Editor-in-Chief

Prof. Dr. Sri Maliawan, SpBS
(Scopus ID), (Google scholar)
srimaliawan@unud.ac.id / maliawans@yahoo.com
Department of Neuro Surgery, Udayana University

REVIEW

Bali Medical Journal (*Bali MedJ)* 2021, Volume 10, Number 2: 515-520
P-ISSN.2089-1180, E-ISSN: 2302-2914

Bali Medical Journal
www.BaliMedicalJournal.org
Published by Bali Medical Journal

One Health concept and role of animal reservoir in avian influenza: a literature review

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Ni Luh Putu Harta Wedari[1], I Dewa Made Sukrama[2*], Ni Nyoman Sri Budayanti[2,3], Dwijo Anargha Sindhughosa[4], I Putu Yuda Prabawa[5], Ida Bagus Amertha Putra Manuaba[6,7]

[1]Clinical Microbiology Residency Program, Faculty of Medicine, Universitas Udayana, Sanglah General Hospital, Bali, Indonesia
[2]Clinical Microbiology Department, Faculty of Medicine, Universitas Udayana, Sanglah General Hospital, Bali, Indonesia
[3]Udayana One Health Collaborating Center (OHCC), Universitas Udayana, Bali, Indonesia
[4]Internal Medicine Residency Program, Faculty of Medicine, Universitas Udayana, Sanglah General Hospital, Bali, Indonesia
[5]Clinical Pathology Department, Faculty of Medicine, Universitas Udayana, Sanglah General Hospital, Bali, Indonesia
[6]International PhD Program in Medicine, College of Medicine, Taipei Medical University, Taipei, Taiwan
[7]Medical and Health Education Unit, Faculty of Medicine, Universitas Udayana, Bali, Indonesia

*Corresponding to:
I Dewa Made Sukrama; Clinical Microbiology Department, Faculty of Medicine, Universitas Udayana, Sanglah General Hospital, Bali, Indonesia
sukrama.idm@gmail.com

Received: 2021-02-22
Accepted: 2021-05-19
Published:2021-06-26

ABSTRACT

One Health concept is composed of a collaborative strategy approach in conducting program implementations, policies, legislative aspects, and research studies that involve active participation from various sectors to achieve global public health goals better. It represents a collaborative implementation between clinical, veterinary and government to overcome a specific illness. In Avian influenza, clinical networks should monitor risk factors and clinical signs of severe avian influenza to be controlled or eliminated effectively and quickly. Also, active laboratory surveillance should be conducted, rather than just passive one. Veterinary surveillance possesses high importance in controlling transmission and eliminating avian influenza disease. Well coordination, collaboration, cooperation concerning animal and human surveillance, and disease management involving various health professionals in every sector should be implemented and expanded simultaneously.

Keywords: One Health, Avian Influenza, Collaboration, Surveillance
Cite This Article: Wedari, N.L.P.H., Sukrama, I.D.M., Budayanti, N.N.S., Sindhughosa, D.A., Prabawa, I.P.Y., Manuaba, Amertha, I.B.P. 2021. One Health concept and role of animal reservoir in avian influenza: a literature review. *Bali Medical Journal* 10(2): 515-520. DOI: 10.15562/bmj.v10i2.2532

INTRODUCTION

Nowadays, the risk of the environment is becoming one of the significant challenges due to interconnected complexity in the era of global epidemiology, microbial adaptation, climate change, human demography dynamics, and borderless human movement across nations. These critical facts lead to awareness and a new initiative to work together to focus on health management by synchronizing the health aspect of the ecosystem, human, and animal. So the One Health concept being introduced and developed across the globe. One Health is defined as a collaborative strategy approach in conducting program implementations, policies, legislative aspects, and research studies involving active participation from various sectors to achieve global public health goals better.[1-3] However, notably, many people have a different definition of health according to their perspective. These differences bring the definition of One Health, therefore no firm definition of One Health considering the critical impacts in every aspect such as social, economic, and politics. For some, the objective is achieving; however, animal and ecosystem health are equally important for others. One Health essentially covers these three interdependent components. World Health Organization (WHO) Constitution 1946 defined health as 'a state of complete physical, mental and social well-being, not merely the absence of disease or infirmity'.[1-3] For many years, humans depend on animals for food consumption. In addition, animals play a critical role in transporting and harvesting foods.

