years</td>
<td>11 (10.2)</td>
</tr>
<tr>
<td>Child age 3–5 years</td>
<td>28 (25.9)</td>
</tr>
<tr>
<td>Child age 6–10 years</td>
<td>57 (52.8)</td>
</tr>
<tr>
<td>Child age 11–18 years</td>
<td>72 (66.7)</td>
</tr>
<tr>
<td>Hospitalized in past two months</td>
<td>3 (2.8)</td>
</tr>
<tr>
<td>Upper respiratory infection in past two months</td>
<td>53 (49.1)</td>
</tr>
<tr>
<td>Taken antibiotics in the past two months</td>
<td>59 (54.6)</td>
</tr>
<tr>
<td>Had pneumonia in the past year</td>
<td>15 (13.9)</td>
</tr>
<tr>
<td>CD4 count &lt;200 cells/µL b</td>
<td>89 (90.8)</td>
</tr>
<tr>
<td>Currently taking anti-retrovirals</td>
<td>71 (65.7)</td>
</tr>
<tr>
<td>Currently taking trimethoprim—sulfamethoxazole</td>
<td>69 (63.9)</td>
</tr>
</tbody>
</table>

a Reported as count data (%) except for age, which is shown as mean (SD) in years.
b Of the 600 participants, 554 had a known CD4 count (colonization N = 98; no colonization N = 456).
(36.8 years) was slightly but significantly younger than those who were not colonized (38.5 years) \((p = 0.035)\) (Table 1). Oropharyngeal colonization did not vary by CD4 count, with 18.7% (89/476) of the HIV patients having CD4 counts <200 cells/µL and 11.5% (9/78) of the HIV patients having CD4 counts >200 cells/µL being colonized \((p = 0.12)\). Taking prophylactic TMP–SMX against opportunistic infections was not associated with increased pneumococcal colonization.

**Children in the household**

Overall, 85.3% (512/600) of subjects reported having a child living in their household, with 29.5% (177/600) of subjects having at least one child less than five years old living in their household. There was no significant association between having children in the household and being colonized with pneumococcus.

**Antibiotic use in the previous three months**

A total of 58.5% (351/600) of the participants reported that they had received an antibiotic in the past three months. The most commonly administered antibiotics were TMP–SMX (70.4%, 247/351) and the penicillins (penicillin 3.1%, 11/351 and amoxicillin/ampicillin 22.5%, 79/351). Other agents, including ciprofloxacin, chloramphenicol, erythromycin, and tetracycline, were rarely utilized. Overall, 54.6% (59/108) of the pneumococcal carriers and 59.3% (292/492) of the non-carriers had received at least one antibiotic recently (Table 1). This difference was not statistically significant \((p = 0.39)\).

**Hospitalization**

A total of 47 subjects had a history of hospitalization in the past two months. Of the participants, 19.0% (105/553) who were not recently hospitalized and 6.4% (3/47) of those who were recently hospitalized were colonized with pneumococcus, suggesting that antimicrobial administration during hospitalization may have eradicated pneumococcal carriage \((OR = 0.29, 95\% CI 0.089–0.955, p = 0.03)\).

**Antimicrobial susceptibility**

A total of 109 pneumococci were isolated from 108 participants, with one of the participants carrying two distinct pneumococcal isolates (Table 2). Overall, 28.4% (31/109) of the pneumococcal isolates were PCN susceptible (MICs \(\leq 0.06\) µg/mL) and 71.6% (78/109) were PCN intermediate (MICs 0.12–0.5 µg/mL). There were no PCN resistant isolates (MICs \(\geq 2\) µg/mL). Based on current interpretative breakpoints, all isolates are susceptible to penicillin G at a dose of at least 2 million units every 4 h, while only PCN sensitive isolates (28.4%) are susceptible in patients with pneumococcal meningitis. There were no isolates resistant to amoxicillin, ceftriaxone (at both meninginal and non-meningeal breakpoints), clindamycin or levofloxacin.

