Research Paper

The epidemiology of avian influenza and its significance for public health

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ABSTRACT

Background: Avian influenza (AI) is a significant zoonotic disease that poses a major threat to global public health. It comes from animal reservoirs and primarily affects poultry, especially chickens and turkeys. This leads to economic losses and illnesses that can range from mild to severe. The virus spreads through fecal-oral transmission and aerosols, with respiratory transmission being the most common route for Low Pathogenicity Avian Influenza (LPAI) viruses.
Objective: To describe the epidemiological aspects of avian influenza and emphasize its importance for public health.
Results: Avian influenza viruses fall into two categories: Highly Pathogenic Avian Influenza (HPAI) and Low Pathogenicity Avian Influenza (LPAI), based on their severity in poultry. HPAI viruses can cause serious respiratory illness, pneumonia, and high death rates in birds. They can also infect humans, leading to major health issues. We can diagnose AI infection through virus isolation in eggs or cell cultures, detection of viral proteins or nucleic acids, or by identifying AI virus antibodies. We can use antiviral medications, including adamantanes and neuraminidase inhibitors, to prevent and treat influenza infections.
Conclusions: Avian influenza continues to be a significant concern for both animal and human health due to its potential to spread and its economic impact. To prevent and control AI outbreaks, especially HPAI incursions, we need effective surveillance, quick diagnosis, timely medical intervention, annual vaccination programs, supportive legislation, and emergency management systems.

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1. INTRODUCTION

Avian influenza (AI), which originated from the animal reservoir, is one of the current greatest risks to public health at the moment. Compared to the number observed during the previous 40 years, the number of AI outbreaks in poultry has significantly grown over the last five years. The number of birds involved in AI outbreaks has increased 100-fold, from 23 million birds from 1959 through 1998 to more than 200 million from 1999 through 2005 [1].

All viruses that cause avian influenza (AI) are negative-strand, segmented RNA viruses that are members of the genus Influenza of the family Orthomyxoviridae. Influenza A viruses can be classified into subtypes based on which of the nine neuraminidase (NA) antigens and the 15 antigenically different haemagglutinin (HA) antigens they possess (N1 to N9). Almost all bird-isolated HA and NA combinations have been discovered. Aquatic birds, which are responsible for the continued occurrence of these viruses in nature, are the main source of genetic material for all AI viruses [2].

Specific influenza serotypes Avian influenza, a fatal illness that affects birds and certain animals, is brought on by a virus (AIV), a member of the Orthomyxoviridae family [2]. The distinction between serotypes is made on the basis of the virion antigens hemagglutinin (H) and neuraminidase (N). Recently, a 10th and 11th-N type, as well as a 17th and 18th H type, were found in bats. 16 H-types and 9 N-types were previously recognized [3], [4]. AIV spreads most frequently through aerosol and the fecal-oral pathway, where it multiplies in the digestive and respiratory systems of chickens [5]. specific influenza serotypes A virus (AIV), a member of the Orthomyxoviridae family, is what causes avian influenza, a fatal illness of birds.

As of June 4, 2013, 375 people had died as a result of the avian-origin HPAI H5N1 pandemic, which originated in East Asia in 2003 and progressed westward from there since 2005. It is still endemic in Bangladesh, Cambodia, China, Egypt, and Viet Nam [6]. At the height of the outbreak, a major area of investigation was the potential role of wild birds in spreading the disease westward. The LPAI H7N9 strain with a poultry origin that was recently found in healthy pigeons is the cause for concern for the entire world. In China, this strain has already resulted in 139 laboratory-confirmed human cases with 47 fatalities as of December 1 [7].

The symptoms of an AIV infection might differ greatly depending on the infected species, age, sex, strain, subtype, concurrent infections, and, of course, a variety of predictable and unpredictable environmental factors. Clinical symptoms might range from minor to severe disturbances of the neurological, reproductive, and gastrointestinal systems. The economic effects of AIV in poultry are typically significant since it affects not only egg production but also egg quality. Additionally, a high rate of bird death has been noted [8].

