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Haematology, bronchoalveolar cellular changes and pathology of swine pneumonia in Nigeria

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Abstract

Respiratory diseases are of considerable economic importance in pigs, and less emphasis is on the diagnostic approaches in porcine health in our environment. The aim of this study was to compare the diagnostic accuracy of haematology, gross, bronchoalveolar lavage (BAL) and histopathological changes of pneumonia in pigs. The study was conducted at a municipal abattoir for over three months. A total of 146 finished pigs were clinically examined. Blood samples were taken, while the plucks were examined for lung lesions. Lavage samples and lung sections were taken for BAL and histological examinations. Six breeds were slaughtered comprising Large White 112 (76.7%), Mixed Breed 15 (10.3%), Duroc 7 (4.8%), Local 6 (4.1%), Hampshire 4 (2.7%), and Large Black 2 (1.4%). Based on sex, 71 (48.6%) were males while, 75 (51.4%) were female. Grossly, there was pneumonia in 92 (63.0%) of the pigs and the mean pulmonary consolidation score was 9.6±1.2. The large white breed had the highest consolidation score. Also, the right and left caudal lobes had the highest consolidation scores. Clinically, there was mild anaemia and leukocytosis, and BAL fluid cellular differential showed increased lymphocytic and neutrophilic counts in the pigs with pneumonia ($p<0.05$). Histologically, 91 (62.2%) of samples were normal, bronchointerstitial pneumonia was 31 (21.4%), bronchopneumonia was 18 (12.4%), granulomatous pneumonia was 1 (0.7%), bronchiolitis was 4 (2.7%), and verminous pneumonia was 1 (0.7%). Bronchointerstitial pneumonia was the most prevalent pattern. Porcine pneumonia is still important in our environment; the roles of different causal agents need to be elucidated for production of vaccines and control in Nigeria and other parts of West Africa.

Keywords: Bronchoalveolar lavage, Cytology, Swine, Pneumonia, Diagnostics

Introduction

The burden of respiratory diseases in pigs is largely under-reported and the clinical cases of infectious and non-infectious respiratory diseases appear to be on the increase (Emikpe *et al*., 2015). Over the years, less emphasis has been placed on the diagnostic approaches in porcine production. Bronchoalveolar lavage (BAL) as a technique has been used for etiological diagnosis of spontaneous pneumonia in swine (Ganter *et al.,* 1993), and has also been used to determine the effects of aerogenic or oral immunization on cell composition in lavage fluids (Delventhal *et al.,* 1992).

One of the most common routes of transmission for infectious agents is direct pig-to-pig contact,

whereas movement of infected pigs in close physical contact with non-infected pigs is decisive in transmitting diseases. Economic forces may also increase the possibility of geographical spread of disease. Different pandemics and initial uncertainties about the role of pigs in disseminating zoonotic agents like the influenza virus (Adeola *et al.,* 2016) led the Food and Agricultural Organization of the United Nations (FAO), the World Organization for Animal Health (OIE) and the World Bank to give the highest priority to developing tools for improving biosecurity in pig production. These biosecurity principles derive directly from scientific knowledge of the epidemiology and transmission of key swine pathogens (FAO, 2010).

The effective interventions to reduce mortality due to pneumonia are available through vaccinations and antibiotics (Wang *et al.,* 2012). However, rapid diagnostics on the field and at point of care are not readily available. Moreso, rapid diagnostics for distinguishing between viral and bacterial pneumonia are not yet well developed. Existing laboratory tests for certain biochemical markers (procalcitonin, C-reactive protein) only detect the likelihood of bacterial pneumonia (Wang *et al.,* 2012). In addition, clinical signs including fever, dyspnoea, wheezing, or crepitation and radiographic tests indicative of consolidation or infiltration in the lungs can confirm or disprove diagnosis of pneumonia. However, it is difficult to differentiate between viral and bacterial pneumonia in resource-poor settings especially across Africa.

This study is set to investigate respiratory conditions of pigs using haematology, bronchoalveolar lavage, and pulmonary pathology. Also to correlate these diagnostic approaches with a view to differentiating between lesions caused by different causative agents.