Of the other cephalosporins tested, 95.4% of isolates were susceptible to cefuroxime based on parenteral administration, while >98% were susceptible to cefuroxime based on oral administration and the oral cephalosporins, cefdinir and cefpodoxime. Almost all isolates (108/109) were TMP–SMX resistant (MICs \(\geq 1\) µg/mL) with MICs ranging from 2.0 to >4.0 µg/mL. Only one isolate was resistant to macrolides, with an azithromycin MIC of 4 µg/mL, and it contained the \(mefA\) gene, which codes for efflux-mediated macrolide resistance.

Use of any antibiotic within the past two months was not associated with colonization but was associated with carriage of a PCN non-susceptible pneumococcus \((p = 0.029)\). Meaningful subgroup analysis of PCN non-susceptibility based on exposure to particular antibiotics could not be done due to insufficient sample sizes. There were no other demographic risk factors associated with either PCN non-susceptibility or TMP–SMX resistance.

A total of 43.5% (47/108) of the subjects with TMP–SMX resistance were taking TMP–SMX at the time of enrollment. None (0/78) of the subjects with PCN non-susceptible isolates

<table>
<thead>
<tr>
<th>Agent</th>
<th>Breakpoints (^b)</th>
<th>MIC range (µg/mL)</th>
<th>MIC(<em>{50})/MIC(</em>{90}) values (µg/mL)</th>
<th>Susceptible (^a)</th>
<th>Intermediate (^a)</th>
<th>Resistant (^a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penicillin G</td>
<td>≤0.06/0.12–1/≤2</td>
<td>≤0.015–0.5</td>
<td>0.25/0.5</td>
<td>31 (28.4)</td>
<td>78 (71.6)</td>
<td>0</td>
</tr>
<tr>
<td>Penicillin G, high dose IV</td>
<td>≤1/−/≤2</td>
<td>≤0.015–0.5</td>
<td>0.25/0.5</td>
<td>109 (100)</td>
<td>—</td>
<td>0</td>
</tr>
<tr>
<td>Amoxicillin</td>
<td>≤2/4/≥8</td>
<td>≤0.015–2</td>
<td>0.12/0.25</td>
<td>109 (100)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Azithromycin</td>
<td>≤0.5/1/≤2</td>
<td>≤0.03–4</td>
<td>0.06/0.12</td>
<td>108 (99.1)</td>
<td>0</td>
<td>1 (0.9)</td>
</tr>
<tr>
<td>Ceftriaxone, non-meningitis</td>
<td>≤1/2/≤4</td>
<td>≤0.015–0.5</td>
<td>0.06/0.12</td>
<td>109 (100)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Ceftriaxone, meningitis</td>
<td>≤0.5/1/≤2</td>
<td>≤0.015–0.5</td>
<td>0.06/0.12</td>
<td>109 (100)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Cefuroxime, parenteral</td>
<td>≤0.5/1/≤2</td>
<td>≤0.03–2</td>
<td>0.25/0.5</td>
<td>104 (95.4)</td>
<td>4 (3.7)</td>
<td>1 (0.9)</td>
</tr>
<tr>
<td>Cefuroxime, oral</td>
<td>≤1/2/≤4</td>
<td>≤0.03–2</td>
<td>0.25/0.5</td>
<td>108 (99.1)</td>
<td>1 (0.9)</td>
<td>0</td>
</tr>
<tr>
<td>Cefdinir</td>
<td>≤0.5/1/≤2</td>
<td>≤0.03–2</td>
<td>0.12/0.25</td>
<td>107 (98.2)</td>
<td>1 (0.9)</td>
<td>1 (0.9)</td>
</tr>
<tr>
<td>Cefpodoxime</td>
<td>≤0.5/1/≤2</td>
<td>≤0.03–1</td>
<td>0.12/0.25</td>
<td>108 (99.1)</td>
<td>1 (0.9)</td>
<td>0</td>
</tr>
<tr>
<td>Clindamycin</td>
<td>≤0.25/0.5/≥1</td>
<td>≤0.015–0.06</td>
<td>0.03/0.06</td>
<td>109 (100)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Levofoxacin</td>
<td>≤2/4/≥8</td>
<td>0.5–1</td>
<td>0.5/1</td>
<td>109 (100)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Trimethoprim–sulfamethoxazole</td>
<td>≤0.5/−/≥1</td>
<td>0.25–&gt;4</td>
<td>4/≥4</td>
<td>1 (0.9)</td>
<td>—</td>
<td>108 (99.1)</td>
</tr>
</tbody>
</table>

\(^a\)Reported as No. (percentage) of strains.

