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Rate of isolation of streptococcus species from children with bacterial infections: an indication for introduction of streptococcal vaccines

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Abstract *Background:* Streptococcus species are among the commonest bacterial causes of childhood morbidity in developing countries. Streptococcal diseases in children have not been as well characterized in Nigeria as it has been in industrialized countries. The rudimentary nature of public health surveillance makes the true epidemiology of the disease difficult to ascertain. The predominance of *Streptococcus pneumoniae* in the causation of invasive diseases has led to the advocacy of inclusion of pneumococcal vaccine in the National Programme on Immunization. However, local data critical to inform on vaccine deployment are scarce, thus the need for the present study.

Objective: To study the rate of isolation of Streptococcus species from children aged zero to 15 years, with suspected bacterial infections.

Materials and Methods: Laboratory records of results of bacteriological studies of samples from children with suspected bacterial infections in University of Abuja Teaching Hospital from January 2008 through December, 2010 were retrieved and analyzed for bacterial growth. Data analysis Version 3.5.1. Statistical significance was set at $p < 0.05$.

Results: A total of 2,247 samples were received during the study period. Of the 1,242 bacteria isolated, 502 (40.4%) were *Staphylococcus aureus*, 232 (18.7%) were *Escherichia coli* and 146 (11.8%) were Streptococcus species: 78 were isolated from blood, 9 from sputum, 11 from throat swabs and 28 from other sites while urine and eye swabs had 10 each. One hundred and six (72.6%) of the streptococci were from children aged 5 years and below. Most of the Streptococci (88.1%) were untyped. Among the 17 Streptococcal isolates typed, 10 were *Streptococcus pneumoniae* and three were group B Streptococcus.

Conclusion: Streptococcal infections remain an important cause of severe disease in children in Nigeria. The use of effective, safe and affordable vaccine could significantly reduce morbidity from these infections, thus suggesting the need for more studies to conclude on streptococcal vaccine deployment.

Key words: Streptococcal infections, Nigeria, Streptococcal vaccines

Introduction

The genus Streptococcus comprises of more than 30 species. *Streptococcus pneumoniae*, group A Streptococcus and group B Streptococcus are the most common causes of human streptococcal infections.[1] These organisms are among the commonest bacterial causes of childhood morbidity in developing countries like Nigeria. The predominance of *Streptococcus pneumoniae* in the causation of invasive diseases has lead to the advocacy of inclusion of pneumococcal vaccine in the National Programme on Immunization.[2] However, there is paucity of data in Nigeria on the burden of streptococcal infections in children thus making the debate for vaccine deployment inconclusive

It is hopeful that data generated from this study may offer ample evidence for the need for streptococcal vaccine inclusion in national immunization programmes.

Objective

To study the rate of isolation of Streptococcus species from children aged zero to 15 years, with suspected bacterial infections.

Materials and Methods

The study was retrospective, on bacteriological samples from children aged 15 years and below that were evaluated for suspected bacterial infections at the Paediatric Department of University of Abuja Teaching Hospital, Gwagwalada, Abuja. The hospital is a tertiary institution at the centre of Nigeria and serves as a major paediatric referral centre for communities in the Federal Capital Territory and those of the neighbouring states in North central Nigeria.

Samples for bacteriological studies were processed as recommended by Cheesbough et al.[3] For blood culture, 2 ml of venous blood was collected aseptically after thorough skin preparation with 70% alcohol. The blood samples were introduced into thioglycollate broth through a sterile needle in the ratio of one part of blood to five parts of the broth and incubated at 37°C for seven days. The cultures were examined daily for evidence of bacterial growth such as turbidity, clot and gas formation. In samples that showed such evidence, sub-cultures onto chocolate and blood agar plates were performed and incubated at same temperature for 24 to 72 hours. Organisms isolated were identified by conventional methods.[3]
Smears of swabs of eye, ear, umbilical and vaginal discharges as well as those of wound and skin swabs, cerebrospinal fluid and urine samples, were inoculated on MacConkey, chocolate and blood agar plates and incubated for 24 to 48 hours and the bacteria grown were identified using standard methods.[3]
Bacteriological results between 1st January 2008 and 31st December, 2010 were collated and analyzed to identify the pattern and distribution of bacterial growth.