Depending on the infected species, age, sex, strain, subtype, concurrent infections, and, of course, a range of predictable and unpredictable environmental circumstances, the symptoms of an AIV infection may vary significantly. Clinical symptoms can include minor to serious disruptions to the gastrointestinal, reproductive, and neurological systems. Since AIV affects both egg production and egg quality in chicken, it frequently has considerable economic consequences. A high rate of bird mortality has also been noted [9]. A complete diagnosis of AI can be made using any of the following methods: isolation and identification of the AI virus[10], direct detection of AI viral proteins or genes in materials such tissues, swabs, cell cultures, or embryonating eggs, or molecular detection. Since human avian influenza vaccines are still not widely accessible and the only effective treatments for human infections are supportive therapy and antiviral medication [11], [12], presently no practical, effective treatment for AI virus infections in commercial poultry. Additionally getting worse is antiviral resistance.

Because we frequently come into contact with chickens, ducks, and other birds in our daily lives and in live poultry markets, the avian influenza virus is hard to control. Additionally, the annual movement of wild birds from one region to another throughout the planet increased the spread of viruses [13]. Important information that is frequently overlooked in avian influenza risk analyses includes the fact that vaccination and consistent infection with low-pathogenic avian influenza viruses do not protect birds from catching the highly pathogenic H5N1 influenza virus, but they can protect infected birds from showing symptoms or passing away [14].

Therefore, the objectives of this seminar paper are:

- To describe the available of epidemiological aspects of AI.
- To concisely mention public health impact of avian influenza.

2. RELATED WORK

2.1. Etiology

Avian flu viruses are segmented, negative sense ribonucleic acid viruses that belong to the Orthomyxoviridae family. Orthomyxoviridae is a family of segmented viruses that includes the Type A, B, and C influenza viruses. Wild ducks, chickens, turkeys, pigs, horses, mink, seals, and people can all contract Type A influenza viruses, which include all AI viruses. The only animals that occasionally get viruses of types B and C are humans and pigs [15].

Heamagglutinin (HA) and neuraminidase, two surface proteins of influenza viruses, are used to categorize them into subtypes (NA): heamagglutinin and neuraminidase, which come in sixteen different forms (H1 to H16) (NA). For instance, a virus's subtype H1N2 would be one containing type 1 HA and type 2 NA. There are known to be nine neuraminidases (N1 to N9) and at least 16 different hemagglutinin types (H1 to H16) in birds, two additional HA and NA types in bats, and small subsets of avian subtypes in other mammals [4]. The lipids bilayer of the host cell's membrane contains the proteins sequence (M2), neuraminidase (NA), and hemagglutinin (HA) [16].

2.2. Epidemiology

Geographic Distribution: Wild birds are susceptible to LPAI viruses from all over the world, despite regional variations in the circulating viruses [17]. In wealthy countries, control strategies often exclude these viruses from commercial, confined poultry. However, other birds, such flocks in backyards or those sold live at poultry markets, may still contain them [18]. Eurasian descent in several regions of Asia, the Middle East, and Africa, H9N2 LPAI viruses are endemic in poultry [19]. There have also been sporadic reports of their appearance in flocks of domesticated poultry, wild birds, or game birds in Europe [20]. Only imported cases in persons who had visited China have been linked to the zoonotic H7N9 LPAI viruses, which are still common in poultry in mainland China [21].

While domestic flocks are usually devoid of Highly pathogenic viruses, the introduction of Asian lineage H5 viruses in avian populations has increased the frequency of outbreaks in formerly HPAI-free countries [22]. Asian-lineage H5N1 Highly pathogenic viruses are still widespread in poultry in a number of Asian and Middle Eastern countries. 635 Other subtypes of this lineage, in particular the H5N6 and H5N8 HPAI viruses, are particularly common in poultry in parts of Asia and have been seen in Africa [23]. Various subtypes of Asian lineage H5 Highly pathogenic viruses occasionally infect wild birds in Eurasia and North America [22].