Nowadays, some animals become the main reservoir of certain diseases. Thus, the contributions of animals and ecosystem health are significant to human health. Therefore, One Health construction not merely focuses on zoonotic and infectious diseases. It incorporates human activities and events that naturally impact ecosystem health. Therefore, health is defined as broad and interdependent cause and effect among ecosystem, animal, and human by seizing biodiversity, prosperity, well-being, and health security in the One Health paradigm.[2-5] Based on those mentioned above, this review aims to evaluate further One Health concept and the role of the animal reservoir in avian influenza according to the literature.

ONE HEALTH CONCEPT

Particular areas currently work together under the scheme of the One Health approach, e.g., food safety, zoonotic diseases (the diseases that are being spread among animals and humans such as avian influenza, rabies, dengue fever, malaria), and human diseases management. One Health also includes management of antibiotic resistance, the condition resulting from low compliance of finishing antibiotic regimen dosage that makes the change of bacteria resistant to particular antibiotics (Figure 1). One Health is produced since various microbes infecting humans and animals because they live in the same habitat.[2,5,6] Moreover, such an individualistic effort only from one sector is not able to solve and manage the issues. An example can be seen in eliminating avian influenza that will be successfully achieved by targeting the avian animal's group as the virus reservoir and treating the human with antiviral drugs. A wide range of health workers, medical doctors, veterinarians, and other professionals are strongly advised to actively contribute in supporting One Health.[1-3] Preventing or overcoming the outbreaks needs sharing information and efforts beyond one expertise area to the others. Notably, the government sector, researchers, and health workers from the vast range levels (local, regional, national, and international) should apply implementation linkage in response to various health threats (Figure 2).[4-8]

A BRIEF HISTORY OF ONE HEALTH

One Health concept is not a single standing origin in the human aspect. It is a fundamental condition of life on this earth that is re-discovered throughout human history development.[2] It grows from the natural interdependence between humans, animals, land, water, and the ecosystem, an intrinsic part of belief and culture in various civilizations and modern human life. Hippocrates in 460 BCE – 367 BCE, as stated 'On Airs, Waters, and Places,' implicitly affirm the interdependence importance of public health and a clean environment. A few years later, Aristotle (384 BCE – 322 BCE) established the idea of comparative medicine based on general features across different species (people and mammals) in his book titled 'Historia Animalium.' 2,000 years later, an Italian physician, Giovanni Maria Lancisi (1654 – 1720), signified the fundamental role of the environment in diseases spreading to humans and animals. Rudolf Virchow (1821 – 1902), a German physician, pointed 'zoonosis' and stated, "Between animal and human medicine there are no dividing lines – nor should there be. The object is different, but the experience obtained constitutes the basis of all medicine".[2] From that quote, it can be seen that humans and animals only different in their details. Environmental factors are in health determinants outcomes. Calvin Schwabe (1927 – 2006) and James Stele (1913 – 2013) from the USA successfully promoted human and animal health ecological nature. Steele also initiated veterinary public health known as the Centers for Diseases Control and Prevention (CDC) in the USA. Being said, One Health has many historical roots but a common concept. The relationship between human and animal health as well as to the environment is not a new thing. However, the molecular era and rapid development of technology have made us aware that drastic environmental changes trigger emerging infectious diseases sourced or transmitted by animals.[2]