Statistical analysis

Statistical analysis was done using Epi Info software version 3.5.1(CDC, Atlanta, GA, USA, 2008). Frequency tables were generated while Chi square and Fischer's exact tests were used to test associations between categorical variables. Statistically significant difference level was set at $p < 0.05$.

Results

A total of 2,247 samples were received during the study period, of which 918 were blood samples, 400 were urine, 292 were stool, 226 were cerebrospinal fluid, 19 were sputum, 344 were swabs from various body sites, 43 were aspirates while 5 specimens were not properly labeled to reveal their site of origin. Of the 1,247 (55.5%) specimens that yielded growths, 1,234 yielded 1,242 bacteria while 13 yielded 13 candida species. Bacterial growth in 1226 samples was monomicrobial while 8 samples yielded polymicrobial growths. The rate of bacterial yield from the various samples is thus: blood - 62.6%, urine - 45.5%, stool - 43.5%, cerebrospinal fliud - 8.4%, swabs from various sites - 72.1%. Of the 1,242 bacteria isolated, 502 (40.4%) were *Staphylococcus aureus*, 232 (18.7%) were *Escherichia coli* and 146 (11.8%) were Streptococcus species. Table 1.

Table 2 shows the rate of isolation of Streptococcus species from the various samples analyzed. About 76.0% of isolates from throat swabs were Streptococcus species while 36.8% of organisms recovered from the cerebrospinal fluid, 36.0% of bacteria cultured from the sputum, 20.8% of the eye swabs isolates, 13.6% of isolates from blood and 8.3% of those recovered the ear swabs were equally Streptococcus species. Similarly, a higher proportion of the Streptococcus species (72.6%) were recovered from samples taken from children aged 5 years (Figure1).

Analysis of the contribution of Streptococcus species to infections in children is compared with those of other bacterial pathogens on Table 3, which show that Streptococcus organisms is more associated with respiratory tract infections, subarachnoid space infections and blood stream infections. Majority of the Streptococcus species isolated (88.1%) were not further characterized, however, *Streptococcus pneumoniae* accounts for 7.5% (10), group B beta haemolytic Streptococcus was 2.2% (3) while anaerobic Streptococcus was 4(3.0%). Four cases of *Streptococcus pneumoniae* were isolated from the sputum, three from throat swab and one each from the cerebrospinal fliud, pleural tap and the stool.

Table 1: Distribution of isolates based on the site of isolation

Bacteria	Sources of bacterial isolates										
	Blood	Urine	Stool	CSF	Eye	Ear	Sputum	Wound	Throat	Others	Total (%)
Staphylococcus aureus	311	64	3	6	24	27	16	17	4	30	502(40.4)
Streptococcus species	78	10	1	7	10	9	9	4	11	7	146(11.8)
Escherichia coli	55	55	89	1	3	10	-	9	1	9	232(18.7)
Klebsiella species	46	40	7	3	7	10	4	5	2	16	140(11.2)
Pseudomonas species	6	2	2	-	2	51	-	13	-	13	96(7.7)
Other bacteria	79	11	25	2	1	4	-	1	-	3	126(10.1)
TOTAL	575	182	127	19	47	111	29	49	18	78	

Others refer to aspirates from joint space, pleural cavity, gastric contents, peritoneal fluid (ascites), pus and discharges from umbilicus, vaginal as well as swabs of skin lesions and those of non-specified sites

Table 2: Rate of isolation of Streptococcus species from laboratory samples with positive bacterial growth.