Materials and Methods

Study animals

The pigs were from different farms in south-west Nigeria, including Lagos, Osun, Oyo, and Ogun; sourced and bought for slaughter in the Bodija abattoir. The abattoir is located in Ibadan ($7^{o}23'47''N$ $3^{o}55'0''E$), the largest indigenous city in sub-Saharan Africa with a population of over 3 million. 146 finished pigs were examined randomly within 12 weeks ante-mortem and after slaughter.

Study variables such as the signalment (age, sex and breed) of the animals were taken from each animal. The body condition scoring system was as described by Battaglia (2001) on a scale of 1-5, using amount of fat and muscle at key anatomical points. 1= very thin (poor), 2= thin (fair), 3= normal (good), 4=fat (obese) and 5= (very obese).

Welfare statement

The animals were not manipulated inhumanely prior to slaughter so as not to interrupt diagnostic purposes and humane handling of animals.

Haematology

Blood was collected into EDTA bottles for haematology. The packed cell volume (PCV) was determined by the micro-hematocrit method while the haemoglobin concentration (Hb) was determined by Sahli's (acid haematin) method. The total erythrocyte counts and leukocyte counts were determined manually using Neubauer haemocytometric methods and differential leukocyte counts were determined from Giemsa stained blood smears.

Lung consolidation

The plucks were removed for gross examination and assessment of lesions on the Lungs. Lung consolidation was determined visually for colour changes of dark red to gray and on palpation for texture changes (Lopez, 2012). Photographs of the whole lung ex situ (dorsal and ventral surfaces) were further taken for image analysis of consolidation as described by Ostanello *et al.* (2007). The surface proportion of the lung lesion was estimated in relation to the total lung surface.

Bronchoalveolar lavage

The bronchoalveolar lavage method was as described by Ezeasor *et al.* (2013). Briefly, following removal of the pluck, 20ml of warm sterile phosphate buffered saline (PBS) was infused into the lungs. This was followed by gentle massage of the lungs before the fluid was recollected into a beaker. The lavage fluid was physically viewed for its color (bloody, straw or fibrinous) after which the fluid was then centrifuged at 2000 rpm for 10minutes and then the supernatant was decanted and total nucleated cells counted. The sediment was carefully smeared on clean glass slides and fixed with methanol. Afterwards it was stained with May-Granward Giemsa stain for cytological examination. The slides were then evaluated for cytological differential leucocyte details.

Histopathology

Sections of lung tissue of approximately 1.0cm by 0.5cm were taken and placed in tissue cassettes and processed routinely (Winsor, 1994). The pathological changes observed in the tissues were used in the classification of the pneumonia (Lopez, 2012).

Statistical analysis

Data were descriptively analysed, presented as percentages and mean ± standard deviation (M±SD), and compared at 5% significance. Morphological changes in the lungs were also recorded.

Results

Distribution of pigs

Breed: Of the 146 pigs, the breed distribution was 112 (76.7%)-Large White, 2 (1.4%)-Large Black, 15 (10.3%)-Mixed Breed, 6 (4.1%)-Local, 7 (4.8%)-Duroc and 4 (2.7%)-Hampshire.

Sex: The number of male pigs examined was 71 (48.6%) while the number of female pig examined was 75 (51.4%).

Age: the ages of the animal were represented as adult (>24 months) and young (<24 months) respectively based on the tooth wearing pattern (Hongo & Meadow, 1998) and a new system for computing dentition-based age profiles in *Sus scrofa* (Lemoine *et al.*, 2014). The number of adult animals was 102 (69.9%) while that of the relatively young animals was 44 (30.1%).

Clinical score

Ten pigs were in good body condition, 134 were in fair body condition, while 2 were in poor body condition. The clinical distribution of the pigs according to breed, sex and age is shown in table 1. The large white breed seems to be the most predominant slaughtered pig, followed by mixed and local breeds. The animals were apparently healthy, as most of the pigs were in fair body conditions.