\(^b\)Susceptible/intermediate/resistant breakpoints in µg/mL based on CLSI breakpoints, except for \(\text{trimethoprim–sulfamethoxazole where values are shown as trimethoprim component and intermediate values are combined with resistant.}\)^\(^\text{6,7}\)

\(^c\)High doses of IV penicillin G (at least 2 million units every 4 h in adults with normal renal function) are effective in treating pneumococcal pneumonia due to strains with penicillin G MICs ≤1 µg/mL.\(^7\,\,^\text{1,6}\)
were taking penicillin at the time. The one TMP–SMX susceptible isolate was also PCN susceptible. The one isolate that was macrolide resistant was also resistant to TMP–SMX.

**Serotype and resistance pattern distribution**

Thirty-two pneumococcal serotypes were identified in the 109 isolates. The most common were serotypes 3 (14.7%), 19F (6.4%), 23F (6.4%), and 16 (5.5%) (Figure 1). Of the serotype 3 isolates, 92% occurred in participants with CD4 <200 cells/μL, and all 16 serotype 3 isolates were PCN non-susceptible. There were five serotype 29 pneumococci identified, all of which were intermediate to PCN. Novel PCN intermediate serotypes included 7, 11, 16, 20, 22, 24, and 34. Thirty percent of the isolates belonged to the common pediatric serogroups 6, 9, 14, 19, and 23. Twenty-six percent (28/109) of the pneumococci and 28.2% (22/78) of the PCN intermediate isolates are covered by the seven-valent conjugate vaccine. Fifty-two percent (57/109) of the pneumococci and 64.1% (50/78) of the PCN intermediate isolates are covered by the 23-valent polysaccharide vaccine. The one macrolide resistant isolate belonged to serotype 18C.

**Discussion**

Pneumococcal disease is a significant cause of morbidity and mortality in adults infected with HIV. Because invasive infection likely follows nasopharyngeal and oropharyngeal colonization, important information can be ascertained from the strains that colonize this patient population. Our study shows that the prevalence of oropharyngeal colonization with pneumococci in HIV-infected adults visiting an HIV clinic in Uganda was 18%. Although there are few data regarding the prevalence of pneumococcal colonization in HIV-infected adults, our results are consistent with a recent longitudinal study done in the USA that suggests that between 12.6% and 22.2% of HIV-infected adults have oropharyngeal colonization with pneumococci at any particular point in time.

The pneumococcal isolates in our study showed a high degree of antibiotic resistance, especially to TMP–SMX and PCN. The presence of TMP–SMX resistance is not surprising because TMP–SMX resistance is known to be widespread around the world. Nonetheless, the high prevalence of resistance at a level greater than 99% is impressive. Recent studies show that TMP–SMX resistance in pneumococcal isolates is in the range of ~30% in the USA. In Africa, a study of 160 pneumococcal isolates from cases of invasive disease in all age groups in Zimbabwe showed resistance of >50%, while a study of isolates in South Africa in 1997 showed resistance >64%. The only study to approach the level of TMP–SMX resistance seen in our study was an evaluation done by Joloba et al. in 1995 of 115 strains in Ugandan children that showed a resistance prevalence of 83.5%.

While studies from around the world have also shown large variations in PCN resistance patterns (0–79% non-susceptible) between various countries, it is well documented that PCN resistance in pneumococci has been increasing globally. In the USA, studies have shown that between 20% and 35% of pneumococcal isolates are now non-susceptible. A large study of invasive pneumococcal disease in South Africa showed PCN resistance in all ages had increased to 18%. In East Africa, most of the studies have been done on nasopharyngeal colonization of pneumococci in children. Just as has been seen with TMP–SMX, the prevalence of resistance to PCN in this part of the world appears to be on the higher end of the global spectrum. While a study of Kenyan children showed intermediate PCN resistance in 60% of 94 pneumococcal isolates, Jo1oba et al. showed 83.5% of 115 isolates had intermediate PCN resistance in Uganda in 1995.

