RESEARCH ARTICLE

REVISED *Streptococcus pneumoniae* Serotype Epidemiology among PCV-10 Vaccinated and Unvaccinated Children at Gertrude's Children's Hospital, Nairobi County: A Cross-Sectional Study [version 2; referees: 2 approved, 1 not approved]

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Abstract

Background: Serotype replacement and emergence of multidrug resistant *S. pneumoniae* has exacerbated the need for continuous regional serotype surveillance especially in the developing world. We investigated *S. pneumoniae* serotypes circulating among vaccinated and unvaccinated children ≤5 years in Nairobi County post PCV10 era.

Methods: A total of 206 vaccinated and unvaccinated children attending Gertrude's Children's Hospital (GCH) were recruited for this study. Nasopharyngeal swabs collected using Copan Flocked Swabs were the main study specimen. Culturing and isolation of *S. pneumoniae* was done on BA with gentamicin and BA plates respectively at the GCH main laboratory. Serotyping was done using the Quellung reaction at the KEMRI-Wellcome Trust, Kilifi.

Results: Out of the 206 subjects sampled, 20.39% (42) were found to be carriers of *S. pneumoniae*. About 52% (n=22) of the *S. pneumoniae* carriers had received the recommended dose of PCV-10, while 48% (n=20) of the carriers had not. Almost all (n=41; 19.90% of subjects) isolates contained non-vaccine type *S. pneumoniae* serotypes, while n=1 of the serotypes (in 0.49% of subjects) were untypeable. Serotypes 28F, 6A, 11A, 3 and 7C were prevalent in both vaccinated and unvaccinated children, whereas serotypes 23A, 17F, 35F, 48, 13 and 35B, and 23B, 20, 19B, 21, untypeable, 15B and 39 were found among unvaccinated and vaccinated groups, respectively.

Conclusions: All *S. pneumoniae* serotypes isolated from the subjects sampled were non PCV-10 vaccine type. These results therefore highlight the importance of monitoring and evaluation to provide epidemiological information to determine the effectiveness of PCV10 in Kenya's Public health services.

Open Peer Review

Referee Status: ✓ ✓ ✗

	Invited Referees 1	2	3
REVISED version 2 published 31 Jan 2019	✓ report		
version 1 published 22 Jun 2018	? report	✓ report	✗ report

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Comments (0)

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REVISED **Amendments from Version 1**

After receiving reviews from the three proposed peer reviewers, I have made corrections to include their concerns as follows:

1. Changed description of *Streptococcus pneumoniae* from "highly invasive" to "friendly gram positive inhabitant of the human upper respiratory tract" in paragraph 1.
2. Edited the use of the abbreviation "SP*n*" to "*S. pneumoniae*" across the text.
3. Reviewed paragraphs 1 & 5 to remove noted repetitions and inconsistencies regarding the exact number of *S. pneumoniae* serotypes
4. I changed the previous wording of the conclusion in the abstract from "Kenyan children currently using PCV-10 vaccine are not protected" to "these results therefore highlight the importance of monitoring and evaluation to provide epidemiological information to determine the effectiveness of PCV10 in Kenya's Public health services"
5. Reviewed the paper to indicate that the evaluation was done after introduction of PCV-10 in 2010 and also reviewed the methodology section to make it a summarized version of what is in the main text.

See referee reports

Introduction

Streptococcus pneumoniae is a friendly gram positive inhabitant of the human upper respiratory tract but can be highly invasive in some conditions (Mitchell & Mitchell, 2010). It is a major cause of morbidity and mortality globally as it kills more children than any other illness (Jones *et al.*, 2010). *Streptococcus pneumoniae* is classified into serogroups (denoted by numbers and letters, e.g. 18c, 23f) (Kellogg *et al.*, 2001). There are over 90 known serotypes whose distribution and occurrence vary geographically across the globe (Hackel *et al.*, 2013). Different serotypes exhibit differing potentials to cause disease and may cause different syndromes in different age groups (Harboe *et al.*, 2009).

