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Retrospective Study of Pneumonia Diagnosed, from 2013 – 2023, at The Necropsy Unit of The Veterinary Teaching Hospital, Ahmadu Bello University Zaria, Kaduna State, Nigeria

Muhammed Shuaib Muhammed[1], Jerome Amari Adole[1], Ochuko Orakpoghenor[2], Faruk Saleh Umar[1], Ahmadu Saleh[1], Sohnap James Sambo[1], Bisalla Mohammed[1], Muhammad Yakasai Fatihu[1], Sunday Blessing Oladele1 and Najume Doguwa Giginya Ibrahim[1]

[1]Department of Veterinary Pathology, Faculty of Veterinary Medicine, Ahmadu Bello University Zaria, Nigeria
[2]Department of Veterinary Pathobiology, Faculty of Veterinary Medicine, Bayero University Kano, Nigeria

Abstract

This retrospective study, conducted at the Necropsy Unit of the Veterinary Teaching Hospital, Ahmadu Bello University Zaria, Nigeria, investigated the temporal trends and patterns of pneumonia diagnosed from 2013 to 2023 in diverse animal species. Data were extracted from the record book, entered into Microsoft Excel sheet, and analysed using descriptive statistics. Results revealed that pneumonia was diagnosed in 27.9% (293/1052) of the carcasses presented during the study period. The temporal trend showed that cases of pneumonia diagnosed were highest in 2017 (17.4%), and least in 2023 (1.7%). Based on species, caprine (33.1%) exhibited the highest prevalence, followed by canine (28.3%) and ovine (18.4%), with porcine displaying the lowest prevalence (1.7%). Marked sex variations existed, with males having higher pneumonia rates in canine (56.6%), equine (63.6%), lagomorph (61.1%) and porcine (60.0%) species, while females exhibited higher prevalence in bovine (52.9%), caprine (61.9%), feline (75.0%), and ovine (55.6%) species. Also, the age variations showed highest pneumonia cases in animals <1 year old in several species, whereas in canine species, the highest prevalence occurred in the 1-3 years age group, and in animals >3 years in equine and porcine species. There was significant (p<0.05) association between age and the species of animals diagnosed with pneumonia. This study provides valuable insights into the complex dynamics of respiratory infections in veterinary pathology, and the multifaceted nature of pneumonia prevalence. Thus, there is need to consider these factors in the understanding and effective management of respiratory infections in diverse animal populations.

Keywords: *Pneumonia, temporal trends, species prevalence*

Introduction

Pneumonia, a prevalent respiratory disorder, poses a significant threat to animal health across various species (Debnath et al., 2022). This condition is characterized by inflammation of the lung parenchyma, thus, leading to compromised respiratory function (Quinton et al., 2018). In animals, pneumonia can be caused by a diverse range of infectious agents, including bacteria, viruses, fungi, and parasites (Freidl et al., 2017; Dear, 2020). The susceptibility of animals to pneumonia is influenced by factors such as age, immune status, environmental conditions, and overall health. Also, the manifestation of pneumonia often involves a complex interplay of multiple factors (Quinton et al., 2018; Otter and Brzozowska, 2022).

The clinical presentations of pneumonia in animals are diverse and may include coughing, nasal discharge, dyspnoea, decreased feed intake, and lethargy (Hraiech et al., 2015; Dear, 2020). Therefore, the timely and accurate diagnosis is crucial for effective management, as different pathogens may require distinct treatment approaches. Moreover, untreated or improperly managed cases of pneumonia can result in significant economic losses for livestock producers due to reduced growth rates, decreased milk production, and increased mortality rates (Otter and Brzozowska, 2022).

The gross lesions of pneumonia include changes in the color, texture, and overall appearance of lung tissue. These changes may be depicted, in acute cases, by areas of consolidation characterised by red to grayish discoloration of the lungs, with the affected lobes often appearing firm, heavy, and may fail to collapse upon palpation (Carvallo and Stevenson, 2022). On the other hand, in chronic cases, the consolidation may progress to the development of abscesses, caseous nodules, or fibrous adhesions between the lung lobes (Haydock et al., 2023). Based on histological examination, pneumonia presents a spectrum of inflammatory patterns, reflecting the nature of the underlying causative agents. These range from multifocal areas of consolidation around bronchi and bronchioles, cellular infiltrations, alveolar oedema, presence of fibrin to the deposition of fibrous tissue and granulation tissue formation (Hraiech et al., 2015; Orakpoghenor and Markus, 2020; Carvallo and Stevenson, 2022; Haydock et al., 2023).

