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Prevention and Control of Avian Influenza in Poultry Production

Aamir Sharif
Government Poultry Farm, Bahawalpur,
Directorate of Poultry Research Institute, Rawalpindi,
Livestock and Dairy Development Department,
Government of the Punjab, Lahore – Pakistan
Email: aamirsharifcheema@gmail.com

Muhammad Umer
Lasbela University of Water,
Agriculture and Marine Sciences,
Uthal, Lasbela – Pakistan

Tanveer Ahmad
Department of Clinical Medicine and
Surgery, University of Agriculture,
Faisalabad, Pakistan.

***Abstract* – Avian influenza is highly infectious and contagious disease of poultry and has caused numerous losses to the poultry industry. The mutating nature of avian influenza virus has added the concerns of poultry farmers about pathogenicity and outbreak diseases due to AI. Poultry industry has faced huge economic losses due to outbreak of AI in Pakistan. Apart from birds humans are also at risk of AI. Regular sero-monitoring along with strict quarantine measures are pre-requisite for prevention and control of Avian Influenza in poultry flocks.**

***Keywords* – Avian Influenza, Poultry, Signs, Symptoms, Prevention, Control.**

I. Introduction

Poultry industry is continuously expanding in Pakistan. Along with that poultry industry is encountered with challenges of disease outbreaks in commercial poultry flocks. Newcastle disease (ND), Infectious Bursal Disease (IBD), Infectious Coryza, Fowl Cholera, Coccidiosis and the Avian Influenza (AI) (bird flu) are economically important diseases of poultry birds. For economical and profitable poultry farming it is pre-requisite that birds should be prevented from contagious and non-contagious diseases.

Avian influenza (AI) is an acute, contagious, highly fatal disease of chicken, turkey, pheasant, quail, duck, geese, guinea fowl, water-fowl, ostrich and wide variety of other wild birds (Hagan and Brunner, 1988; Clavijo *et al.,* 2003). Layers, broilers and layer breeders are affected with avian influenza virus (Shane, 2002). AI is caused by viruses of orthomyxoviridae family. Migratory birds are the reservoir of strains of avian influenza viruses. In past, the AI has caused the considerable economic losses to the poultry industry in America and Europe. Avian influenza has also inflicted heavy economic losses to commercial poultry production in Pakistan after first report in of H_7N_3 in 1995 (Naeem and Hussain, 1995; Naeem *et al.,* 1999; Swayne and Suarez, 2001). It is said that possibility of spread of Avian influenza is still predictable in Pakistan due to certain reasons that regular vaccination against avian influenza is not carried out in Pakistan, the bio-security protocols are very weak at most of the poultry farms, movements of poultry farm workers are unrestricted across the poultry raising areas, the vehicles, utensils, farm equipments etc. are not properly disinfected to avoid the spread of avian influenza virus, etc. The information elaborated below would be helpful to understand the need and importance of prevention and control of avian influenza in poultry flocks.

II. Types of Avian Influenza Virus

Avian influenza is caused by a virus known as orthomyxovirus. There are different types of this virus A, B and C. The subtype of Avian Influenza virus 'A' which are H_5 and H_7 cause high mortality in birds. AI virus is of three types viz., A, B and C. Influenza 'A' virus is divided on the basis of the antigenic relationships in its surface, glycoproteins, into haemagglutinins (H) and neuraminidase (N) subtypes (Cox *et al.,* 2000; Lu *et al.,* 1982). At present there are 16 H subtypes and 9 N subtypes, these can occur in H_xN_y combinations (Alkhalaf, 2010; Banbura *et al.,* 2000; Fouchier *et al.,* 2005). Influenza type 'A' viruses are roughly spherical or filamentous particles, 80-120 nm in diameter. The nucleo-capsid has a helical symmetry and is enclosed within a protein matrix and is covered by two types of glycoprotein projections or spikes with which are associated with Haemagglutinin (H) and Neuraminidase (N) activities of virus. Influenza virus A and B viruses are enveloped with segmented genome made of eight single stranded RNA segments (Kamps *et al.,* 2006).

III. Classification of AI Virus

The genetic makeup of avian influenza virus mutates again and again and based on it, the virus causes low to high pathogenicity in the poultry flocks. Based on the pathogenicity of disease Avian influenza is classified as Low Pathogenic Avian Influenza (LPAI) and High Pathogenic Avian Influenza (HPAI). AI can be highly pathogenic (HP) and lowly pathogenic (LP) depending on disease symptoms i.e. severity of illness and fatality. Only type 'A' viruses of H_5 and H_7 subtypes are the cause of highly pathogenic avian influenza (HPAI). HPAI H_5N_1, often referred to as the "Asian" H_5N_1, is having worldwide importance. LPAI H_5N_1, often referred to as the "North American" H_5N_1, is of less concern. The AI virus of type H_5N_9 is proved to be less virulent for chickens than turkeys (Narayan, 1969). Low Pathogenic strain may convert to high pathogenic strain through antigenic drift and shift (Vander *et al.,* 2003). So it is categorized into High Pathogenic Avian Influenza (HPAI) and Low Pathogenic Avian Influenza (LPAI). Fowl plague, which is categorized in HPAI, is one of the most nefarious members of the AI viruses with H_7 antigen and any of several N antigens. Recently H_5 is also included in HPAI (Lu *et al.,* 2004).