Some strains also have a greater potential to develop antibiotic resistance than others (Song *et al.*, 2012). The 13 most common serotypes of *S. pneumoniae* cause 80–93% of serious pneumococcal disease in children (Johnson *et al.*, 2010). According to the World Health Organization (WHO) and UNICEF Global Action Plan for the Prevention and Control of Pneumonia, pneumonia kills more children than any other illness in the world (WHO & UNICEF, 2009). Given the high burden of under-five mortality associated with pneumonia, control efforts are critical to achieving Sustainable Development Goal 3 (Colglazier, 2015). WHO and UNICEF estimates indicate that over 800,000 children under 5 years of age die from pneumococcal disease each year in the developing world (O'Brien *et al.*, 2009). In Kenya, an estimated one in every five children less than 5 years of age dies from this disease every year (WHO, 2013).

S. pneumoniae vaccines protect against several severe forms of pneumococcal disease, such as meningitis, pneumonia and bacteremia (Feldman & Anderson, 2014). These vaccines will not protect against these conditions if they are caused by agents other than *S. pneumoniae* or from strains not included in the vaccine (Moffitt & Malley, 2011). The 10-valent pneumococcal conjugate vaccine (PCV10) was introduced into the Kenya Expanded Program on Immunization (KEPI) in February 2011 with a 2+1 schedule (at 6, 10, 14 weeks) without catch-up vaccinations (Hammitt *et al.*, 2014). The vaccine covers 1, 4, 5, 6b, 7f, 9V, 14, 18c, 19f and 23f serotypes.

Various *S. pneumoniae* serotypes with antigenic similarities are classified under the same groups (9A, 9L, 9N and 9V) while those lacking antigenic similarities are given numbers only (1, 2, 3, 4 and 5). The degree of interaction (cross-reactivity) between various *S. pneumoniae* groups may vary. For instance, serotypes 6A and 6B have identical chemical composition except for one of the bonds between two sugars yet they are highly cross-reactive but serotypes 19F and 19A are less reactive.

Pneumococcal conjugate (PCVs) and polysaccharide (PPVs) vaccines are designed according to their virulence mechanisms and how they generally interact with the human immune system (Castañeda-Orjuela *et al.*, 2012). The WHO has advised that all children ≤5 years should be immunized against pneumococcal disease and continuous surveillance done to keep out the disease especially in the developing world (Vandenbos *et al.*, 2013). The need for continuous surveillance has been exacerbated by the acute emergence of multi-drug resistant *S. pneumoniae* strains and escalated child mortality and morbidity due to pneumococcal disease, despite the availability of PCVs and PPVs (Väkeväinen *et al.*, 2010). This study therefore sought to establish the *S. pneumoniae* serotypes among vaccinated and unvaccinated children ≤5 years of age in Nairobi County, Kenya.

Methods

Study Location

This study was conducted among children ≤5 years attending the outpatient department of Gertrude's Children's Hospital in Nairobi County between May 2017 and February 2018. Subjects were clinically assessed by a physician and those who presented with pneumococcal disease symptoms recommended to the study nurse for recruitment. Gertrude's Children's Hospital is the largest standalone health care facility specializing in pediatric care in East and Central Africa. The hospital is accredited by the Joint Commission on International Accreditation (JCIA). *S. pneumoniae* isolation and stocking was done at Gertrude's Children's Hospital Main Laboratory and capsular serotyping done at KEMRI Wellcome Trust, Kilifi, Kenya.

Study Design

This was a descriptive cross-sectional study. *S. pneumoniae* serotype epidemiology among PCV-10 vaccinated and unvaccinated children between 6 months and 5 years of age was measured. Children who had no history of any chronic disease and whose parents or legal guardians consented to the study were systematically recruited. Children whose parents or legal guardians declined to give consent and those with any known immunosuppressive conditions were excluded from the study.

Sample Size Determination

To determine the minimum sample size, the formula developed by Chow *et al.* (2007) was used, with a prevalence rate of 16% (Agweyu *et al.*, 2014).

$$n = \frac{z^2 \hat{p}(1-\hat{p})}{m^2}$$

Where n= desired minimal sample size; *z*= standard normal deviation (1.96, from the tailed normal table); $\hat{p}$ = prevalence rate; and *m*= the desired degree of accuracy at a 95% confidence level of 0.05. This gave a sample size of 206.