The diagnosis of pneumonia involves a combination of clinical signs, laboratory analysis, imaging techniques, and necropsy (Dear, 2020; Otter and Brzozowska, 2022). Necropsy, or postmortem examination, is a fundamental tool in veterinary diagnostics. It involves the systematic examination of animal carcasses to identify the cause of death and understand the pathological changes associated with diseases (Küker et al., 2018). In cases of pneumonia in animals, postmortem examination and histopathological analysis play a pivotal role in confirming the diagnosis, revealing characteristic gross and microscopic lesions in the affected lung tissue (Caswell et al., 2012; Otter and Brzozowska, 2022).

The aim of this study was to conduct a 10-year (2013 – 2023) retrospective survey of

pneumonia diagnosed at the Necropsy Unit of the Veterinary Teaching Hospital (VTH), Ahmadu Bello University (A.B.U.) Zaria, Kaduna State, Nigeria. The rationale behind this study focused on the need to enhance our understanding of pneumonia in animals, specifically in Zaria, Kaduna State Nigeria. By conducting a retrospective analysis of necropsy records, we sought to identify patterns, trends, and potential risk factors associated with pneumonia in animals. This information is invaluable for veterinarians, researchers, and policymakers in designing targeted interventions and preventive measures. In addition, this study has the potential to provide invaluable insights into the epidemiology of pneumonia, thus, contributing to evidence-based veterinary practices and animal health management.

Materials and Methods

Study area

The study was conducted in the Necropsy Unit of the Veterinary Teaching Hospital (VTH), Ahmadu Bello University (A.B.U.) Zaria, Kaduna State, Nigeria. Zaria is a major city in Kaduna State, Northwestern Nigeria, located at longitude 7043'11.802" E and latitude 1105'7.948" N, with an average elevation of 644 metres above sea level. It has a total land area of 523 km2, a human population of 408,198 according to the 2006 census, and a density of 730/km2. The climate in Zaria includes a wet season, lasting from April to September, and a dry season from October to March (Benedine and Ahmed, 2007).

In the Necropsy Unit of the VTH, A.B.U. Zaria, postmortem examinations of carcasses are carried out for the purpose of establishing morphologic diagnoses, and the cause of mortality.

Study design

The study was retrospective in design, and reviewed pneumonia diagnosed in carcasses presented to the VTH for a period of ten years, i.e., from January, 2013 to December, 2023.

Data extraction

The data used for the study were obtained from the record book of the Necropsy Unit of the VTH, A.B.U. Zaria, Kaduna State, Nigeria. Pneumonia diagnosed in carcasses whose data were incomplete or not available were not included in this study. The data variables extracted were year in which the pneumonia was diagnosed, and species, sex, and age of the animal.

Data analyses

Data were checked for completeness, entered and cleaned in Microsoft office excel version 2013, and later exported to Statistical Package for Social Sciences (SPSS version 23.0) for analysis. The data were expressed as frequencies and percentages, and presented using tables and charts. Chi-square statistic was used to test for association between sex, age, and the species of animals diagnosed with pneumonia. Value of $p \leq 0.05$ was considered significant.

Results

Overall pneumonia diagnosed

A total of 1052 carcasses were presented from 2013 – 2023, out of which,

pneumonia was diagnosed in 27.9% (Table 1).

Yearly distribution of the pneumonia diagnosed

The highest (17.4%) pneumonia were diagnosed in the year 2017 followed by in 2016 (14.0%), 2019 (13.7%), 2013 (13.0%) and 2014 (13.0%), and the least in 2020 (2.7%), 2022 (3.1%) and 2023 (1.7%). The proportions of pneumonia diagnosed in the years 2015, and 2018, were 9.6%, and 4.4%, respectively (Fig. 1).

