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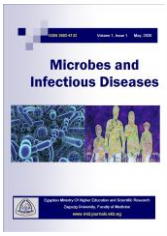

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Original article

Aetiology of pneumonia in Ondo State, southwest Nigeria

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ABSTRACT

Background and rationale: Pneumonia is still a serious issue in most developing countries. It affects all age groups. It can be caused by bacteria, fungi and viruses. Since there is dearth of information on the etiology of pneumonia in Ondo State, Nigeria, this study was conducted to know the types of bacteria associated with pneumonia among the patients attending the chest clinic of selected Government hospitals in Ondo State, Southwest, Nigeria. **Methods**: Ninety five percent (95%) confidence level of Andrew Fisher's formula was adopted to determine the sample size used for the study. Sputum sample (n = 430) was collected from the patients who gave their consent to participate in the study at the chest clinic of the selected Government hospitals in Ondo State and the laboratory analysis was carried out at the Department of Microbiology, Federal University of Technology, Akure between the months of June and September, 2022. Isolation and identification of the organisms was done by using standard microbiological methods. **Results**: Out of a total of 430 sputum samples collected across the three senatorial districts in Ondo State for the study; three hundred and ninety sputum samples (90.7%) had bacterial growth with the break down as follows: *Streptococcus pneumoniae* (230; 59%), *Staphylococcus aureus* (115; 29%) and *Klebsiella pneumoniae* (45; 12%) **Conclusion**: *Streptococcus pneumoniae* (59%) is the most prevalent cause of pneumonia among the patients attending the selected government hospitals in Ondo State, Southwest, Nigeria.

Introduction

Pneumonia is an inflammatory condition of the lung primarily affecting small air sac known as alveoli [1, 2]. Pneumonia is an umbrella term for a group of syndromes caused by a variety of organisms resulting in varied manifestation and sequelae [3]. [4] reported that pneumonia is classified into three, which are: community acquired pneumonia (CAP) which is a pneumonia acquired outside of a hospital, hospital acquired pneumonia (HAP) which is a pneumonia acquired 48hrs after being admitted in a hospital and ventilator associated pneumonia (VAP) which is a pneumonia acquired 48hrs after endotracheal intubation. Symptoms of pneumonia include productive or dry cough, chest pain, fever and difficulty breathing [5]. Pneumonia is still a serious issue in most part of the developing world. It can be caused by bacteria, fungi and viruses but bacteria are the most common cause of CAP [6, 7]. These bacteria include *Acinobacter baumannii*, *Escherichia coli*, *Haemophilus influenzae*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa* and *Streptococcus pneumoniae* [8]. The

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aim of this study is to identify the bacterial species implicated in pneumonia from sputum samples of patients attending the chest clinics of selected Government Hospitals in Ondo State, Nigeria.

Materials and methods

Three hospitals were selected based on the number of senatorial districts in Ondo State. The districts are Ondo North, Ondo Central and Ondo South, respectively. In Ondo North, Federal Medical Center, Owo was picked, in Ondo Central, University of Medical Sciences Teaching Hospital, Ondo was selected while General Hospital, Akure was selected for Ondo South senatorial district accordingly. The selection of hospitals from each senatorial district was based on patient's patronage, availability of qualified medical personnel and equipment.

Determination of sample size for the study

The sample size of the sputum collected for the study was determined using 95% confidence level of Andrew Fisher's formula and are shown below:

$$\text{Sample size} = \frac{(\text{Z-score})^2 \times \text{Standard Deviation} \times (1-\text{Standard Deviation})}{(\text{Confidence interval})}$$

At 95% confidence level (z-score= 1.96), standard deviation =0.5 and confidence interval (margin error) of ±5%

Study design/period/place

Sputum specimen was collected from volunteered patients (n=430) attending the chest clinic of the selected Government hospitals in Ondo State and the laboratory analysis was carried out at the Department of Microbiology, Federal University of Technology, Akure between the period of June and September, 2022.

Ethical consideration

Ethical clearance for the study was sought for and approval was gotten from the Ondo State Ministry of Health (OSHREC29/12/21/411) and Federal Medical Center, Owo (FMC/OW/380/VOL.CXXXVI/66). The informed consent form was filled before collection of samples from the patients recruited for the study. A well-structured questionnaire was administered to the recruited patients to generate their socio-demography data.

Transportation of sputum specimen

The sputum specimen collected was transported to the Medical Microbiology Laboratory of the Department of Microbiology, Federal University of Technology, Akure in a cooler with ice packs for microbial isolation and identification.