Pneumonia

Gross

Of the 146 animals, 54 (37%) were normal and 92 (63%) pneumonic. The mean consolidation score was 9.6±1.2. The distribution of pulmonary consolidation according to breed, age and sex is shown in table 2. More cases of pulmonary consolidations (pneumonia) were observed in large white and mixed breeds, also in adults and pigs with fair body conditions. Pigs with poor body conditions showed 100% pulmonary consolidation.

Bronchoalveolar lavage BAL

Of the 146 pigs, the BAL showed increased proportion of inflammatory cells including neutrophils, macrophages and lymphocytes in 37 (25%) pigs (pneumonia) while 109 (75%) were of normal cellular constituents.

The distribution of the pigs based on BAL changes indicative of pneumonia and those not pneumonic is also shown in Table 2. More inflammatory changes pneumonia) were observed in large white and mixed breeds, also in adults and pigs with fair body

Table 1: Distribution of the pigs based on body score and other signalments

		Body score			
		Good	Fair	Poor	Total
Breed	Large white	6	104	2	112 (76.7)
	Duroc	2	5	0	7 (4.8)
	Local	0	6	0	6 (4.1)
	Mixed breed	2	13	0	15 (10.3)
	Large black	0	2	0	2 (1.4)
	Hampshire	0	4	0	4 (2.7)
	Total	10	134	2	146 (100.0)
Sex	Male	6	64	1	71 (48.6)
	Female	4	70	1	75 (51.4)
	Total	10	134	2	146 (100)
Age	Adult	6	94	2	102 (69.9)
	Young	4	40	0	44 (30.1)
	Total	10	134	2	146 (100.0)

Table 2: Pattern of Pneumonia in the examined pigs

		Gross			BAL		Total
		Normal	Pneumonic	Total	Normal	Pneumonic	
Breed	Large white	40 (27.3%)	72 (49.2%)	112 (76.5%)	80 (54.8%)	32 (21.8%)	112 (76.7%)
	Duroc	0	7 (4.8%)	7 (4.8%)	4 (2.7%)	3 (2.1%)	7 (4.8%)
	Local	3 (2.1%)	3 (2.1%)	6 (4.2%)	6 (4.1%)	0	6 (4.1%)
	Mixed breed	6 (4.1%)	9 (6.2%)	15 (10.3 %)	14 (9.6%)	1 (0.7%)	15 (10.3%)
	Large black	2 (1.4%)	0	2 (1.4%)	2 (1.4%)	0	2 (1.4%)
	Hampshire	3 (2.1%)	1 (0.7%)	4 (2.8%)	3 (2.1%)	1 (0.7%)	4 (2.7%)
	Total	54 (37.0%)	92 (63.0%)	146 (100.0%)	109 (74.7%)	37 (25.3%)	146 (100%)
Sex	Male	25 (17.1%)	46 (31.5%)	71 (48.6%)	54 (37.0%)	17 (11.6%)	71 (48.6%)
	Female	29 (19.9%)	46 (31.5%)	75 (51.4%)	55 (37.7%)	20 (13.7%)	75 (51.4%)
	Total	54 (37.0%)	92 (63.0%)	146 (100.0%)	109 (74.7%)	37 (25.3%)	146 (100.0%)
Age	Adult	35 (24.0%)	67 (45.9%)	102 (69.9%)	78 (53.4%)	24 (16.4%)	102 (69.9%)
	Young	19 (13.0%)	25 (17.1%)	44 (30.1%)	31 (21.2%)	13 (8.9%)	44 (30.1%)
	Total	54 (37.0%)	92 (63.0%)	146 (100.0%)	109 (74.7%)	37 (25.3%)	146 (100.0%)
Bodyscore	Good	2 (1.4%)	8 (5.4%)	10 (7.4%)	8 (5.4%)	2 (1.4%)	10 (6.8%)
	Fair	52 (35.6%)	82 (56.2%)	134 (91.8%)	101 (69.2%)	33 (22.6%)	134 (91.8%)
	Poor	0	2 (1.4%)	2 (1.4%)	0	2 (1.4%)	2 (1.4%)
	Total	54 (37.0%)	92 (63.0%)	146 (100.0%)	109 (74.6%)	37 (25.4%)	146 (100.0%)