Table 1. Retrospective data of pneumonia diagnosed from 2013 – 2023 at the Necropsy Unit of the Veterinary Teaching Hospital, Ahmadu Bello University Zaria, Nigeria

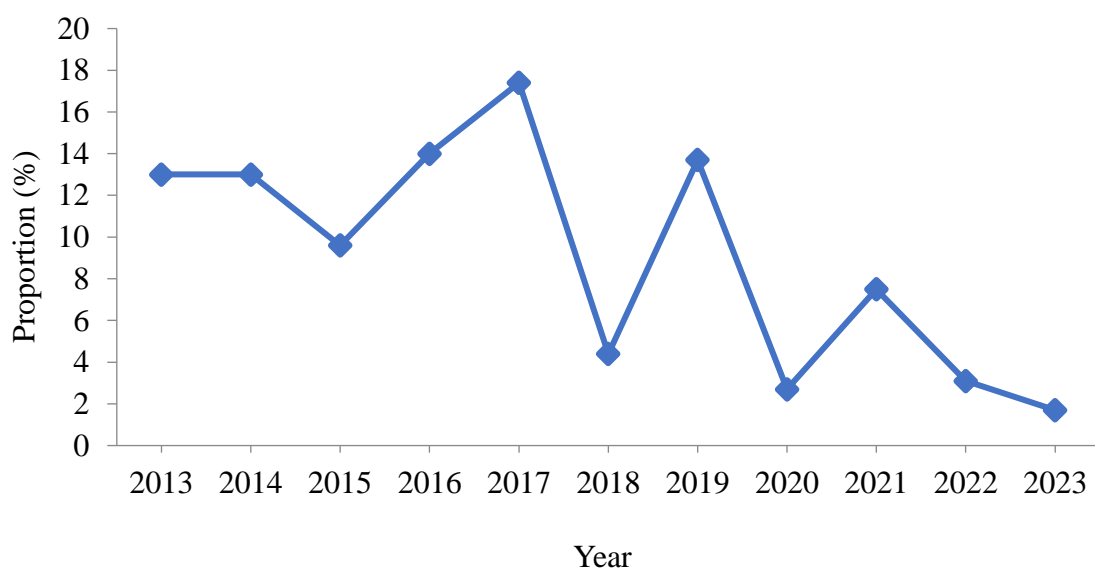| Year	Total number of carcasses presented	Frequency of pneumonia diagnosed	Proportion (%)
2013	105	38	36.2
2014	105	38	36.2
2015	193	28	14.5
2016	128	41	32.0
2017	102	51	50.0
2018	107	13	12.1
2019	128	40	31.3
2020	44	8	18.2
2021	64	22	34.4
2022	36	9	25.0
2023	40	5	12.5
Overall	1052	293	27.9

Fig. 1. Yearly trend of pneumonia diagnosed from 2013 – 2023 at the Necropsy Unit of the Veterinary Teaching Hospital, Ahmadu Bello University Zaria, Nigeria.

Speies distribution of the pneumonia diagnosed

The animal species with the highest pneumonia cases was caprine (33.1%) followed by canine (28.3%) and ovine

(18.4%), and the least in porcine (1.7%). The proportions of pneumonia cases diagnosed in the other animal species were 5.8% (bovine), 3.8% (equine), 2.7% (feline), and 6.1% (lagomorph) (Fig. 2).
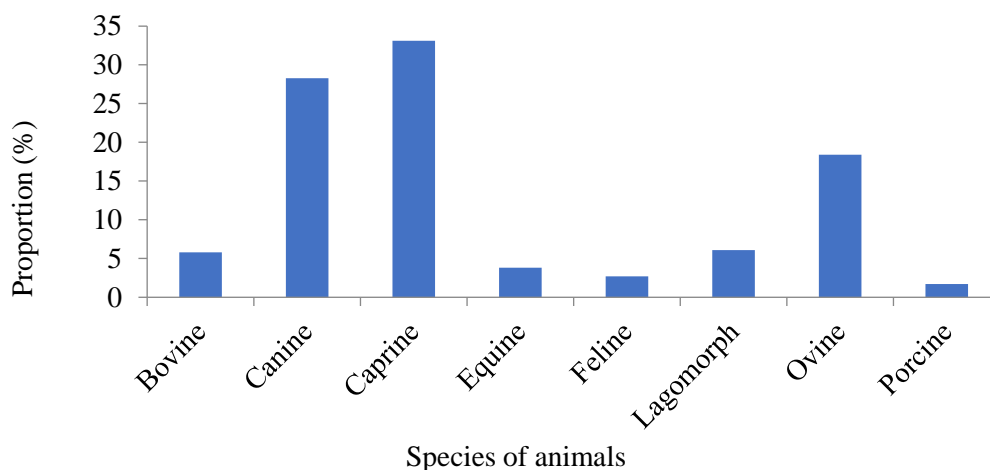

Fig. 2. Species distribution of pneumonia diagnosed from 2013 – 2023 at the Necropsy Unit of the Veterinary Teaching Hospital, Ahmadu Bello University Zaria, Nigeria.