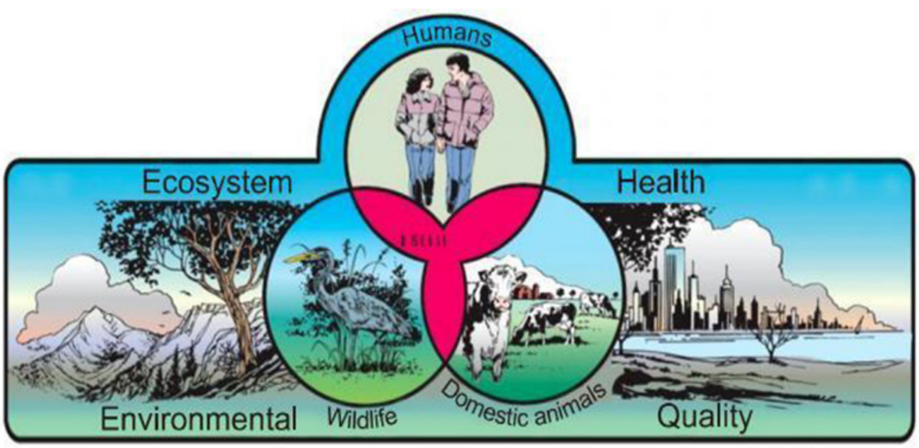

Figure 1. Illustration of One Health concept.[3]

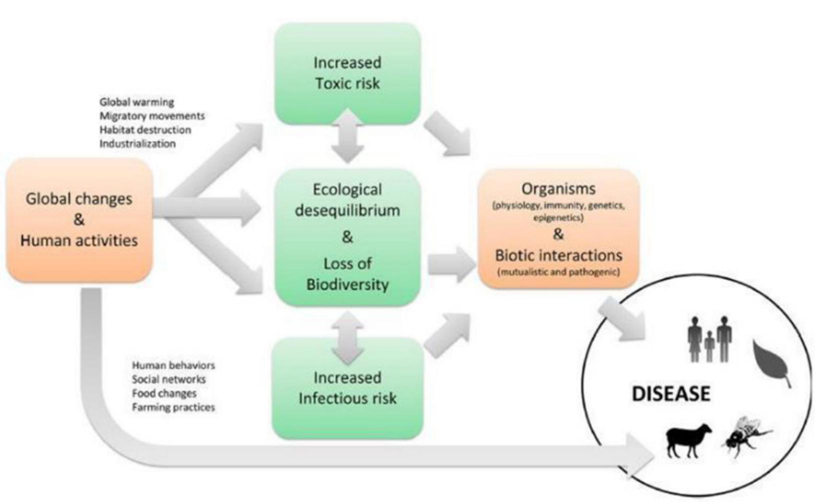

Figure 2. Interconnected of human, animal, and environment in zoonotic disease.[4]

ONE HEALTH IMPLEMENTATION

Role of Animal Reservoir in Avian Influenza

Avian influenza is caused by *influenza A virus* species, *influenza virus A* genus, *Orthomyxoviridae*. The virus is also called type influenza. They are classified into some subtypes according to surface protein, namely hemagglutinin (HA) and neuraminidase (NA). Nowadays, there are H1 to H16 (16 hemagglutinins) and N1 to N9 (9 neuraminidases) have been identified. HA and NA are the main targets of an immune response.[3-8] Influenza A has many variants. Two viruses share the same subtype related to each other due to genetic reassortment and mutation causing moderate changes of HA and NA, the process called antigenic drift. If HA and NA have permanently changed, the immune response is not able to protect the host anymore. Conversely, genetic reassortment results in whirlwind changes. Influenza A has 8 gene fragments in which if two different viruses infect the same host cell, the segment of a gene will be packed into a single virion. Significantly, genetic reassortment can create a virus carrying new HA or new NA or both, called antigenic shift, causing the immune response to be evaded entirely. Afterward, if the newly established species circulated throughout time, antigenic shift and antigenic drift will create abundance variants of virus (Figure 3).[3-8]