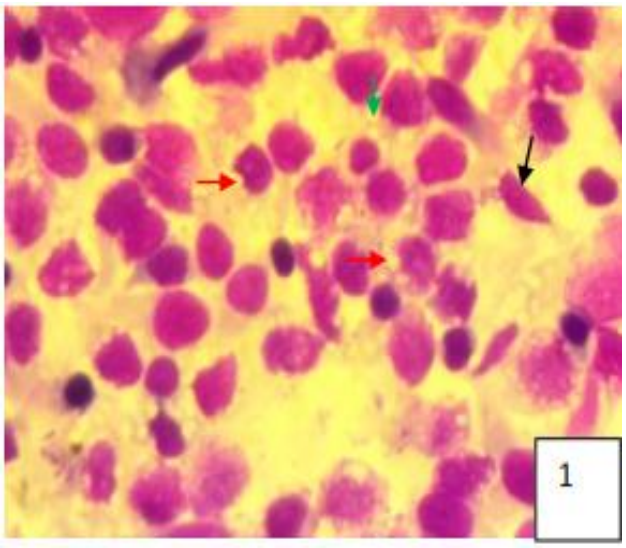

Plate I: Photomicrograph of bronchoalveolar lavage fluid cytology showing alveolar macrophages (red arrows), lymphocytes (green arrow) and a few epithelial cells (black arrow). Giemsa x1000

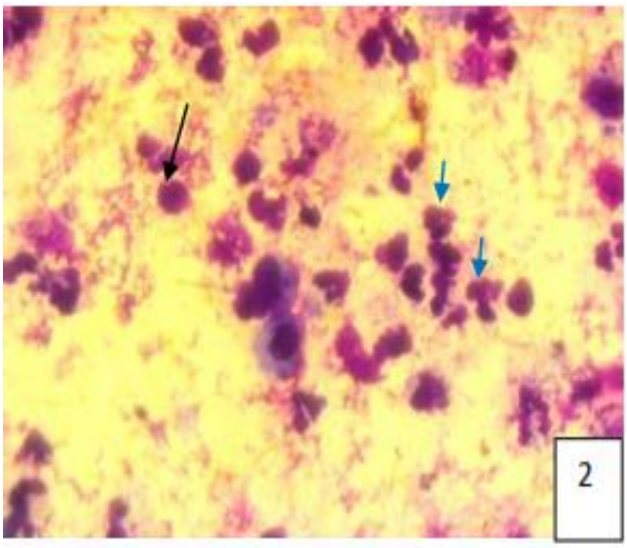

Plate II: Photomicrograph of bronchoalveolar lavage fluid cytology showing BALF with neutrophils (blue arrows) and a few macrophages (red arrows). Giemsa x1000

conditions. Pigs with poor body conditions showed 100% pulmonary consolidation.

Cytologically, a few or no neutrophils were present in normal lungs (<2%). Macrophages were the most predominant ranging from 22- 85% (Plates I and II). Lymphocytes constituted 13%. In the pneumonic lungs there was an increase in the polymorphonuclear cell counts (neutrophils- up to 22%, eosinophils- 12%) and also lymphocytes and plasma cells ($p<0.05$).