Isolation and identification of bacterial species

Isolation of the organisms was done by inoculating the collected sputum on nutrient agar (NA), MacConkey agar (MA), chocolate agar (CA) and blood agar (CA) prepared according to manufactures specifications. The inoculated NA, MCA and BA plates were incubated at 37^{o}C for 24-48 hours for the growth of aerobic bacteria and the inoculated CA plates in anaerobic jar for the growth of anaerobic bacteria, respectively. Gram's staining, subculturing on selective agar and biochemical tests were carried out on pure bacterial isolates according to [9].

Statistical analysis

Results obtained were expressed in percentages.

Results

Types of bacteria isolated from the sputum of patients attending chest clinics of the selected government hospitals in Ondo State, Nigeria

Out of a total of 430 sputum samples that were collected across the three senatorial districts in Ondo State, 390 were positive for bacterial growth (90.7%) and these were considered for the study while the remaining 40 that had no bacterial growth (9.3%) were excluded from the study **(Table 1).** One hundred and fifteen (29.5%) of the bacterial isolates were identified as *Staphylococcus aureus*, 230 (59.0%) were identified as *Streptococcus pneumoniae* while the remaining 45 (11.5%) were *Klebsiella pneumoniae* **(Table 2).**

Frequency of occurrence of the isolated bacterial species from sputum samples based on selected hospitals

The highest frequency of occurrence of all the isolated bacterial species was observed among patients attending General Hospital, Akure with the breakdown as follows; *Staphylococcus aureus* (60.9 %), *Streptococcus pneumoniae* (50.0 %), and *Klebsiella pneumoniae* (53.3 %). On the other hand, the least frequency of occurrence of the isolated bacterial species was observed among the patients attending Federal Medical Centre, Owo **(Table 3).**

Frequency of occurrence of the isolated bacterial species based on gender, age and literacy level of the recruited patients

The frequency of occurrence of the isolated bacterial species from the sputum of the recruited patients based on gender shows that more males than females among the patients recruited for the study irrespective of hospitals from where the samples were collected had bacterial growth in their sputum **(Table 4).** On the basis of age, majority of the patients with bacterial growth were observed to be adults (> 18 years) **(Table 5)** while based on literacy level, majority of the patients recruited for the study with secondary school educational level were observed to have high frequency of bacterial growth **(Table 6).** The overall distribution of the isolated bacterial species from the sputum sample of patients attending different chest clinics of major government hospitals in Ondo State based on gender, age and literacy level is shown in **table (7).** Bacteria implicated in pneumonia was majorly found in the male gender (62.8 %) than the female gender among the patients sampled. Most of the infected patients (61. 3 %) were > 18 years of age and majority of them (70.7 %) had only secondary school certificate as the highest level of education.

Table 1. Number of sputum samples collected in each hospital and number positive for bacterial growth.

Hospital	No. of patients	No. positive for bacterial growth	%	No. negative for bacterial growth	%
UNIMED	167	150	89.8	17	10.2
FMC	40	30	75.0	10	25.0
GHA	223	210	94.2	13	5.8
Total	430	390	90.7	40	9.3

Key: UNIMED - University of Medical Sciences Teaching Hospital, Ondo
FMC – Federal Medical Centre, Owo
GHA – General Hospital, Akure

Table 2. Types of bacterial species isolated from the sputum of patients attending chest clinics of selected hospitals in Ondo State.

Bacterial species	No. Of samples	No. positive	(%) positive
Staphylococcus aureus	390	115	29.5
Streptococcus pneumoniae	390	230	59.0
Klebsiella pneumoniae	390	45	11.5
	Total	390	100.0

Table 3. Frequency of occurrence of the isolated bacterial species based on the selected hospitals.

Bacterial species	Hospital / No. positive				
	FMC (%)	UNIMED (%)	GHA (%)	Total	Ratio
Staphylococcus aureus	10 (8.7)	35 (30.4)	70 (60.9)	115	2
Streptococcus pneumoniae	15 (6.5)	100 (43.5)	115 (50.0)	230	5
Klebsiella pneumoniae	5 (11.1)	15 (33.3)	25 (55.6)	45	1

Key: UNIMED - University of Medical Sciences Teaching Hospital, Ondo
FMC – Federal Medical Centre, Owo
GHA – General Hospital, Akure

Table 4. Gender distribution of the recruited pneumonic patients with bacterial growth in their sputum across hospitals.