Identification of *S. pneumoniae*

Nasopharyngeal swabs were per nasally collected using Copan flocked swabs and temporarily suspended in Armies medium for transportation to the main laboratory. Each swab was inoculated onto a selective gentamicin with 5% sheep blood agar (BA) plate. All swabs were plated within 24 h of collection. The plates were incubated at 37°C in a 5% CO_2 atmosphere and examined at 16–24 h and then again at 40–48 h for growth of *S. pneumoniae*. Isolates were identified as *S. pneumoniae* by colony morphology (Mucoid, draughtsman appearance, α-haemolysis) and susceptibility to optochin (positive, ≥14 mm zone of inhibition; negative, <14 mm zone of inhibition). Plates with colonies akin to *S. pneumoniae* morphological features but with optochin clearance zones below 14 mm were further subjected to solubility in bile salts (positive, bile soluble; negative, bile insoluble).

The isolation of a single colony indicated carriage. Single colonies were picked using sterile inoculating loops and evenly plated on BA. After 24–48 h, enough inoculum was stocked in brain heart infusion (BHI) agar with 5% sheep blood (Ultralab East Africa, Ltd), gently vortexed and stored at –70°C for serotyping.

Serotyping of *S. pneumoniae*

Capsular serotyping was done using the Quellung reaction test. Frozen vials containing *S. pneumoniae* stocks stored at -70°C were thawed at room temperature for about 30 minutes. A loopful of the stored *S. pneumoniae* cells were suspended in 50 µl PBS and gently vortexed. Subsequently, 10 µl of the suspended cells were added on to a glass slide and mixed with 5 µl pooled antisera (Statens Serum Institute, cat. No.16744). The glass slide was swirled gently while observing for any agglutination reaction until a positive reaction was observed with various pooled antisera. The process was repeated with individual groups under various antisera pools.

After that, 10 µl of the suspended cells in PBS were added to a glass slide and mixed with various *S. pneumoniae* serotype-specific antisera included in the antisera pools that gave a positive reaction. This was done until a positive reaction with the particular serotype specific antisera was observed. Those serotypes that did not belong to any pool were typed directly until a positive agglutination reaction was observed. The cells/PBS/serotype-specific antisera mixture on the glass slide were covered with a cover slip and observed under a phase contrast microscope with a ×100 objective lens with oil emulsion.

Results

Out of n=206 (100%) of the subjects sampled, n=97 (47.1%) were male and n=109 (52.9%) were female. In total, 68 (33.0%) of the children studied were within the age bracket of 6–12 months, 47 (22.8%) were between the ages of 13–24 months, 46 (22.3%) were between the ages of 25–36 months, 17 (8.3%) were between the ages of 37 and 48 months and 28 (13.6%) were between the ages of 49 and 60 months. Out of the total number of subjects (n=206) sampled, 20.39% (n=42) were found to be carriers of *S. pneumoniae*; 52% (n=22) of the *S. pneumoniae* carriers had received the recommended dose of PCV-10 immunization, while 48% (n=20) had not. All isolates (n=42; 20% of subjects) contained non-vaccine-type *S. pneumoniae* serotypes, while n=1 (0.49% of the subjects) of the serotypes were untypeable (Table 1). In total, 18 different *S. pneumoniae* serotypes were found in this population. They include: 28F (8 instances), 6A (5 instances), 3 (4 instances), 23B (3 instances), 20 (3 instances), 23A (3 instances), 19B (2 instances), 17F (2 instances), 7C (2 instances), 11A (2 instances), 35F (1 instance), 15B (1 instance), untypeable (1 instance), 48 (1 instance), 35B (1 instance), 21 (1 instance), 39 (1 instance) and 13 (1 instance).

Various serotypes were found to be prevalent in different age groups. For instance, out of the 42 serotypes found, 9 (23.53%) were prevalent among children at 6–12 months of age (n=16). They

Table 1. Overall *Streptococcus pneumoniae* Carriage of Vaccine Type and Non-Vaccine Type Serotypes.

	All children		Vaccinated children		Unvaccinated children	
	N	%	N	%	N	%
Overall *S. pneumoniae* carriage	42	20.39	22	10.68	20	9.71
Proportion of *S. pneumoniae* Serotypes	count	%	count	%	count	%
PCV10	0	0.00	0	0.00	0	0.00
Non PCV10 serotypes	41	19.90	41	19.90	41	19.90
Non typeable	1	0.49	1	0.49	1	0.49

include: 28F (4 instances), 11A (2 instances), 23A (2 instances), 3 (2 instances), 6A (2 instances), 17F (1 instance), 35F (1 instance), 7C (1 instance) and untypeable (1 instance). There were 7 (16.67%) serotypes prevalent among children at 13–24 months (n=8), including: 20 (2 instances), 21 (1 instance), 39 (1 instance), 28F (1 instance), 35B (1 instance), 17F (1 instance) and 13 (1 instance). There were 8 (19%) serotypes found among children of 25–36 months of age (n=12), including: 23B (3 instances), 19B (2 instances), 3 (2 instances), 20 (1 instance), 28F (1 instance), 7C (1 instance), 23A (1 instance) and 48 (1 instance). There were 3 (7%) serotypes prevalent among children at 37–48 months old (n=4), including: 6A (2 instances), 15B (1 instance) and 28F (1 instance).