Table 3: Histopathological distribution of lung samples from examined pigs

		Histopathology						
		Normal	Broncho interstitial pn	Bronchopn	Granulomatous pn	Bronchiolitis	Parasitic pn	Total
Breed	Large white	69(47.1%)	24(16.3%)	16(11.0)	1(0.7%)	1(0.7%)	1(0.7%)	112(76.5%)
	Duroc	3(2.1%)	3(2.1%)	0	0	1(0.7%)	0	7(4.9%)
	Local	4(2.7%)	0	1(0.7%)	0	1(0.7%)	0	6(4.1%)
	Mixed breed	10(6.8%)	3(2.1%)	1(0.7%)	0	1(0.7%)	0	15(10.3%)
	Large Black	2(1.4%)	0	0	0	0	0	2(1.4%)
	Hampshire	3(2.1%)	1(0.7%)	0	0	0	0	4(2.8%)
	Total	91(62.2%)	31(21.4%)	18(12.4%)	1(0.7%)	4(2.8%)	1(0.7%)	146(100.0%)
Sex	Male	49(33.5%)	16(11.0%)	5(3.4%)	1(0.7%)	0	0	71(48.6%)
	Female	42(28.8%)	15(10.3%)	13(8.9%)	0	4(2.7%)	1(0.7%)	75(51.4%)
	Total	91(62.3%)	31(21.3%)	18(12.3%)	1(0.7%)	4(2.7%)	1(0.7%)	146(100.0%)
Age	Adult	63(43.1%)	22(15.1%)	13(8.9%)	0	3 (2.1%)	1(0.7%)	102(69.9%)
	Young	28(19.2)	9(6.1%)	5(3.4%)	1 (0.8%)	1(0.7%)	0	44(30.1%)
	Total	91(63.3%)	31(21.2%)	18(12.3%)	1 (0.8%)	4 (2.7%)	1(0.7%)	146(100.0%)
Body score	Good	6(4.1%)	2(1.4%)	2(1.4%)	0	0	0	10(6.9%)
	Fair	85(58.1%)	28(19.2%)	14(9.6%)	1(0.7%)	4(2.7%)	1(0.7%)	134(91.0%)
	Poor	0	1(0.7%)	2(1.4%)	0	0	0	3(2.1%)
	Total	91(62.2%)	31(21.3%)	18(12.4%)	1(0.7%)	4(2.7%)	1(0.7%)	146(100.0%)

Histopathology

Of the 146 pigs examined (Table 3), 91 (62%) of were normal, bronchopneumonia (Plate III) was 18 (13%), broncho-interstitial pneumonia (Plate IV) was 31 (21%), granulomatous pneumonia was 1 (0.7%), bronchiolitis was 4 (3%), and verminous pneumonia (Plate V) was 1 (0.7%). Comparatively, over 75% of the pneumonic lungs were identified by gross, BAL and histological levels; as there was a strong positive correlation (+.65, p<.05) between the diagnostic approaches.

Haematology

The packed cell volume, haemoglobin concentration and red blood cell counts were lower in the Large Black breed of pigs and the platelets higher in the mixed breeds (p> 0.05).

The packed cell volume of the pigs with poor body score was lower. The haemoglobin concentration and white blood cell counts (leucocytosis) were higher in the pigs with poor body condition.

The packed cell volume and white blood cell counts of the young pigs were higher. The packed cell volume was lower in male pigs and the white blood cell counts low in female pigs (p>0.05).

The packed cell volume, haemoglobin concentration and red blood cell counts were high in pigs with broncho-interstitial pneumonia and bronchiolitis (table 4). Also, there was a slight lymphocytosis in pigs with bronchiolitis and eosinophilia in pigs with parasitic pneumonia (Tables 5 and 6).

Table 4: Haematological parameters from the examined pigs

	PCV (%)*	Hb (g/dl)	Rbc ($x10^3 \mu l^{-1}$)	Wbc ($x10^3 \mu l^{-1}$)	Platelet ($x10^3 \mu l^{-1}$)	MCV (fl)	MCHC (pg)
Large white	30.6 ± 0.9^a	$10.2\pm0. .3^a$	5.0 ± 0.2^a	10.0 ± 0.6^a	69.1 ± 8.8^a	62.4±0.5	33.0±0.2
Duroc	29.7 ± 2.2^b	9.8 ± 0.9^a	4.8 ± 0.4^a	10.2 ± 1.0^a	57.3 ± 57.1^a	60.4±0.8	33.3±0.6
Local	29.5 ± 3.9^b	9.7 ± 1.3^a	5.0 ± 0.7^a	9.1 ± 1.1^a	20.1 ± 0.1^b	59.6±0.5	33.1±0.6
Mixed breed	35.6 ± 1.6^a	12.0 ± 0.6^a	5.9 ± 0.3^a	9.2 ± 0.8^a	80.4 ± 42.3^c	60.2±0.9	33.8±0.4