IV. Losses Due to Avian Influenza

The economic losses of Avian Influenza are well known. For last few decades the AI viruses are causing substantial loses in domestic / rural poultry throughout the world. Outbreaks of AI have also caused heavy economical losses to commercial poultry industry of Asian countries. The AI viruses have emerged as much more economically serious pathogens of the poultry industry, than they had been in the previous years (Chen *et al.,* 2004). Calculation of economic impact includes all factors of high cost of production, e.g., medication extra feed, extra care, quarantine measures, vaccines, decreased carcass quality, cleaning and sterilizing, and loss of local and international trades and many other factors responsible for high cost of production in AI virus affected flocks (Calnek, 1992). AI is cosmopolitan in occurrence that affects the chickens of all ages. Depending upon the pathogenicity of AI virus the mortality ranges from 30% to 100% in poultry flocks. AI virus has potential to disrupt commercial poultry production (Shane, 2002) and is common in poultry in many countries of the world. In Pakistan AI virus of H_7N_3 type affected broiler breeders and killed about one million birds in 1994 (Naeem and Hussain, 1995). The AI virus of H_9N_2 type has also caused low production and immuno-supression in breeders and commercial layers in different areas of Punjab in 1996 and the same strain (H_9N_2) was then after used in local vaccines for vaccination against AI (Muhammad *et al.,* 1997). AI virus of H_9 type caused respiratory syndrome in broilers and layers, and resulted in the morbidity of 100% and mortality of 50% in broilers and layers flocks, respectively. The AI viruses of subtype H_3N_1 caused 10-12% mortality in chickens in 1977 in USSR (Kovalchuk-lvanyuka *et al.,* 1975). The AI virus of H_9 sub-type had caused 100% morbidity and 50% mortality in affected birds (Muhammad *et al.,* 2001; Hagan and Brunner, 1988). AI virus of H_9N_2 subtype did not caused considerable mortality in the broiler breeders and commercial layer flocks but caused low production and suppression of the immune system and rendered them susceptible to other bacterial and viral infections in Punjab province of Pakistan (Muhammad *et al.,* 1997). H_5N_1 is more virulent and causes 100% mortality in poultry flocks. Economic losses of Rs.I532.56/- million due to AI virus in the form of mortality, medication, vaccination and losses of eggs, meat and chicks in have been recorded in Pakistan (Bhatti, 1995). AI viruses resulted in losses of over 409 million US dollars in Pennsylvania (USA) (Lasely, 1987). In 1975, Federal Govt. of USA had spent more than 10 millions to eradicate the AI from Minnesota State (Poss and Halvorson, 1987). The threat of economic and political crisis to poultry industry due to outbreaks of AI is still predictable.

V. Survival of AI Virus

AI virus can survive in cool and cold environment for a long time and on getting chance can spread the disease in poultry flocks. AI virus cannot survive for long time on warm and high temperature environments. The virus persists in water for four days at 22°C and over 30 days at 0°C (Webster *et al.,* 1978). AI virus can remain viable for a considerable period at moderate temperatures and can survive for long time in frozen material. The incubation period of virulent avian influenza in laboratory chickens is usually 3 to 4 days (Shinya *et al.,* 1995).

VI. Prevalence of AI in Poultry Flocks

In non-vaccinated broiler flocks of age between 26 – 38 days the sero-prevalence of AI at rate of 20, 50 and 30% has been recorded in farms located at Wazirabad road, Pasroor road and Lahore road respectively in District Gujranwala of Pakistan (Cheema *et al.,* 2011). Domestic or wild duck, is an important species of birds, which is highly susceptible to AI viruses. $H_{12}N_6$ has been isolated from domestic ducks in England in 1956. An isolate from domestic ducks in Minnesota was also identified as an influenza virus in 1967 (Koppel *et al.,* 1956). The prevalence of AI infections in ducks during the fall season migration averaged about 5.9% (Slemons *et al.,* 1991). It is also reported that the chicken flocks with a previous history of respiratory tract infection and some without overt clinical respiratory signs had seroconverted to H_9N_2 type of AIV (Naeem *et al.,* 2003). Older age birds become more susceptible to AIV than the younger ones and the recovered birds show poor growth in their future life (Burgh, 1996; Cheema *et al.,* 2011). Avian influenza in 60 weeks old broiler breeder flocks was also reported (Naeem and Hussain, 1995). In some of the outbreaks of AI the virus involved was of H_7 type (Esterday and Hinshow, 1991; Naeem and Hussain, 1995; Cheeema *et al.,* 2011). Under the field conditions and with the low infecting dose, the incubation period of AI virus may be range from 5 to 7 days. However the incubation period of AI virus may vary depending on the type of virus host species and the severity of exposure (Cheema *et al.,* 2011). High prevalence (12.80%) of AI in birds of more than 34 weeks of age group and low (3.13%) in birds of 8-12 weeks of age is also recorded (Nooruddin *et al.,* 2006). Lack of vaccination, poor management and lack of standard biosecurity result in spread of AI in birds (Naeem *et al.,* 1999).