There were 2 (4.76% of the total) serotypes prevalent among children at 49–60 months (n=2): 6A (1 instance) and 28F (1 instance) (Table 2). Out of the 42 isolates (found in 20.39% of subjects), serotype 28F was the most prevalent (3.88% of the total), followed by 6A (2.43%), 3 (1.94%) and 20, 23A and 23B all at 1.46% (n=3). Each of the serotypes 7C, 11A, 17F and 19B represented 0.97% (n=2) of the total serotypes, while serotypes: 13, 21, 39, untypeable, 48, 15B, 35B and 35F represented 0.49% (n=1) each of the total serotypes found (Figure 1 and Figure 2). In total 51% (n=106) of the total sampled subjects were confirmed to have received a full dose of the PCV-10 vaccination as per the recommended schedule of immunization at 6, 10 and 14 weeks. Approximately 11% (n=12) of the immunized children were carriers of *S. pneumoniae* in their nasopharyngeal region; 10% (n=10) of the non-immunized group were also carriers (Table 3). Serotypes 28F (5 instances), 23A (3 instances), 6A (3 instances), 17F (2 instances), 11A (1 instance), 3 (1 instance), 35F (1 instance), 48 (1 instance), 13 (1 instance), 35 (1 instance) and 7C (1 instance) were prevalent among the 9.71% (n=20) of the total sample group that had not received PCV-10 immunization. Serotypes 3 (3 instances), 28F (3 instances), 23B (3 instances), 20 (3 instances), 19B (2 instances), 6A (2 instances), 21 (1 instance), 11A (1 instance), 7C (1 instance), untypeable (1 instance), 15B (1 instance) and 39 (1 instance) were prevalent among the 10.68% (n=22) of the total sample group that received immunization (Table 4).

Dataset 1. List of basic demographic information for each subject, with the size of the optochin clearance zone and serotype of *Streptococcus pneumoniae*, if found

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Table 2. *S. pneumoniae* Serotype Distribution by Age.

	All	6–12 Months	13–24 Months	25–36 Months	37–48 Months	49–60 Months
Numbers with carriage (n)	42	16	8.00	12	4	2
Carriage (%)	20.39	23.53	17.02	26.09	23.53	7.14
Number of different serotypes seen	18	9	7	8	3	2
Serotypes seen	28F (8)	28F (4)	20 (2)	23B (3)	6A (2)	6A (1)
	6A (5)	11A (2)	21 (1)	19B (2)	15B (1)	28F (1)
	3 (4)	23A (2)	39 (1)	3 (2)	28F (1)	
	23B (3)	3 (2)	28F (1)	20 (1)		
	20 (3)	6A (2)	35B (1)	28F (1)		
	23A (3)	17F (1)	17F (1)	7C (1)		
	19B (2)	35F (1)	13 (1)	23A (1)		
	17F (2)	7C (1)		48 (1)		
	7C (2)	untypeable (1)				
	11A (2)					
	35F (1)					
	15B (1)					
	untypeable (1)					
	48 (1)					
	35B (1)					
	21 (1)					
	39 (1)					
	13 (1)					