SAMPLE	**Number of positive cases N (%)**	**Number of strep species isolated N (%)**	**Proportion (%) of strep among positive cases**
Blood (n = 918)	575(62.6)	78 (8.5)	*13.6*
Stool (n = 296)	127(43.5)	1(0.3)	*0.8*
Urine (n = 400)	182(45.5)	10 (2.5)	*5.5*
Cerebrospinal fluid (n = 226)	19(8.4)	7 (3.1)	*36.8*
Eye swabs (n = 66)	48(72.7)	10 (15.2)	*20.8*
Ear swabs (n = 129)	111(86.1)	9 (7.0)	*8.3*
Wound swabs (n = 57)	49(85.9)	4 (7.0)	*9.5*
Throat swabs (n = 19)	18(94.7)	11 (57.9)	*75.9*
Sputum (n = 39)	29(74.4)	9 (23.1)	*36.0*
Aspirates+ (n = 43)	25(58.1)	4 (9.3)	16.0
Skin swabs (n = 21)	11(52.4)	-	-
Vaginal swabs (n = 21)	11(52.4)	2 (9.5)	18.2
Umbilical swabs (n = 8)	8(100.0)	-	-
Miscellaneous** (n = 5)	3(60.0)	1 (20.0)	33.3

** Miscellaneous = Site of specimen collection was not stated in 5 of the analyzed samples.
+ refer to aspirates from joint space, pleural cavity, gastric contents, peritoneal fluid (ascites) and abscesses.

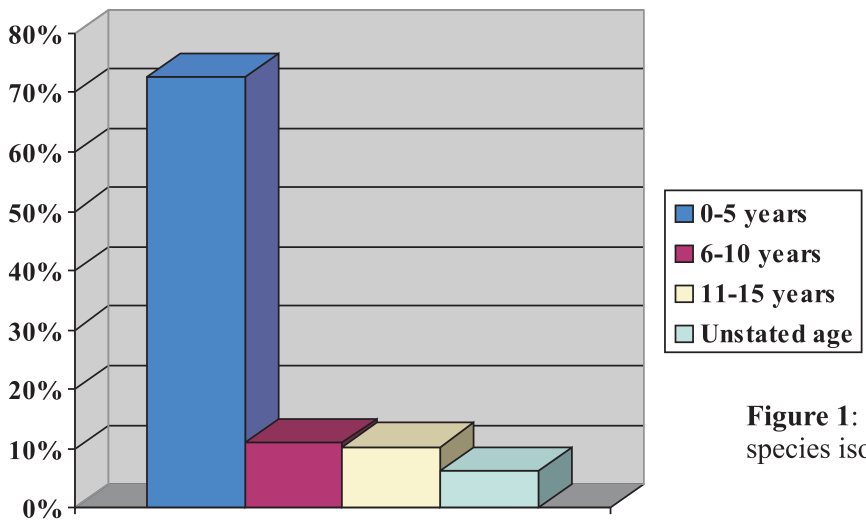

Figure 1: Proportion of Streptococcus species isolated from various age-groups

Table 3: Comparison of the contribution of Streptococcus species to those of other commonly isolated bacteria in the causation of infection** in children.

Bacteria	Site of isolation				
	Blood (n=575)	CSF (n=19)	Ear (n=109)	Resp tract (n=47)	Others (n=484)
Strep (n=146)	78	7	9	20	32
Staph (n=502)	311	6	27	20	138
χ^2	3.68	FET	0.03	16.79	1.52
P	0.0791	0.0125	0.8732	<0.0001	0.2149
Strep (n=146)	78	7	9	20	32
E. coli (n=232)	55	1	11	1	164
χ^2	33.41	FET	0.13	27.59	83.44
P	<0.0001	0.0063	0.7145	<0.0001	<0.0001
Strep (n=146)	78	7	9	20	32
Klebsiella (n=140)	46	3	12	6	73
χ^2	11.49	FET	0.31	6.57	26.81
P	0.0007	0.0501	0.5799	0.0104	<0.0001

CSF = Cerebrospinal fluid; Resp tract = Respiratory tract; Staph = *Staphylococcus aureus*; Strep = Streptococcus species; E. coli = *Escherichia coli*
** Isolation of bacteria from specimens taken from stated body sites is considered as infection of that site
+Others refer to isolates from stool, urine, eye, ear, wound and aspirates from joint space, pleural cavity, gastric contents, peritoneal fluid (ascites), pus and discharges from umbilicus, vaginal as well as swabs of skin lesions and those of non-specified sites

Discussion

Streptococcal organisms are common bacterial agents causing childhood morbidity and mortality. Almost all organ systems could be affected by these agents and there are indications that the incidence of infections with these agents may be increasing.[4] The overall prevalence of streptococcal infections in the present study is 11.8%. However, with further categorization, 75.9% of isolates from throat swabs, 36.8% of organisms recovered from the cerebrospinal fluid and 36.0% of bacteria cultured from the sputum were Streptococcus species.