Sex distribution of the pneumonia diagnosed

There was higher pneumonia diagnosed in males in canine (56.6%), equine (63.6%), lagomorph (61.1%) and porcine (60.0%) species, than in the females. In bovine (52.9%), caprine (61.9%), feline (75.0%), and ovine (55.6%) species, pneumonia diagnosed were higher in females than in the males. There was no significant (p>0.05) association between sex and the species of animals diagnosed with pneumonia (Fig. 3).

Age distribution of the pneumonia cases diagnosed

The pneumonia diagnosed was highest in animals less than a year-old in bovine (41.2%), caprine (62.9%), feline (62.5%), lagomorph (88.9%), and ovine (42.6%) species. There was highest pneumonia diagnosed in animals aged 1 – 3 years-old in canine (41.0%), and in animals greater than 3-years-old in equine (54.5%), and porcine (60.0%) species. Significant (p<0.05) association existed between age

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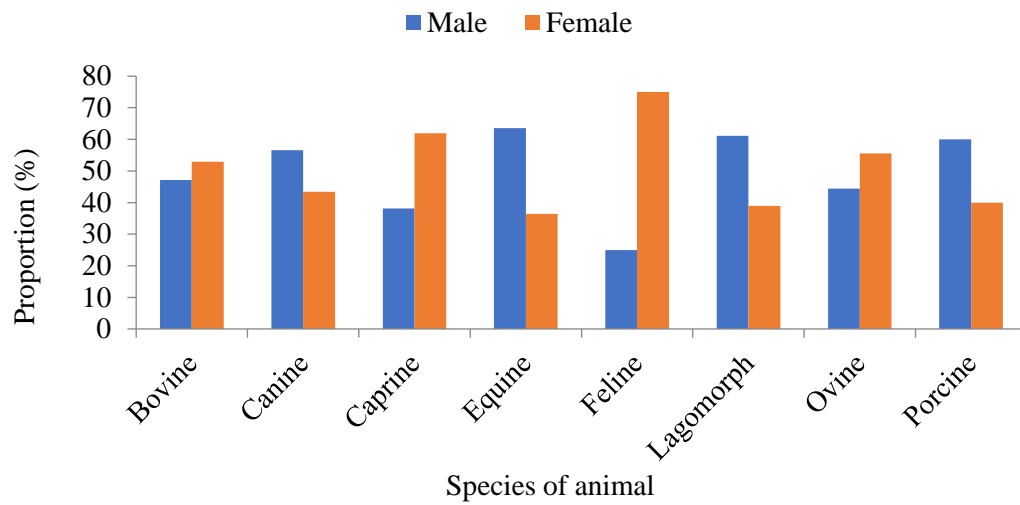and the species of animals diagnosed with   pneumonia (Fig. 4).