S. pneumoniae serotypes as found in children at varying age groups

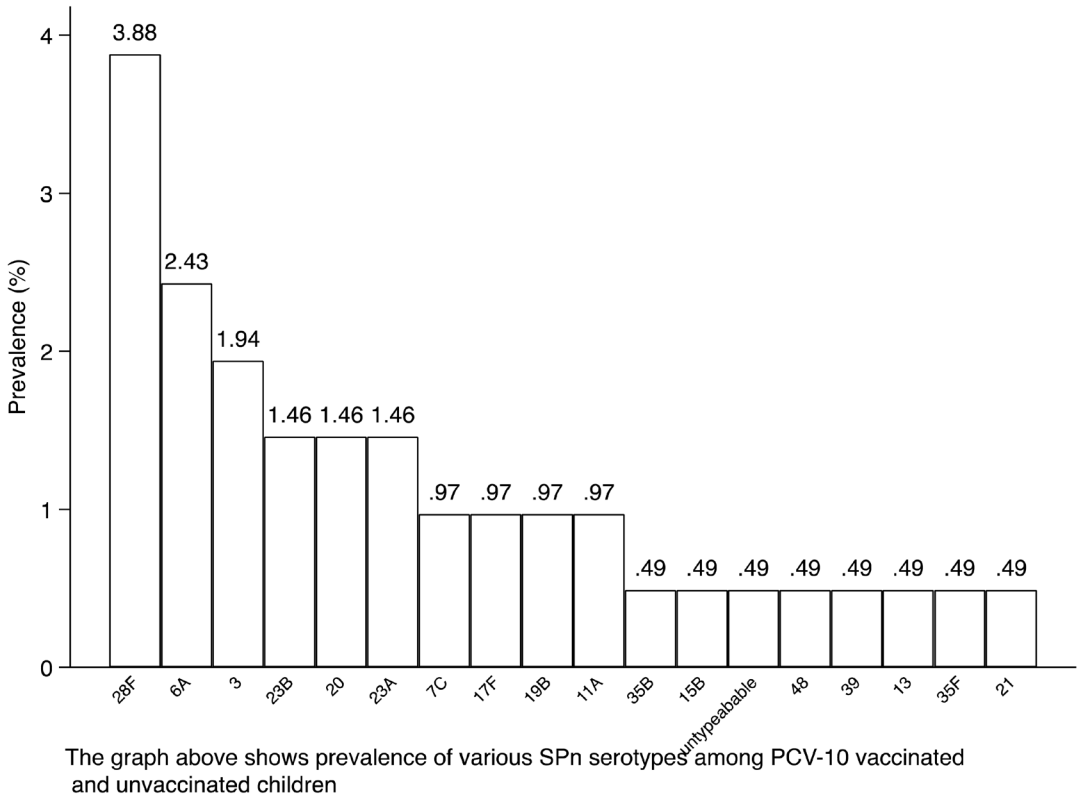

Figure 1. **Percentage *S. pneumoniae* Serotype Distribution.**

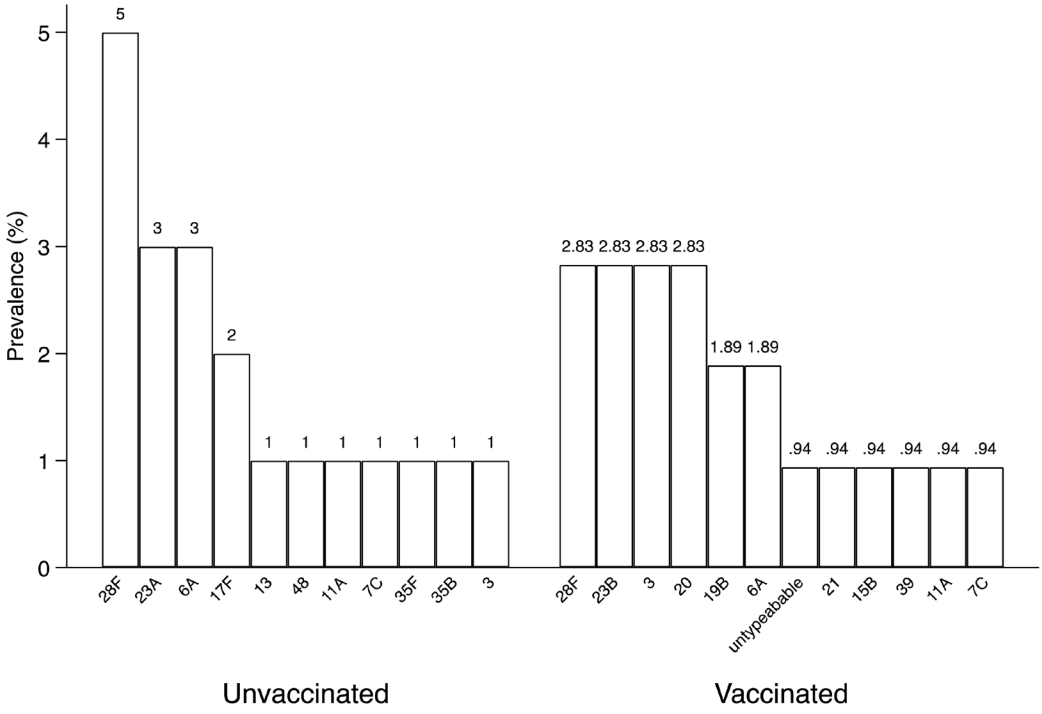

Figure 2. ***S. pneumoniae* Serotype Distribution by PCV-10 Vaccination Status.**

Table 3. *S. pneumoniae* Serotype Distribution by PCV-10 Vaccination Status.