Influenza A/H5N1 virus was first isolated from the goose in Guangdong Province, China, in 1996. Consequently, the virus spread has led to massive poultry death along with human respiratory infections was happened in Hong Kong 1997.[9-11] In 2003, the virus has been spreading continuously to Southeast and Eastern part of Asia, Russia, Africa, and some parts of India; therefore, it was recognized as a biggest zoonotic disease affecting poultry and birds. Influenza A (H5N1) was found to be highly contagious and caused death in birds. The spreading became evenly more massive and rapid due to poultry trade and wild aquatic bird migration. Classification into low pathogenic (LPAI) or high pathogenic (HPAI) based on virus ability to cause severe disease in inoculation of young chickens or specific genetic components associated with HPAI high virulence.[10,11] LPAI usually caused milder infection overall avian groups. Avian influenza viruses are shed in birds' feces and respiratory secretion. Large amounts of viruses are transmitted from the feces of aquatic birds, like waterfowl.

However, some viruses have already adapted to *gallinaceous*; for example, an H5N1 HPAI Asian lineage isolate possesses higher amounts of viruses in respiratory secrets than in feces. In addition, some LPAI has been found primarily on the respiratory secrets of waterfowl.[10,11] After entering the poultry or birds, the avian influenza virus will be spread to the farm either by fecal-oral route or aerosol as proximity among birds. It also has been identified in yolk and egg albumen of chickens, quail, and turkey infected with HPAI viruses. Duration of contagiousness in birds is varied across species, and some usually shed LPAI for the first week, some shed LPAI and HPAI for a couple of weeks. Transmission to humans occurred by close contact with infected birds. Furthermore, H5N1 HPAI cases associated with raw meat consumption of infected birds and two cases have been reported after eating undercooked duck blood in Vietnam, 2005.[11,12]

Even though avian influenza viruses are adjusted to spread in a particular host, it is infrequently able to infect other species. Mostly, the influenza A virus, which could not be spread among certain species, will go and disappear. However, some influenza viruses, whole or after reasserted with the others, may continue to spread within the new host. Hence, some influenza A viruses able to adapt to life and spread in mammals like pigs, humans, and dogs, with the birds still its progenitor either recently happened or over the past time.[3-7] Most LPAI are perpetuated in wild birds, especially in wetland and other watery habitats. Some LPAI species could also infect terrestrial land wild birds under certain circumstances. However, it is very rarely the infection that may occur. Few of the species of wild birds could preserve the viruses for a long period of time, whereas the rest may be at the point where the viruses can be controlled in the host. Birds that migrate for long away potentially trading off and interchange viruses subtype at various stages of their migration.[3-7] Conversely, HPAI viruses are uncommon to be identified in wild