Fig. 3. Sex distribution of pneumonia diagnosed from 2013 – 2023 at the Necropsy Unit of the Veterinary Teaching Hospital, Ahmadu Bello University Zaria, Nigeria. X^2=10.804, p=0.147
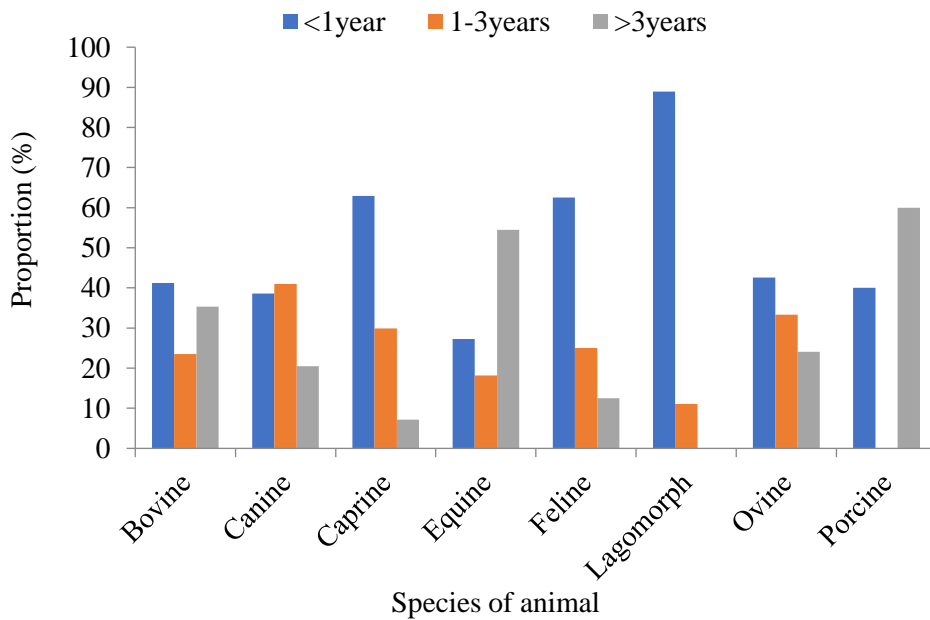

Fig. 4. Age distribution of pneumonia, based on age of animals, diagnosed from 2013 – 2023 at the Necropsy Unit of the Veterinary Teaching Hospital, Ahmadu Bello University Zaria, Nigeria. X^2=47.312, p<0.0001

Discussion

The outcome of this study, indicating that pneumonia was diagnosed in 27.9% of the total carcasses presented from 2013 to 2023, emphasises the significance of respiratory infections in veterinary pathology. This finding aligns with previous studies that have highlighted pneumonia as a common and significant cause of morbidity and mortality in various animal species. For instance, a previous report on fatal diseases and conditions encountered from 1980 – 1991 in and around Zaria revealed pneumonia prevalence of 24.96% (Mohammed, 1992). A study on animal models of polymicrobial pneumonia emphasised the importance of understanding the precise pathogen-specific pathogenicity and host-pathogen responses, thus, underlining the significance of pneumonia in animal health (Hraiech et al., 2015). Also, another study on livestock-associated risk factors for pneumonia in an area of intensive animal farming in the Netherlands documented a significant positive association between pneumonia in humans and living close to goat and poultry farms (Freidl et al., 2017). Furthermore, a case–control study in Kenya identified contact with animals as a specific local risk factor for community-acquired pneumonia among adults (Muthumbi et al., 2017).

The variation in the prevalence of pneumonia diagnosed across different years, as observed in this study, raises intriguing questions about the temporal dynamics of this respiratory condition in Zaria, and Kaduna State, Nigeria. The lower prevalence in 2020, 2022, and 2023 may be attributed to the low number of cases presented as a result of the COVID-19 pandemic, industrial action, and economic hardship, respectively. In addition, the temporal fluctuation may be associated with a myriad of factors, including changes in environmental conditions, infectious agent dynamics, and management practices.

The impact of climatic variations and seasonal influences on the incidence of respiratory infections in animals has been well-documented in previous studies. For instance, periods of increased rainfall or extreme temperature fluctuations were reported to create favourable conditions for the proliferation and transmission of respiratory pathogens in animals (Maggioli et al., 2022; Liao et al., 2023). Also, management practices such as animal density, housing conditions, and biosecurity measures were identified as influential factors in the likelihood of disease outbreaks (Mach et al., 2021; Maggioli et al., 2022). These findings, therefore, emphasise the complex and multi-layered nature of respiratory diseases in veterinary medicine, where both environmental and management factors play a significant role in disease occurrence, severity, and outcome (Maggioli et al., 2022). Also, this temporal analysis emphasises the importance of ongoing surveillance and research to adapt control measures to the evolving dynamics of respiratory diseases in veterinary settings.