Unvaccinated (100/206)			Vaccinated (106/206)		
Serotype	***n***	**%**	**Serotype**	***n***	**%**
28F	5	5	3	3	2.83
23A	3	3	28F	3	2.83
6A	3	3	23B	3	2.83
17F	2	2	20	3	2.83
11A	1	1	19B	2	1.89
3	1	1	6A	2	1.89
35F	1	1	21	1	0.94
48	1	1	11A	1	0.94
13	1	1	7C	1	0.94
35B	1	1	Untypeable	1	0.94
7C	1	1	15B	1	0.94
			39	1	0.94

Table 4. *S. pneumoniae* carriage by Vaccination Status.

Child Immunization Status	*S. pneumoniae*	*n*	%
PCV-10 Immunized	NGR	84	40.78
	S. pneumoniae	22	10.68
Non PCV10-Immunized	NGR	80	38.83
	S. pneumoniae	20	9.71
Total	N/A	206	N/A

NGR, no growth observed; SP *n, Streptococcus pneumoniae*; NA, not applicable

Discussion

This study found that 20.39% of all children studied, from both the PCV-10 vaccinated and unvaccinated groups, were carriers of *S. pneumoniae.* While this is a significant reduction from the pre-vaccine era, it is still high compared to malaria, diarrhea and HIV/AIDS (Feikin *et al.*, 2010). In total, n=41 of the serotypes found were non-vaccine type (in 19.90% of the subjects), with one additional untypeable serotype. This is a very important finding as it explains the high level of child morbidity and mortality due to pneumococcal disease despite the availability of PCV-10.

While these findings agree partially agree with those of (Jacobs *et al.* (2008), where a significant decrease in the vaccine type *S. pneumoniae* serotypes found in isolates was observed, a 97.6% (n=41) decrease is, at the very least, surprising. This trend may be attributed to the increased level of antimicrobial misuse by a greater percent of the study population (Domenech de Cellès *et al.*, 2011). 10-valent pneumococcal conjugate vaccine contains 10 different serotypes, which include: 1, 4, 5, 6B, 7F, 9V, 14, 18C, 19F, 23F (Slotved *et al.*, 2016). None of these 10 serotypes was found in the study population yet this is the vaccine currently included in KEPI, targeting the same population.

S. pneumoniae carriage decreased with age as 11.65% (n=24) were obtained from children aged between 6–24 months and 8.74% (n=18) from children >24 months. The study results demonstrated a linear relationship between child age and *S. pneumoniae* carriage. A similar study done elsewhere reported findings that partly agree with this and partly disagrees (Hill *et al.*, 2008).

The former being attributable to development of *S. pneumoniae*-specific IgG antibodies due to vaccination and during that window before most children start attending school (Corscadden *et al.*, 2013). Unlike findings from a study by (de Paz *et al.* (2015), serotype 28F was the most prevalent and was present in all five age groups profiled. This is a likely scenario of serotype replacement as *S. pneumoniae* attempts to evade the action of the immune system and eventually shares the resistant genes within the microbial community, especially in the nasopharyngeal region (Donati *et al.*, 2010).

Serotypes 28F, 6A, 11A, 3 and 7C were prevalent in both vaccinated and unvaccinated children, whereas serotypes 23A, 17F, 35F, 48, 13, 35B and 23B, 20, 19B, 21, untypeable, 15B, 39 were found among unvaccinated and vaccinated groups respectively. There exist different antigenic features between and within various strains of *S. pneumoniae* (Song *et al.*, 2012). While the majority, if not all, *S. pneumoniae* serotypes are capable of causing disease, the frequency with which they are isolated varies (Kalin, 1998). In this case, vaccination would only be partially effective and, if so, due to inter-strain antigenic characteristics.