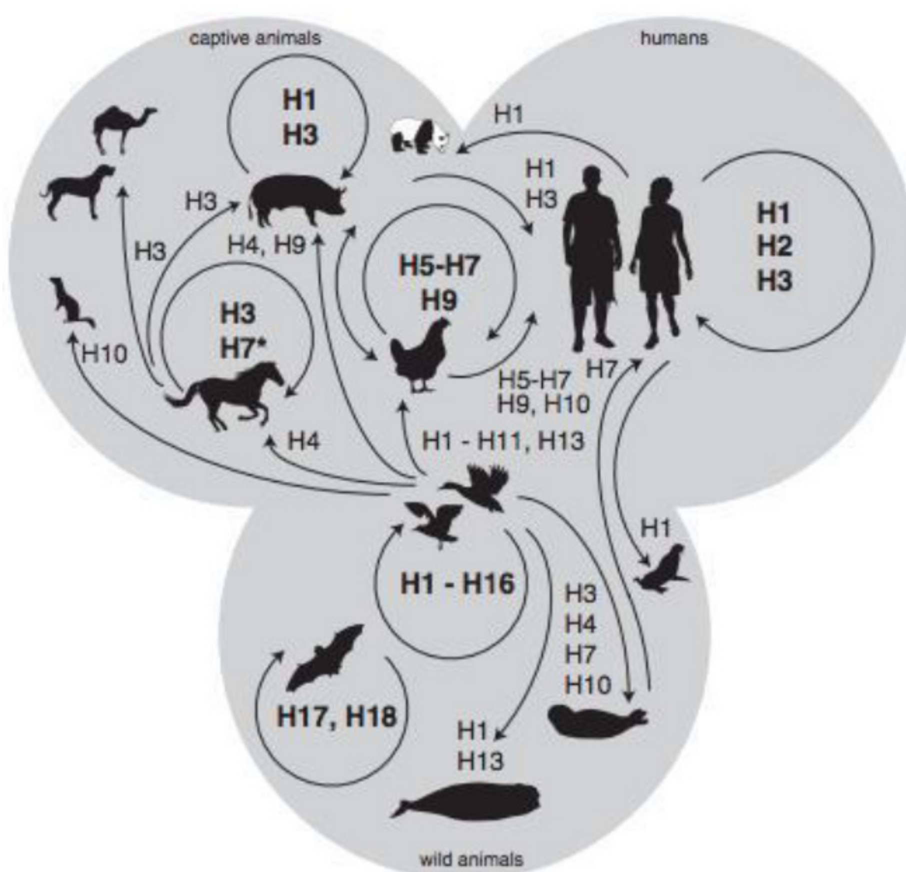

Figure 3. Avian influenza reservoir and inter species transmission.[1]

birds, even though in some conditions they could be isolated during an avian influenza outbreak in poultry, including cases that happened in Asian countries in 1960 with H5N1 lineage along with the reassortments. H5N1 was remaining the leading cause of high death cases in the wild birds' population.[10-11]

During the circulation of LPAI viruses in wild birds, it can be fetched to domestic poultry, but its dissemination would not be efficient. Still, it then will adapt to a new host and LPAI continue to transmit. Under particular circumstances, e.g., the viruses contain H5 or H7, they have a high probability of being HPAI type. If the viruses have successfully adapted to poultry, they are uncommonly established again to wild birds. Either HPAI or LPAI has already been found in few domestic birds, e.g., ducks, ratites, geese, cage birds, and pigeons. Occasionally, avian influenza H5N1 HPAI infections have been found in various mammals, including dogs, cats, horses, and donkeys.[12-18]

Infected domestic poultry is highly potential in introducing avian influenza, particularly during the HPAI incubation period. Eggs to be used for consumption could be infected by avian influenza, but they rarely contact poultry anymore. In such circumstances, the packaging components along with the trays have a much higher risk. Therefore, egg or other poultry products are obligatory to go through heat-up treatment in order to inactivate the viruses. Regarding wild birds that are captivated, import and quarantine have been strengthened, so only those from limited countries are approved. Therefore, it could be known that spreading risk is due to the illegal import of domesticated wild birds.[12-18]

ONE HEALTH APPROACH TO AVIAN INFLUENZA

Clinical Surveillance

Clinical networks should monitor risk factors and clinical signs of severe avian influenza to be controlled or eliminated effectively and quickly regarding human health aspects. Laboratory methods advancement to diagnose the disease rapidly is supposed to confirm and identify the diagnosis, virus strain, and appropriate antivirals recommendation and drug resistance (if any). Most respiratory tract infections present mild symptoms than severe clinical signs, which means determining the true positive influenza rate is strongly needed. The influenza virus infections vary according to the season, age groups infected, and the underlying health status, leading to clinical surveillance. For instance, laboratory tests need to differentiate variability in viral causes. Real-time comprehensive surveillance such as through ICU registration, hospitalization due to respiratory tract infection, or outbreak investigation in an elderly care health facility is strongly required to conduct appropriate treatments further.[19,20]