2.3. Transmission of Avian Influenza

Avian influenza viruses are excreted in bird feces and respiratory secretions, although the proportion of the virus in each of these two sites changes depending on the virus and host species [24], [25]. The most common mode of infection for aquatic species, such as ducks, is typically fecal-oral transmission (although fecal-cloacal transfer may also be possible) [26], [27]. However, it has been demonstrated that respiratory transmission is more common with some waterfowl LPAI viruses and some viruses that were transmitted to these birds from gallinaceous poultry (for example, Asian lineage H5N1 HPAI viruses) [28], [29]. While infected bodies (cadavers) are anticipated to be a substantial source of exposure for raptors, respiratory transmission may also be considerable in some terrestrial wild birds [30]. Avian influenza viruses can spread in flocks of chickens via aerosols and the fecal-oral pathway. Although fecal shedding can occasionally be significant, respiratory transmission of LPAI viruses typically predominates [31]. Fly-borne pathogens such as fumites may play a significant role in transmission [32],

[33]. There hasn't been any conclusive evidence to support a study's hypothesis that HPAI viruses could spread between farms via the wind [34].

2.4. Pathogenesis

Avian influenza virus is categorized into low and highly pathogenic strains (LPAIV and HPAIV, respectively) depending on how dangerous it is to domestic hens (Gallus gallus) [35], [36]. LPAIV typically results in subclinical infection in domestic poultry, with viral shedding in infected birds, if not a moderate respiratory illness. The HPAIV, formerly known as the "fowl plague," on the other hand, affects both domestic and wild birds and is a multiorgan systemic disease with a high rate of morbidity and mortality [2], [35]. Both the H5 and H7 subtypes have the potential to evolve into very dangerous virus strains. A characteristic that may presage the appearance of reassorted H5 strains with pandemic potential is that the more recent H5 viruses in circulation appear to be more pathogenic in mammals and birds than the earlier H5 viruses [37], [38]. Human upper respiratory epithelial cells contain sialic acid molecules with alpha 2–6 galactose receptors, which human influenza viruses preferentially bind to in order to infect host cells. Sialic acid molecules with alpha 2-3 galactose receptors, which are ubiquitous in bird respiratory tracts but have also been found throughout the human respiratory tract, notably in alveoli and distal airways, are preferred by avian influenza viruses, including H5N1 [39].

2.5. Clinical Sign of Influenza

Despite the possibility of undetected influenza infections in poultry, primarily in chickens and turkeys, they frequently cause production losses and a range of clinical illnesses in infected flocks, ranging in severity from moderate to severe. Viruses that cause systemic infections as well as mucosal infections in the respiratory and/or gastrointestinal tract can typically be divided into two groups. The term "low pathogenicity" or "mildly pathogenic AI" (LPAI) is commonly used to describe viruses that cause mucosal infections. Usually, LPAI viruses do not significantly increase flock mortality. Systemic infections are typically fatal, and the viruses that cause them are known as highly pathogenic AI, high pathogenicity AI (HPAI), or previously as chicken plague viruses [40].

The LPAI viruses can cause asymptomatic infections, although often mild to severe respiratory disease is the most prevalent symptom. When accurate records of consumption are kept, a decrease in feed or water consumption is another frequent sign of flock infection. Decline in egg production can also be seen in flocks of breeder or layer chickens. As is frequently observed in turkey breeders afflicted with swine-like influenza viruses, the flocks' egg production might drop significantly and never fully recover [41].