One possible cause for the high resistance to PCN and TMP–SMX in the HIV-infected patients in our study is that these strains are prevalent in people of all ages in Uganda. The adults in the HIV clinic, however, have other reasons that may also contribute to these high levels of resistance. For one thing, there is evidence to suggest that comorbid conditions such as HIV disease itself, is associated with PCN non-susceptible pneumococcal infections. Although our study did not evaluate this factor, other studies of invasive pneumococcal disease, some of which have been done in Africa, have shown that HIV-infected patients have infections with pneumococci with a higher proportion of PCN non-susceptibility than HIV negative patients. For example, Gwanzura et al. showed that 50% of isolates from HIV-infected individuals in Zimbabwe compared to 16% of HIV negative individuals were infected with PCN non-susceptible strains. In addition, a study of invasive disease in Kenyan adults showed that the PCN non-susceptibility rate in HIV positive individuals was 27% compared to 7% in HIV negative subjects.

The population of HIV-infected adults in our study is also frequently exposed to these two commonly prescribed antibiotics. For example, 75.2% of patients with a CD4 count <200 cells/μL were taking TMP–SMX as OI prophylaxis. In addition, the penicillins are some of the cheapest and most readily available antibiotics in Uganda and Ugandans, according to Ugandan physicians, self-medicate liberally for their...
medical complaints. In fact, many HIV-infected patients only present to the clinic if their own efforts at cure from local pharmacies are ineffective. Our study found an association between recent use of any antibiotic and PCN non-susceptibility. Because the sample sizes were too small, it was not possible to do subgroup analysis to see if particular antibiotics were associated with PCN non-susceptibility. Other studies have, however, shown that PCN non-susceptibility is associated with recent penicillin use.

All of the isolates in our study that were non-susceptible to PCN were also resistant to TMP–SMX. Although the reason for this association is not well delineated (since their mechanisms of resistance are different), it has been well documented that TMP–SMX and PCN non-susceptibility frequently occur in the same isolate. While multi-drug resistance is becoming more prevalent in other parts of the world such as in the USA, where rates are as high as 14%, there were no isolates in our study with multi-drug resistance. In addition, the one isolate with macrolide resistance in our study was associated with recent penicillin use.

Serotyping showed that there were 32 serogroups identified in 109 isolates, with rare serotypes, such as serotype 29, representing 4.6% (5/109) of the isolates. In addition, 70% of the isolates did not belong to any of the common pediatric serogroups, and isolates of seven rare serotypes, 7, 11, 16, 20, 22, 24, and 34, showed novel PCN non-susceptibility. Our study, therefore, suggests that an array of less common serotypes is circulating among this high-risk population of patients.

Serotype 3 was the most common serotype isolated, and all of the serotype 3 isolates were PCN intermediate. Serotype 3 is known to be more common in adults than in children, so the high prevalence in this study may not be surprising. Whether the emergence of PCN non-susceptibility in this serotype is related to the HIV status of these individuals or to other factors is not known. The PCN non-susceptible serotype 3 isolates have been reported from the USA, Taiwan, Kenya, Italy, and France.

Past studies in the pre-HAART era have shown that the polysaccharide vaccine was not effective in HIV-infected adults. Our study may complicate matters even further because it suggests that only a small portion of the colonizing serotypes in Uganda are included in any of the current vaccine preparations. For example, only 52% of the serotypes identified in our study are included in the 23-valent polysaccharide vaccine preparation, and only 26% of the serotypes identified in our study are included in the seven-valent conjugate vaccine preparation. A counter argument to this may be that several of the serotypes identified in our study are colonizers without the capability of invasive disease. Either way, our results give more support to the concept that the prospects for controlling pneumococcal disease in Uganda in the near future by immunization are challenging.

Ultimately, therefore, it may be worthwhile to continue to monitor the serotypes and antibiotic susceptibilities in this HIV-infected population of patients, since these individuals are at high risk for poor outcomes with invasive pneumococcal disease. To investigate this specific issue, a reasonable future study would be to conduct a case-control study in Kampala, Uganda of invasive pneumococcal disease in HIV-infected and HIV-non-infected adults to detect differences in pneumococcal characteristics between these two patient populations.

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Conflict of interest: No conflict of interest to declare.

References