In the present study, the variations in pneumonia prevalence across different animal species emphasises the diverse susceptibility of animals to respiratory

infections. The variables that may be contributing to these differences include anatomical and physiological variations, host immune responses, and specific infectious agents prevalent in each species (Maggioli et al., 2022). For instance, in canine species, pneumonia can be caused by a range of viruses and bacteria, such as Canine Parainfluenza Virus (CPIV) and Bordetella bronchiseptica (Vieson et al., 2012). In caprine species, respiratory diseases are often linked to Mycoplasma species, Pasteurella, and Mannheimia (Maggioli et al., 2022). The low prevalence in porcine may be influenced by specific biosecurity measures, vaccination programs, or inherent resistance to common respiratory pathogens. Therefore, an understanding of the species-specific patterns of pneumonia is crucial for developing targeted preventive measures and treatment protocols tailored to the unique characteristics of each animal group.

The observed sex-based variations in pneumonia diagnosed across different animal species in this study highlight the importance of considering sex-related factors in understanding respiratory infections. The results indicate that in canine, equine, lagomorph, and porcine species, pneumonia cases were higher in males, with percentages ranging from 56.6% to 63.6%. Conversely, in bovine, caprine, feline, and ovine species, pneumonia cases were more prevalent in females, with percentages ranging from 52.9% to 75.0%. This sex disparity may be influenced by a combination of physiological, behavioral, and environmental factors (Chamekh et al.,

2017; Maggioli et al., 2022). Previous studies have shown that sex hormones, such as estrogen and testosterone, can impact the immune response and susceptibility to infections (Kadioglu et al., 2011; Taneja, 2018; Sciarra et al., 2023). In addition, behavioural differences between sexes, such as social interactions and stress responses, could influence exposure to pathogens and subsequent disease development (Vázquez-Martínez et al., 2018; Oruganti et al., 2023). Therefore, the higher prevalence of pneumonia in females in certain species of animals in this study may be related to hormonal fluctuations affecting the immune system or specific behavioural patterns that might have increased their exposure to respiratory pathogens. Furthermore, reproductive status could play a role, as pregnant or lactating females may experience immunomodulation, thus, influencing their vulnerability to respiratory pathogens (Maggioli et al., 2022).

The age-specific patterns of pneumonia diagnosed across the various animal species shed light on the significance of age-related factors in the susceptibility to respiratory infections. The findings reveal that pneumonia was highest in animals less than a year old in bovine, caprine, feline, lagomorph, and ovine species, with percentages ranging from 41.2% to 88.9%. This aligns with previous research that often identifies young animals as more susceptible to respiratory infections due to factors such as an immature immune system, lack of acquired immunity, and increased exposure to environmental stressors during the early stages of life

(Maggioli et al., 2022; Liao et al., 2023). Also, neonatal pneumonia is frequently associated with bacterial infections, such as Mannheimia haemolytica and Pasteurella multocida, which can affect young animals with less-developed respiratory defenses (Hooven and Polin, 2017; Gaudino et al., 2022).

On the other hand, it was observed that in canine species, pneumonia diagnosed were highest in animals aged 1 to 3 years, while in equine and porcine species, the highest prevalence was observed in animals greater than 3 years old. This age-related shift in susceptibility might be influenced by changes in immune status, exposure patterns, and environmental stressors as animals mature. This is so as previous studies have suggested that in older animals, factors like concurrent diseases, diminished immune function, and cumulative exposure to environmental pathogens may contribute to an increased risk of respiratory infections (Manskikh, 2015; Wu et al., 2021; Martins et al., 2022). Hence, an understanding of the age-specific patterns of pneumonia is crucial for designing targeted vaccination strategies and implementing appropriate management practices tailored to the specific vulnerability of different age groups in each species.

The findings from this study provide valuable insights into the complex dynamics of respiratory infections in diverse animal species, and emphasise the multifaceted nature of pneumonia prevalence, with factors such as temporal trend, species, gender, and age playing pivotal roles. The observed variations emphasises the importance of considering the unique physiological, behavioural, and environmental characteristics of each variable in understanding disease dynamics, and highlight the need for tailored management and preventive strategies. This study therefore, contributes to the broader understanding of veterinary pathology, and could assist veterinarians and animal health professionals in developing targeted strategies for the prevention and control of pneumonia in animals. Hence, there is need for further research to explore the impact of environmental and management factors on pneumonia prevalence over time.

Acknowledgements

Conflict of interest

The authors declare no potential conflict of interest.

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