Laboratory Surveillance

Avian influenza (A/H5N1 and H1N1 2009) are quarantined cases in New South Wales, Australia, and other countries. However, active laboratory surveillance should be conducted, rather than just passive one. Clinical diagnosis of avian influenza is improved through nucleic acid tests and rapid antigen tests. However, it potentially causes viral isolation to become less frequent, but the isolates remain needed for genetic and antigenic surveillance. For decades, the WHO Global Influenza Network has been conducting influenza isolates surveillance involving five collaboration centers and 110 national centers. In Australia, the WHO center is based in Melbourne and three National Influenza Centers in Sydney. They collaborate with other laboratories in Asia Pacific Region to contribute influenza strains surveillance data at the international level.[20-23]

Veterinary Surveillance

For instance, in Australia, bird populations are mostly to be free from the influenza virus. However, semi-free-range ducks are still highly possible to be in contact with wild aquatic birds. It can be said general population of chicken in Australia are free from influenza A infection. However, when avian influenza infected the poultry, prominent outbreak management was followed rapidly, such as by intervention to bird populations and domesticated poultry on the farm. Information and education by public health agencies to the public community about the spreading risk between animals or humans have reduced the transmission probability significantly. Therefore, veterinary surveillance possesses high importance in controlling transmission and eliminating avian influenza disease. Looking at laboratory view and perspective, avian influenza H5N1 epidemics over various countries worldwide encourage enhancement and betterment in diagnostic capability and readiness of veterinary medical agencies and public health sectors. Additionally, contact and interaction between animals and humans in laboratory aspects have been improved lately under the One Health approach. Continuous support for interconnectedness between animal and human is required, particularly in undertaking an effort to identify and analyze in case there is any new outbreak of emerging disease.[20-26]

Human and veterinary collaboration

In the veterinary aspect, currently, no specific treatment for animals infected. In some countries, domesticated poultry or wild birds infected with HPAI have to be depopulated. In contrast, people infected with LPAI are disposed of in a particular manner according to virus type and country. Veterinarians who suspected avian influenza cases in their respective countries shall follow the guideline to reporting to related agencies or authorities. In addition, abnormal mortality in birds is mandatory to be reported. To prevent the disease from occurring and spreading, well-established biosecurity and hygiene, including preventable contact with other birds or poultry as well as environmental vectors. All-in and/or all-out should be applied in flock management and the birds shall not be returned to the farm from markets or other sources.[20-23] Humans are informed and encouraged to prevent contact with birds infected with avian influenza symptoms. Vaccines include inactivating the whole virus and the latest updated recombinant vaccines, mainly produced for poultry, e.g., chicken and turkey.

Regarding suppressing the clinical signs, few vaccines can increase resistance to infection, at the same time, decrease excretion and transmission of the virus.

However, clinical protections are not importantly associated with decreasing virus shedding and many birds still susceptible to infection. Therefore, vaccination will mask the infections if well-established surveillance is not applied continuously. In various countries, vaccines are administered routinely in order to protect poultry and bird species in the zoo from HPAI such as H5N1.[20-23]

Meanwhile, avian influenza in a human is varied according to the severity degree of the disease. Mainly, infections by the H5N1 HPAI virus caused symptoms in around 5-7 days, even though the incubation period maybe 8 days until 17 days. Antivirals such as neuraminidase inhibitor (oseltamivir, zanamivir, laninamivir, peramivir) and adamantanes group (rimantadine and amantadine) are considered most effective towards influenza A viruses if they are administered at first 48 hours from the beginning of clinical signs. Oseltamivir is able to increase survival chances in patients with H5N1 and H7N9 infection. However, some side effects should be monitored, e.g., gastrointestinal discomfort and central nervous system (CNS) related symptoms.[20-25] Notably, the resistance of influenza antivirals possible to rapidly develop and could emerge within the treatment duration. Currently, the H5N1 HPAI strain in Asian countries is sensitive to oseltamivir but resistant to the adamantanes group. Protective ways to prevent avian influenza should begin from controlling the source of infection such as eliminating the HPAI virus, close the poultry markets infected, avoid contact with infected animals, good hygiene and sanitation such as handwashing properly (e.g., before eating or rubbing eyes) and use personal protective equipment (PPE) in any certain conditions.[20-25]