While trying to evade the action of the immune system, *S. pneumoniae* has a tendency to exchange resistant genes and other antigenic correlates at the nasopharyngeal region (Johnston *et al.*, 2014). Resistance to antimicrobial agents is occasioned by among other factors, misuse of antibiotics (Dinsbach, 2012). This is largely due to lack of properly enforced antibiotic use regulations by the authorities.

Data availability

Dataset 1. List of basic demographic information for each subject, with the size of the optochin clearance zone and serotype of *Streptococcus pneumoniae,* if found. DOI: http://doi.org/10.5256/f1000research.14387.d207458 (Walekhwa *et al.*, 2018).

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Open Peer Review

Current Referee Status: ✔ ✔ ✘

Version 2

Referee Report 07 February 2019

https://doi.org/10.5256/f1000research.18422.r43883

✔ **Bartholomew N. Ondigo**
Centre for Global Health Research, Kenya Medical Research Institute, Kisumu, Kenya

Comments addressed.

Competing Interests: No competing interests were disclosed.

I have read this submission. I believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Version 1

Referee Report 15 November 2018

https://doi.org/10.5256/f1000research.15656.r39482

✘ **Felix Dube**
Division of Medical Microbiology, Department of Pathology, University of Cape Town, Cape Town, South Africa

The study reports pneumococcal carriage in a cohort of Kenyan children. This has significant implication when it comes to the evaluation of the impact of PCV10 on the population structure of pneumococcus.

Specific comments:

1. Pneumococcus is a normal commensal, not "highly invasive" as is reported in intro.

2. The authors must avoid the use of non-standard nomenclature such as SPn. Further, there is inconsistent use of S. pneumoniae and pneumococcus throughout the text. These cannot be used interchangeably.

3. The introduction needs to be reworked and repetitions avoided, i.e. in paragraph 1 and 5, the authors talk about 90 serotypes. The last sentence of paragraph 5 does not include references.

4. The study was conducted between 2017 and 2018, it would really have benefited from the WHO working group report on pneumococcal carriage studies[1]. Most importantly, 79% (164/206) being

non-viable seriously indicates problems in the experimental design. The authors don't say anything about broth enrichment in order to improve recovery of the pneumococcus. Amies media is not ideal for pneumococcus compared to STGG. A 10ul innoculum is very little, did the authors attempt to use bigger volumes especially for the samples with no growth? A 2% BA plate is used as primary culture then selective media, if possible, do this in parallel.

5. Need to be more consistent in reporting proportions.

6. What was the PCV10 vaccine coverage at each timepoint? Also authors need to report non-pcv as non-PCV10 because some of the serotypes the report as "non-vacccine" such as serotype 3 are included in PCV13.

7. Repetition of results. The authors do not report any metadata looking at risk factors for carriage, hence the "epi" in title must fall out.

8. The authors repeatedly report "decrease" in carriage post PCV, but they really can't say this without data on Pre-PCV10.

9. Avoid sweeping statement to infer serotype replacement if they actually don't show this evidence.

10. "While this is a significant reduction from the pre-vaccine era, it is still high compared to malaria, diarrhea and HIV/AIDS" doesn't make sense, what are the authors referring to?

11. "This is a very important finding as it explains the high level of child morbidity and mortality due to pneumococcal disease despite the availability of PCV-10." How do you arrive at this if working with carriage and not invasive disease isolates.
This and other strong conclusions need to be avoided, you surely cant with 42 isolates.

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Is the work clearly and accurately presented and does it cite the current literature?
Partly

Is the study design appropriate and is the work technically sound?
Partly

Are sufficient details of methods and analysis provided to allow replication by others?
Yes

If applicable, is the statistical analysis and its interpretation appropriate?
Yes

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?
Partly

Competing Interests: No competing interests were disclosed.

Referee Expertise: Medical microbiology

I have read this submission. I believe that I have an appropriate level of expertise to state that I do not consider it to be of an acceptable scientific standard, for reasons outlined above.

Referee Report 01 November 2018

https://doi.org/10.5256/f1000research.15656.r39125

Jackie K. Obey
School of Health Sciences, Department of Medical Laboratory Sciences, University of Eastern Africa, Baraton, Eldoret, Kenya

The study carried out by the authors on *Streptococcus pneumoniae* is extremely important for Kenya. It addresses a major health problem that has been addressed by other authors in the past and for which a lasting solution is currently being sought. The study is detailed and was able to employ modern techniques to assess the carriage state of children at The Gertrude's Children Hospital, Nairobi, Kenya. The methods used were appropriate and in line with the study's objectives. The sample size was appropriately determined and descriptive statistics have been used appropriately to describe the results obtained by the authors.