Hospital	Gender	No. Positive	% positive
UNIMED	Male	105	70.0
	Female	45	30.0
	Total	150	100.0
FMC	Male	20	66.7
	Female	10	33.3
	Total	30	100.0
GHA	Male	120	57.1
	Female	90	42.9
	Total	210	100.0

Key: UNIMED - University of Medical Sciences Teaching Hospital, Ondo
FMC – Federal Medical Centre, Owo
GHA – General Hospital, Akure

Table 5. Age distribution of the recruited pneumonic patients with bacterial growth in their sputum across hospitals

Hospital	Age (years)	No. positive	% positive
UNIMED	> 18	95	63.3
	≤ 18	55	36.7
	Total	150	100.0
FMC	> 18	22	73.3
	≤ 18	8	26.7
	Total	30	100.0
GHA	> 18	122	58.1
	≤ 18	88	41.9
	Total	210	100.0

Key: UNIMED - University of Medical Sciences Teaching Hospital, Ondo
FMC – Federal Medical Centre, Owo
GHA – General Hospital, Akure

Table 6. Literacy level of the recruited pneumonic patients with bacterial growth in their sputum across hospitals

Hospital	Education level	No. positive	% positive
UNIMED	Primary	30	20.0
	Secondary	100	66.7
	Tertiary	20	13.3
	Total	150	100.0
FMC	Primary	9	30.0
	Secondary	16	53.3
	Tertiary	5	16.7
	Total	30	100.0
GHA	Primary	35	16.7
	Secondary	160	76.2
	Tertiary	15	7.1
	Total	210	100.0

Key: UNIMED - University of Medical Sciences Teaching Hospital, Ondo
FMC – Federal Medical Centre, Owo
GHA – General Hospital, Akure

Table 7. Overall distribution of the isolated bacterial species isolated from the sputum samples of the recruited pneumonic patients in Ondo State based on gender, age and literacy level

S/NO	Parameter	No. positive	% positive
1	**Gender**		
	Male	245	62.8
	Female	145	37.2
	Total	390	100
2	**Age (year)**		
	Adult (>18)	239	61.3
	Children (≤18)	151	38.7
	Total	390	100
3	**Literacy level**		
	Primary	74	19.0
	Secondary	276	70.7
	Tertiary	40	10.3
	Total	390	100

Discussion

Pneumonia is an inflammatory condition of the lungs which affects all age groups. It can cause significant morbidity and mortality especially in developing countries [10]. Since pneumonia is majorly caused by bacteria [11], therefore it is important to determine the type of bacteria implicated in pneumonia in the community studied specifically among patients attending the chest clinics of selected hospitals in Ondo State, Southwest, Nigeria.

Out of the 390 patients positive for bacterial growth in this study, three types of bacterial species; *Streptococcus pneumoniae, Staphylococcus aureus* and *Klebsiella pneumoniae* were isolated from their sputum. *Streptococcus pneumoniae* was isolated from 230 (59%) of the sputum samples followed by *Staphylococcus aureus* in 115(29%) of the sputums while *Klebsiella pneumoniae* was isolated in 45(12%) of the sputums. This shows *Streptococcus pneumoniae* as the most frequently encountered bacterial species implicated in pneumonia among patients attending selected government hospitals in Ondo State followed by *Staphylococcus aureus* while the only Gram-negative bacterial species identified (*Klebsiella pneumoniae*) was the least frequently encountered. This finding agrees with the findings of previous studies carried out in some European Countries that Streptococcus pneumoniae is the most frequently identified causative agent of pneumonia [12, 13]. In this study, the frequency of occurrence of the isolated bacterial species from the sputum samples examined were in the ratio of 5:2:1 of *Streptococcus pneumoniae* to *Staphylococcus aureus* and *Klebsiella pneumoniae* respectively.

Considering the distribution of the infection based on gender, the male gender was observed to be the most affected group compared to the female gender. The distribution was in the ratio of approximately 2 to 1 of male to female, respectively. This shows that males were mostly affected. This finding also agrees with previous reports conducted in some Europe and Asian countries [14, 15].

The distribution of pneumonia based on age shows that adults (>18 years) were mostly affected compared to children (≤18 years old). This distribution is also in the ratio of approximately 2 to 1 of adults to children, respectively. This shows that adults are mostly affected within the community studied. This finding is in accordance with the findings of [16-19].

The literacy level shows that those patients with tertiary degree were least affected with the causative agents of bacterial pneumonia in the community while the secondary school holders were the most frequently affected followed by the primary school certificate holders. This shows that higher literacy level has a predominant influence in minimizing the risk of contracting pneumonia in Ondo State.

Conclusion

This study revealed that *Streptococcus pneumoniae* is the most frequently encountered bacterial species implicated in pneumonia among patients attending chest clinic of the selected

government hospitals in Ondo State followed by *Staphylococcus aureus* while *Klebsiella pneumoniae* was the least frequently encountered. It also reveals that age, gender and level of literacy are some of the risk factors for pneumonia.

Conflict of interest statement

The authors declare that no conflict of interest.

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