Large black	42.0±2.0^{c}	14.2±0.4^{b}	7.2±0.4^{b}	6.4±1.4^{b}	20.0±0.1^{b}	58.1±0.1	33.7±0.8
Hampshire	27.8±3.1^{b}	9.2±1.1^{a}	4.5±0.5^{c}	7.5±2.0^{a}	68.1±8.6^{a}	62.4±0.9	33.0±0.4
Normal	31.3±0.9^{a}	10.4±0.3^{a}	5.1±0.2^{a}	9.8±0.7^{a}	0.7±0.1^{a}	61.9±0.5	33.1±0.2
Broncho-interstitial	32.9±1.4^{a}	10.9±0.5^{a}	5.3±0.3^{a}	9.8±0.6^{a}	0.6±0.2^{a}	62.4±1.0	33.1±0.3
Bronchopneumonia	28.3±4.6^{b}	9.4±1.6^{a}	4.7±0.8^{a}	8.6±0.9^{a}	0.6±0.3^{a}	60.8±1.6	32.7±0.6
Granulomatous pn	11.0±0.0^{b}	3.4±0.0^{c}	1.6±0.0^{c}	7.5±0.0^{a}	1.4±0.0^{b}	67.5±0.0	30.9±0.0
Bronchiolitis	36.5±5.5^{a}	12.5±1.8^{b}	6.5±1.2^{b}	6.9±1.4^{b}	0.2±0.0^{c}	61.5±2.4	33.6±0.3
Parasitic pn	15.0±0.0^{b}	4.7±0.0^{c}	2.6±0.0^{c}	3.7±0.0^{c}	0.1±0.0^{c}	56.8±0.0	31.3±0.0

PCV- Packed cell volume, Hb- Haemoglobin concentration, RBC- Red blood cell count, WBC- White blood cell count, Platelet, MCV- Mean corpuscular volume, and MCHC- Mean corpuscular haemoglobin concentration. Values with different superscripts are significant at p-value <0.05

Table 5: Leucocyte differentials from the examined pigs

	Lymph (x10^{3}µl-^{1})	Neut (x10^{3}µl-^{1})	Mono (x10^{3}µl-^{1})	Eosin (x10^{3}µl-^{1})
Large white	4.3±0.3	4.6±0.3	0.3±0.0	0.2±0.0
Duroc	5.5±0.6	4..3±0.4	0.3±0.1	0.2±0.1
Local	4.3±0.6	4.3±0.5	0.2±0.0	0.2±0.1
Mixed breed	4.0±0.5	4.1±0.5	0.2±0.0	0.2±0.0
Large black	2.4±0.4	3.6±0.8	0.1±0.0	0.2±0.1
Hampshire	3.3±0.7	3.8±1.2	0.2±0.1	0.2±0.0
Normal	4.4±0.3^{a}	4.8±0.3^{a}	0.3±0.1	0.2±0.1
Broncho-interstitial	4.6±0.3^{a}	4.7±0.3^{a}	0.3±0.1	0.3±0.1
Bronchopneumonia	3.9±0.6^{a}	4.3±0.4^{a}	0.2±0.1	0.2±0.3
Granulomatous pn	2.6±0.0^{a}	4.5±0.0^{a}	0.1±0.0	0.4±0.0
Bronchiolitis	6.3±0.8^{b}	3.1±0.5^{a}	0.2±0.0	0.4±0.0
Parasitic pn	2.2±0.0^{c}	1.2±0.0^{b}	0.2±0.0	1.1±0.0

Lymph- lymphocytes, Neut- neutrophils, Mono- monocytes, Eosin- Eosinophils, Values with different superscripts are significant at p-value <0.05

Table 5: Bronchoalveolar lavage cellular changes in the normal and pneumonic pigs