The title of the study however includes the word 'epidemiology' and this may lead the reader to think that the authors would have tried to determine factors that influenced the establishment of the research problem at the study site. The authors have not determined those factors or risks that lead to Kenyan children being vaccinated, yet not being protected by the PCV-10 vaccine. Those findings would then have given an idea of the risk of expose of children to *Streptococcus pneumoniae* disease and given the hospital and government the strategies to employ for preventive measures against the disease. The conclusion is brief and does not give recommendations to the Government of Kenya or The Gertrude's Children Hospital on what to do after the findings of the study.

Is the work clearly and accurately presented and does it cite the current literature?
Yes

Is the study design appropriate and is the work technically sound?
Yes

Are sufficient details of methods and analysis provided to allow replication by others?
Yes

If applicable, is the statistical analysis and its interpretation appropriate?
Yes

Are all the source data underlying the results available to ensure full reproducibility?
Yes

Are the conclusions drawn adequately supported by the results?
Partly

Competing Interests: No competing interests were disclosed.

Referee Expertise: Medicinal parasitology (Malariology), immunoparasitology and medical entomology, antimicrobial activity of plant extracts

I have read this submission. I believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Referee Report 25 October 2018

https://doi.org/10.5256/f1000research.15656.r39126

? **Bartholomew N. Ondigo**
Centre for Global Health Research, Kenya Medical Research Institute, Kisumu, Kenya

Title: To include Kenya

Corresponding author contacts need to be indicated

Abstract:
Background:
It needs to be indicated that circulating SPn serotypes are being investigated after the introduction of 10-valent pneumococcal conjugate vaccine (PCV10) in 2011.

The methods need to be a summary of the techniques used in data collection. As it is written it appears to be copy pasted from the method section. Indicate number of children assessed. For instance:

Materials:
Two hundred and six children attending and not-attending in ……20-2009 were studied. Materials for study were pharyngeal swabs and sputum. Identification was performed using optochin disks, Quellung reaction,……agglutination on the glass, viewed under a phase contrast microscope and the sent to KEMRI- Kilifi for further confirmative identification tests.

The conclusion seem alarming and need to suggest or indicate. Therefore Kenyan children receiving PCV-10 vaccine are not protected – Revise to something like:-
This study highlights the importance of monitoring and evaluation to provide epidemiological information to determine the effectiveness of PCV10 in Kenya's Public health services.

Repeating ideas should be deleted - causing more deaths than any other infectious disease vs. kills more children than any other illness in the world.

Introduction need to be shortened, preferably to three paragraphs.

Methods:
Were the children admitted or outpatient?
All the source of equipment used and consumables need to be indicated, for instance incubator etc.
The Research Ethics Committee that approved the study need to be indicated.

Software used for calculation of %s need to be indicated?

Results:
Headings need to be introduced that are in agreement with the content. This will help the reader to when reading. Suggested possible headings include:

Demography of the Study Participants
Prevalence of SPn carriage status among PCV-10 vaccinated and unvaccinated children
Prevalence of SPn carriage status by age – You probably have several age groups on this for instance <1, 2 -4 years, 4 – 5 years.

Authors need to clarify on the following:

How many pneumococcus serotypes were identified? Which serotype was most frequent?
Can you please arrange them in a descending order?

Discussion:
Adequate in content.
Consider serotype replacement to enrich your discussion.

Is the work clearly and accurately presented and does it cite the current literature?
Partly

Is the study design appropriate and is the work technically sound?
Yes

Are sufficient details of methods and analysis provided to allow replication by others?
Yes

If applicable, is the statistical analysis and its interpretation appropriate?
Yes

Are all the source data underlying the results available to ensure full reproducibility?
No

Are the conclusions drawn adequately supported by the results?
Partly

Competing Interests: No competing interests were disclosed.

Referee Expertise: Immunoparasitology

I have read this submission. I believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 06 Jan 2019

Michael Walekhwa, Kenyatta University, Kenya

Dear Dr. Ondigo,

Many thanks for your review of this article.

I have read through and keenly updated the areas you highlighted during your review. Kindly revisit.

Many thanks

Competing Interests: No competing interests were disclosed.