The high isolation rate of streptococcus species from the cerebrospinal fluid, sputum, throat swabs and blood in the present study corroborates the findings of other researchers[5-8] and emphasizes the role of streptococcal organisms in systemic infections in children. Although, the 11.8% streptococcal infections prevalence rate in this study is lower than figures from East Africa,[5] it is much higher than those of Onipede *et al*[9] from Ile-Ife, South western Nigeria and Nwadioha *et al* from Kano, North western Nigeria.[10] Differences in methodology may account for this; whereas the report from Ile-Ife[9] considered only patients with deep seated infections, the present study included superficial infections. Similarly, the report from Kano,[10] which revealed isolation of only ten cases of *Streptococcus pneumoniae* from 3840 blood culture samples, also excluded results of bacteriological studies of swabs of body discharges as well as urine, cerebrospinal fluid and stool specimens. Reports are however consistent on the role of streptococcal organisms in invasive diseases.

The high isolation rate of streptococcus species from the cerebrospinal fluid, sputum, throat swabs and blood specimens from children with suspected bacterial meningitis, pneumonia, pharyngitis and septicaemia in the present study is a pointer to the magnitude of invasive streptococcal infections in the area of study and suggests the need for preventive strategies aimed at curtailing the immediate and late untoward effects of invasive streptococcal Infections. Although retrospective analysis of bacteriological samples may not be the best indicator of the burden of bacterial infections in a community, they nevertheless, give a clue to the magnitude of morbidity caused by pathogenic organisms and the distribution of the various agents among susceptible individuals. In resource-limited countries, retrospective analysis may be the main source of aetiological information as bacteriological data from community settings are not readily available due to lack of laboratory and culture facilities in most primary and secondary health facilities.[8]

From the result of the present study, one may speculate that the control of streptococcal infections in children may drastically reduce the burden of bacterial meningitis, bacterial pneumonia, bacterial pharyngitis, septicaemia and possibly, the postinfectious syndromes of acute rheumatic fever and glomerulonephritis.

The experience over the years, of national immunization programs, demonstrates that immunization is one of the effective public health strategies. Rapid deployment and use of traditional vaccines against childhood killer diseases have been the most important contributors to reductions in child mortality and increased life expectancy in developing countries.[11] However, introducing new vaccines into the National Program on Immunization requires enormous human and financial resources including engagement of national leaders responsible for primary health care services and presenting them with evidence on the burden of the disease and the potential impact of new vaccine introduction.[11]

Although group A and group B streptococcal vaccines are at various stages of development, pneumococcal vaccine has been licensed for use in children and have been shown to be associated with a 98% reduction in rates of bacteraemia and meningitis and a 67% reduction in rates of otitis media due to vaccine serotypes.[12] Since it was marketed in 2000, widespread use of this vaccine in developed countries has caused a dramatic decline in the incidence of invasive pneumococcal disease among infants and children.[12]

The high cost of conjugate pneumococcal vaccine (approx US $50 per dose) and the challenges of developing effective and safe vaccines against group A and group B streptococci makes it unaffordable for all but the wealthiest of countries,[13,14] thus for low-income countries to introduce such vaccines, there has to be a strong political commitment. Going by the burden of streptococcal infections in the present study, under-five morbidity is unlikely to reduce significantly without concerted efforts at the control of streptococcal infections; hence introducing vaccines against streptococcus species, though expensive, may be lifesaving and cost-effective. Further studies are therefore recommended on disease burden and the cost implication of streptococcal vaccines in developing countries.

Conclusion

The contribution of streptococcal infections to morbidity in children is enormous. Introduction of effective, safe and affordable streptococcal vaccine could significantly alter the current pattern of childhood morbidity and thus warrants further exploration.

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