	Neut	MQ	Lym	PC	Eosin
Normal	2%	62%	35%	0%	1%
Broncho-interstitial	12%	36%	47%	4%	1%
Bronchopneumonia	22%	43%	32%	0%	3%
Granulomatous pn	9%	52%	29%	10%	0%
Bronchiolitis	13%	48%	36%	3%	0%
Parasitic pn	15%	24%	46%	3%	12%

Pn- pneumonia

Discussion

This study has been able to elucidate the different clinical and pathological changes in types or pattern of porcine pneumonia from an abattoir survey in our environment. The precision of the different diagnostic tools in detecting pneumonia was highlighted. It showed that pneumonia is still significant and broncho-interstitial is the most predominant. From this study, it is clear and, of course necessary to distinguish between healthy and pneumonic pigs. Clinical examinations are, however, often not sufficient because in-apparent stages of

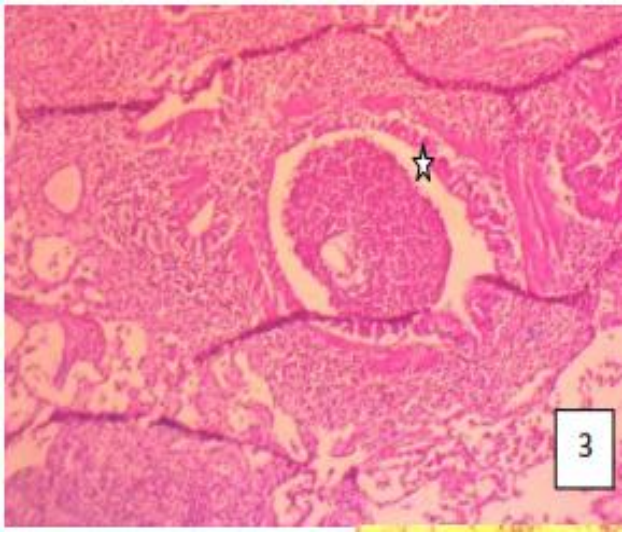

Plate III Photomicrograph of the lung showing diffuse cellular infiltrate in bronchiole (asterick) and alveoli (bronchopneumonia). HE x100

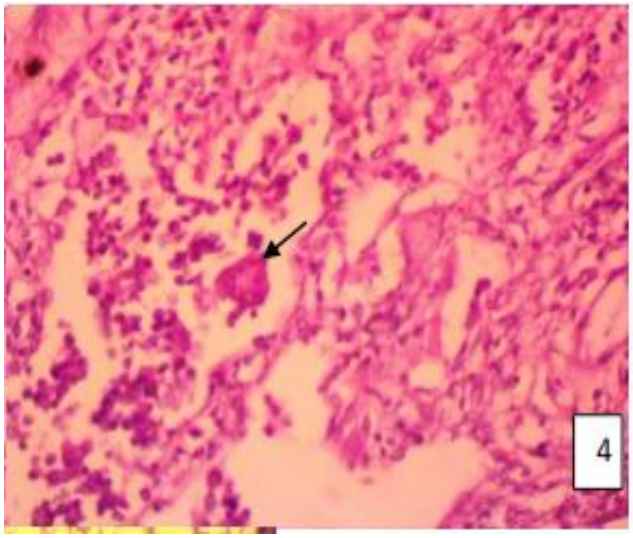

Plate IV Photomicrograph of the lung showing diffuse cellular infiltrate in bronchiole (asterick) and alveoli (bronchopneumonia). HE x100

pulmonary lesions may be overlooked. The age of the pig is also an important risk factor in the assessment of pneumonia. The high number of adult pigs with pneumonia can be adduced to availability of finish pigs for slaughter. Sex of the animals was also observed as a predictor of pneumonia. This is similar to our findings in goats (Jarikre *et al.,* 2016).