2.6. Diagnosis

Avian influenza (AI) has a variety of clinical presentations depending on the host species and viral strain. Since the clinical illness and lesions the virus causes in chickens are not pathognomonic for avian influenza, a laboratory test is necessary for the identification of AI virus infection. By isolating the virus in eggs or cell cultures, or by checking for viral protein, viral nucleic acid, or AI virus antibodies, it is feasible to diagnose AI virus infection or exposure [42]. A disease epidemic is frequently the first sign of an AI virus infection, and affected flocks are frequently found using a combination of viral isolation, serological assays, and direct antigen detection. By directly injecting chicken embryonating eggs that are nine to eleven days old with homogenates from the trachea, lung, feces, and internal organs, influenza viruses have been successfully isolated. In particular, cell culture has been employed as an alternative to traditional virus isolation techniques. Although influenza viruses have been regularly isolated from clinical samples, failures have occurred because the ill birds were examined after viral shedding had ceased, samples were improperly stored, there weren't enough samples or samples, or the samples were too few [43]. Similar tests are used to diagnose human and animal infections with the avian influenza virus. Commercial quick diagnostic test kits for the routine diagnosis of influenza may be able to identify certain viruses, however their sensitivity for influenza viruses may be considerable reduced because these tests are designed for human influenza viruses [44], [45].

2.7. Treatments of AI

For poultry with avian influenza, there is no effective treatment. Broad-spectrum antibiotics, appropriate husbandry practices, and a healthy diet could all help to cut back on secondary infection-related losses. Both adamantine and neuraminidase inhibitors, which both block a viral protein, are examples of antiviral drugs that used to prevent and cure influenza. The 2009 H1N1 virus that is now circulating can be successfully treated with oseltamivir (Tamiflu) and zanamivir (Relenza), but not adamantine (Amantadine and Rimantadine). The anti-influenza medications zanamivir and oseltamivir have received approval from the US Food and Drug Administration. These drugs are structurally related to one another. They work well against avian influenza A variants including the one that caused the 1918 pandemic [46].

2.8. Prevention and Control

2.8.1. Vaccination

The first HPAIV H5N1 vaccination for humans was approved on April 27, 2007 by the Food and Agriculture Organization (FDA) of the United States of America [47]. The list of vaccine producers for chicken influenza was released by the Food and Agriculture Organization of the United Nations [48]. The use of vaccines for poultry outside of outbreak zones may help reduce the risk of infection and cut virus output because animals pose a lesser hygiene risk than humans. The three immunization strategies the FAO recommends are as follows: (1) React to an outbreak, using perifocal vaccination (ring vaccination) or vaccination only of domestic poultry at high risk, in conjunction with the destruction of infected domestic poultry; (2) Immunization in response to a "trigger," due to the discovery of the illness by surveillance studies, in regions where biosecurity is challenging to implement (such as areas with a high density of folks).

2.8.2. Biosecurity

After influenza outbreaks in poultry and the potential pandemic threat posed to humans by the HPAIV of the H5N1 subtype, the two main options for combating the disease are biosecurity measures and the use of weakened or killed vaccinations [49]. Because its major objective is to reduce the possibility of foreign organisms entering the premises where poultry are housed, biosecurity is the best strategy to reduce the risk of illnesses in general, especially when poultry are maintained in confinement. Farms should ideally be built with biosecurity in mind from the start [50].

2.9. Public Health Importance

People who frequently come into touch with birds are known to develop avian influenza illnesses, and volunteers have been experimentally exposed to the H4N8, H6N1, and H10N7 viruses [51]. Prior to the late 1990s, zoonotic infections were only occasionally reported as conjunctivitis, minor illnesses, or asymptomatic infections. There have been a number of severe or fatal cases brought on by the H7N9 LPAI and HPAI viruses now present in China, and rare reports of deaths from other subtypes have also been made [52], [53], [54]. A few human pandemics were brought on largely or entirely by avian viruses, and it is feasible, if uncommon, for avian influenza viruses to adapt to humans. Following the pandemic, these viruses continue to be spread as human influenza viruses [55].

2.10. The Pandemic Threat and the Disease's Current Status in Ethiopia

A global influenza outbreak typically happens when a fresh influenza virus appears, spreads, and causes illness globally [56]. Since ancient times, descriptions of severe, widespread epidemics of a respiratory illness like influenza have been documented. The earliest instance of an illness resembling influenza was documented by Hippocrates in ancient Greece. With intervals ranging from 9 to 39 years, 4 human influenza pandemics occurred in the 20th century [57]. With 25 to 50 million fatalities worldwide and about half of the victims being healthy young people, the Spanish influenza pandemic of 1918–1919 (H1N1) was the deadliest in recorded human history. In 1957, the Asian influenza pandemic, in 1968, the Hong Kong influenza pandemic, and in 1977, a less severe pandemic occurred (Russian influenza). 1950s and then came back in 1977. People under the age of 20 were nearly primarily affected by the sickness. The immunity of elderly people who have antibodies from their prior exposure to essentially identical viruses can be blamed for the pandemic's very low mortality rate [58].