Since the HPAI virus has been identified in meat and eggs of few avian groups, proper food handling management is highly important, especially if work with raw poultry or raw bird product in an endemic region. It is mandatory to cooked poultry products entirely before consuming them. Sanitary precaution measures and cooking methods recommended to kill *Salmonella* and other meat pathogens can be adopted. They are shown to be sufficient to eliminate avian influenza viruses, as with eggs, they should be cooked till yolks and white parts are firm. Antiviral prophylaxis administration is recommended in certain unusual cases, e.g., in people who are culling H5N1 HPAI infected birds, a biologist with close interaction with avian animals, and bird hunters.[26-30] Moreover, vaccination is also recommended for human influenza to reduce the reassortment risk between animal and human influenza viruses. Finally, it is very important that people who became ill inform the doctors in regard to any avian influenza virus exposure. Simultaneous communication enhancement at various levels, i.e., regional, national, or international, will surely assist in supporting rapid zoonotic disease containment. Furthermore, collaboration expansion between human and veterinary medicine experts must be encouraged at various settings, i.e., clinics, diagnostic laboratories, research centers, and health promotion units.[26-30]

CONCLUSION

The interface among human populations, animal populations, and ecosystems has been continually changed and emerged. One Health is embracing the constant problems complexity of human-animal-environment interaction such as in avian influenza zoonotic disease. Well coordination, collaboration, cooperation regarding animal and human surveillance, and diseases management involving various health professionals in every sector should be implemented and expanded simultaneously. One Health is currently widely acknowledged by many institutions at the national and international level to be the most encouraging and constructive strategy addressing issues those cross-human health, animal, and environment.

CONFLICT OF INTEREST

No conflicts of interest exist with regard to this review article.

ETHICS CONSIDERATION

This review article has the following COPE and ICMJE guidelines regarding publication ethics.

FUNDING

None.

AUTHOR CONTRIBUTION

All authors equally contribute to the study from the conceptual framework, data acquisition, data analysis until reporting the study results through literature review publication.

REFERENCES

1. Short KR, Richard M, Verhagen JH, van Riel D, Schrauwen EJ, van den Brand JM, et al. One Health, multiple challenges: The inter-species transmission of influenza A virus. One Health. 2015;1:1-13.
2. Evans BR, Leighton FA. A history of One Health. Rev Sci Tech. 2014;33(2):413-420.
3. Sleeman JM, DeLiberto T, Nguyen N. Optimization of human, animal, and environmental health by using the One Health approach. J Vet Sci. 2017;18(S1):263-268.
4. Eussen BGM, Schaveling J, Dragt MJ, Blomme RJ. Stimulating collaboration between human and veterinary health care professionals. BMC Vet Res. 2017;13(1):174.
5. World Health Organization. Review of latest available evidence on potential transmission of avian influenza (H5N1) through water and sewage and ways to reduce the risks to human health. World Health Organization. 2006. [Available at: https://apps.who.int/iris/handle/10665/204275]
6. Hassan MM, Hoque MA, Debnath NC, Yamage M, Klaassen M. Are Poultry or Wild Birds the Main Reservoirs for Avian Influenza in Bangladesh?. Ecohealth. 2017;14(3):490-500.
7. Capua I, Alexander DJ. Avian influenza vaccines and vaccination in birds. Vaccine. 2008;26 Suppl 4:D70-D73.
8. Kaye D, Pringle CR. Avian influenza viruses and their implication for human health. Clin Infect Dis. 2005;40(1):108-112.
9. European Food Safety Authority. Animal health and welfare aspects of avian influenza and the risk of its introduction into EU poultry holdings. The EFSA Journal. 2008;715:1-162.
10. Parry J. Vaccinating poultry against avian flu is contributing to spread. BMJ. 2005;331(7527):1223.
11. Destoumieux-Garzón D, Mavingui P, Boetsch G, Boissier J, Darriet F, Duboz P, et al. The One Health Concept: 10 Years Old and a Long Road Ahead. Front Vet Sci. 2018;5:14.
12. Dwyer DE, Kirkland PD. Influenza: One Health in action. N S W Public Health Bull. 2011;22(5-6):123-126.
13. Xie T, Liu W, Anderson BD, Liu X, Gray GC. A system dynamics approach to understanding the One Health concept. PLoS One. 2017;12(9):e0184430.
14. Mattar C, Ore AS, Fagerberg SK, Ramachandran R, Tuan W, Wiley E, et al. One Health and Antimicrobial resistance. World Medical Journal, 2016;62(3):108-111.