The haematology and BAL cytology of the pigs in this study can be considered as valuable guidelines for other researchers, as this is possibly the first in our environment. The differences found in both BAL cytology and haematology was similar to those observed by Jolie *et al.* (2000) between high and low health status in pigs and in calves (Allen *et al*., 1992). Segregated early weaning of low health status pigs in a less challenging environment mainly reduced the concentration of neutrophils in BAL fluid and peripheral blood. More studies are needed to evaluate if such changes are important for the long-term respiratory and general health of the pigs (Jolie *et al.*, 2000). In contrast with the BAL cytology, haematological findings were not influenced much by age and were similar to those reported values in normal pigs (Jain, 1986). The anaemia and leucopaenia in the pigs with poor body condition reflects a poor prognosis. Haematological indices like the PCV and WBC suggested the diagnosis of pneumonia.

The precision of BAL in the diagnosis of pneumonia in swine was reported in this study and correlated with findings of Ganter *et al*. (1993) and Delventhal *et al*. (1992). Bronchoalveolar lavage was used to study experimental respiratory infections with

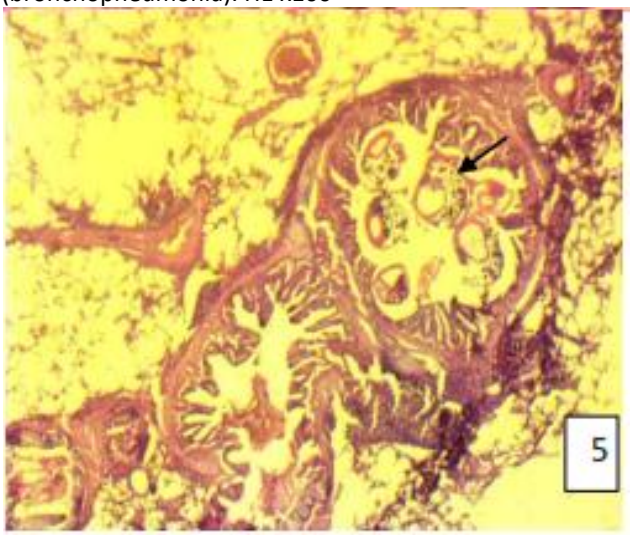

Plate IV: Photomicrograph of the lung showing sections of parasitic larva stages in bronchiole (arrows). HE x100

Pasteurella multocida (Müller *et al.,* 2003; George *et al.,* 2015) and Influenza virus (Charley *et al.,* 1980), and also to study induction of lymphocyte migration within the local immune system of the lung (Pabst & Gehrke, 1990; Huang *et al.,* 1990; Pabst *et al.,* 1995; Pabst, 1996).

However, experience is needed in the measurement and interpretation of acellular components in BAL fluid in this specie. More so, the used lavage protocol shows a best possible standardization, but the major critical point is the lack of comparability between the results of different studies (Hennig-Pauka *et al.,* 2001). Increased cell counts in BAL fluid

are often proportional with an increase in the number of bacteria and indicate an irritated lung in clinically healthy pigs. Quantitative BAL fluid cultures, combined with a BAL differential cell count, were found to be reliable in predicting the degree of oropharyngeal contamination of the BAL sample and in establishing an accurate diagnosis of bacterial pneumonia especially in immunocompromised humans (Costabel, 1994).

The diagnostic tools and some information on clinical features of and risk factors are now available. There is, however, limited information on the sensitivity and specificity of these diagnostic tools and many clinical questions remain unanswered, including the route and time course of infection, pathogenesis of disease, and treatment options (Assiri *et al*., 2013). A thorough knowledge of swine respiratory disease, epidemiology and the routes of disease transmission will enabled authorities and producers to develop adequate biosecurity measures in the pig sector. Some of these measures are applicable across all production systems (FAO, 2010).

This study showed that all diagnostic methods used were useful in diagnosis of porcine pneumonia in a poor resource setting with a strong indication, however, for molecular and immunohistochemical techniques. These diagnostic measures will help in arriving at the possible role of different causal agents in the pathogenesis of porcine pneumonia thereby providing the basis for production of intranasal vaccines capable of curtailing porcine pneumonia in Nigeria and other parts of West Africa. Further studies will investigate the cluster composition of lymphocytes present in porcine BALF, the mechanisms of cell influx in bronchoalveolar lining fluid, correlation of cell composition and microbiological findings.

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