Although there hasn't been an HPAI outbreak in Ethiopia yet, there was a worry in 2006 due to the avian flu. This panic resulted in a huge demand shock, which caused poultry prices to drop precipitously. The Ethiopian government and foreign organizations established a three-year avian flu preparedness strategy in the same year, costing US $ 124 million [59], [60], [61].

3. CONCLUSION

One of the biggest current threats for public health is bird flu which originated from the animal reservoir. It is uncommon in poultry since it can manifest as anything from a subclinical illness to a highly contagious disease with a high fatality rate. It is still a serious health concern for poultry all over the world. Due to its severe clinical condition and implications on trade, highly pathogenic AI has generally been the most concerning. Since LPAI is more extensively distributed than HPAI and has the potential to develop into HPAI, it also continues to be a worry due to its capacity to spread disease and inflict production losses. As a result, its breakouts have resulted in significant financial losses. Its outbreaks have consequently led to significant economic losses and limitations on the sale of agricultural goods. Due to its extensive wetland areas, which are frequently frequented by migrating birds from Asia and Europe, as well as its illegal cross-border trafficking, Ethiopia is at risk for an AI outbreak. Because of the wildlife reservoir, the virus's flexibility, and the dearth of effective control measures, AI viruses are challenging to eradicate.
On the basis of the foregoing conclusions, the following next directions are suggested:

- It is important to plan and deploy a mechanism for early identification of AI outbreaks.
- For disasters, there should be enabling legislation and an emergency management system (i.e., HPAI incursion).
- There should be prompt medical attention and yearly vaccinations provided.
- To reduce the possibility of the AI virus being introduced into domestic poultry, biosecurity measures should be put in place to avoid interactions between domestic and wild birds.

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Author Contributions Statement

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Teshale Adere	✓	✓	✓	✓		✓		✓	✓	✓	✓			
Mesfin Mukaria	✓	✓	✓	✓		✓		✓	✓	✓	✓			

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

Conflict of Interest Statement

The authors declare that there are no conflicts of interest regarding the publication of this paper.

Informed Consent

All participants were informed about the purpose of the study, and their voluntary consent was obtained prior to data collection.

Ethical Approval

Not Applicable.

Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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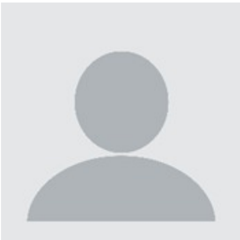
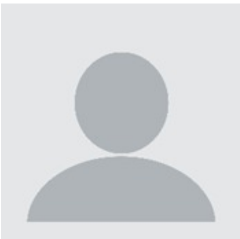
BIOGRAPHIES OF AUTHORS

	**Teshale Adere,** is affiliated with the School of Veterinary Medicine, College of Agriculture and Veterinary Medicine, at Jimma University, Ethiopia. Their academic work focuses on veterinary medicine, contributing to research, teaching, and clinical training within the field. Jimma University is a leading Ethiopian institution known for its strong programs in agriculture and veterinary sciences, and Teshale Adere's role reflects engagement in advancing animal health knowledge, practical training, and academic development within this discipline. Email: tesheadere@gmail.com
	**Mesfin Mukaria,** is affiliated with the School of Veterinary Medicine, College of Agriculture and Veterinary Medicine, at Jimma University, Ethiopia. Their academic work focuses on veterinary medicine, contributing to research, teaching, and clinical training within the field. Jimma University is a leading Ethiopian institution known for its strong programs in agriculture and veterinary sciences, and Mesfin Mukaria's role reflects engagement in advancing animal health knowledge, practical training, and academic development within this discipline.