15. Bidaisee S, Macpherson CN. Zoonoses and One Health: a review of the literature. J Parasitol Res. 2014;2014:874345.
16. Baum SE, Machalaba C, Daszak P, Salerno RH, Karesh WB. Evaluating One Health: Are we demonstrating effectiveness?. One Health. 2016;3:5-10.
17. Kahn LH. Perspective: The one-health way. Nature. 2017;543(7647):S47.
18. Kakkar M, Abbas SS; Roadmap to Combat Zoonoses in India (RCZI) initiative. One Health: moving from concept to reality. Lancet Infect Dis. 2011;11(11):808.
19. Peiris JS, Cowling BJ, Wu JT, Feng L, Guan Y, Yu H, et al. Interventions to reduce zoonotic and pandemic risks from avian influenza in Asia. Lancet Infect Dis. 2016;16(2):252-8.
20. Beigel JH, Farrar J, Han AM, Hayden FG, Hyer R, de Jong MD, et al. Avian influenza A (H5N1) infection in humans. N Engl J Med. 2005;353(13):1374-85.
21. Tarigan S, Wibowo MH, Indriani R, Sumarningsih S, Artanto S, Idris S, et al. Field effectiveness of highly pathogenic avian influenza H5N1 vaccination in commercial layers in Indonesia. PLoS One. 2018;13(1):e0190947.
22. Buchy P, Mardy S, Vong S, Toyoda T, Aubin JT, Miller M, et al. Influenza A/H5N1 virus infection in humans in Cambodia. J Clin Virol. 2007;39(3):164-8.
23. Watanabe Y, Ibrahim MS, Ellakany HF, Abd El-Hamid HS, Ikuta K. Genetic diversification of H5N1 highly pathogenic avian influenza A virus during replication in wild ducks. J Gen Virol. 2011;92(Pt 9):2105-2110.
24. Shimizu K, Li C, Muramoto Y, Yamada S, Arikawa J, Chen H, et al. The nucleoprotein and matrix protein segments of H5N1 influenza viruses are responsible for dominance in embryonated eggs. J Gen Virol. 2011;92(Pt 7):1645-1649.
25. Lee K, Brumme ZL. Operationalizing the One Health approach: the global governance challenges. Health Policy Plan. 2013;28(7):778-785.
26. Fasanmi OG, Odetokun IA, Balogun FA, Fasina FO. Public health concerns of highly pathogenic avian influenza H5N1 endemicity in Africa. Vet World. 2017;10(10):1194-1204.
27. Dudley JP. Public health and epidemiological considerations for avian influenza risk mapping and risk assessment. Ecology and Society, 2008;13(2):21.
28. Reperant LA, MacKenzie J, Osterhaus ADME. Periodic global One Health threats update. One Health. 2015;2:1-7.
29. Landford J, Nunn M. Good governance in 'One Health' approaches. Rev Sci Tech. 2012;31(2):561-575.
30. Pawestri HA, Susilarini NK, Puspa KD, Ikawati HD, Adam K, Nugraha AA, et al. Genetic analysis of the complete genome of influenza A (H1N1) pdm09 during the first wave of the pandemic season in Indonesia. Bali Medical Journal. 2017;6(3):476-485.