VII. Transmission of AI in Poultry Flocks

AI can spread in poultry flocks and birds in many ways. In most of the cases the AI virus transmits from diseased to healthy birds. AI infected birds can contaminate the water or feed, and can affect healthy birds. Moreover, due to close interaction of diseased and healthy birds the AI virus can transfer to healthy birds. As AI infected birds exhibit the symptoms of respiratory illness and cold, thus along with sneezing and coughing large amount of AI virus is excreted with nasal discharge and exhaled air which contaminates the water, feed, utensils and environment and the healthy birds can get diseased. Apart from this large quantity of AI virus is excreted in the fecal droppings of diseased birds and can cause the spread of

AI. Human involvement can also be a factor in the spread of AI at poultry farms. The workers, labourers, assistants, sanitary workers and poultry attendants at poultry farm may cause the spread of AI virus through their clothes, hands, shoes, etc. In layer farms the egg collecting utensils, laying nests, egg crates and equipments related to egg can also cause the spread of AI. It is also observed that AI virus rapidly contracted from infected to susceptible turkeys that were placed in contact but not to those which were placed one meter off from these infected turkeys floor in the same room (Narayan, 1969). AI virus of A/duck/Victoria/76 H_7N_6 type spreads quickly and infects all chickens which contact with virus while AI virus of A/chicken/Victoria/75 H_7N_6 subtype spread slowly and fails to infect contact birds (Westbury *et al.,* 1981). Due to poor biosecurity and intensive farming, the AI started spreading in Pakistan in broiler flocks and due non-usage of vaccine the AI became endemic in Karachi during 1999 (Naeem *et al.,* 1999). AI virus can also be transmitted to healthy birds directly through contact with the secretions and excretions of infected birds as well as contact with carrier migratory birds and indirectly through contact with contaminated equipment, egg crates, vehicles, manure etc (Dochia, 2006). Very small quantity of contaminated feed, water or manure can infect thousand of birds. At some places humans were also held responsible for the spread of AI outbreaks (Pereira *et al.,* 1965; Becker, 1966; Lovov *et al.,* 1984; Iftimovici *et al.,* 1980). AI viruses are excreted through the respiratory tract, conjunctiva, and the droppings, and the likely mode of transmission includes both direct contact between infected and susceptible birds and indirect contact through the aerosols and contaminated fomites. Since infected birds can excrete high levels of virus in their feces, transmission may be accomplished by anything contaminated with the feces, e.g. birds and mammals, feed, water, equipment, supplies, cages, clothes, delivery vehicles, etc, through these agencies viruses are readily transported to other areas. The role of the veterinary professionals in transmission cannot be overlooked and support, marketing services, infected poultry products and the humans can be the main sources for the spread of AI (Homme *et al.,* 1970). AI viruses are transmitted horizontally but no evidence has indicated that the viruses can be transmitted vertically. Scientists also failed to isolate the AI viruses from hens eggs that were experimentally infected with H_5N_2 virus (Beard *et al.,* 1984) and low incidence of AI is recorded in the chicks whose parent flock had suffered from AI in their later ages (Cheema *et al.,* 2011). The AI virus is generally found in wild birds. Apart from it the water fowl and migratory birds can also cause the spread of disease to other birds and act as carrier of virus. The domestic and commercial poultry can be affected from wild and carrier birds having AI infection. The water fowls found inside the ponds and along with the marshy places also cause the spread of AI.

VIII. Signs and Symptoms of AI

The AI affected birds exhibit wide range of signs and symptoms of disease. While infection with HPAI virus the birds exhibit reduction in feed intake, become lazy, dull and lethargic, along with increased mortality rate. The rate of mortality also depends on the type of birds, environment, external stress to the birds, concurrent disease, respiratory congestion, etc. The bird exhibits labored breathing along with it there is discharge from the nose and eyes. There may be inflamed head and nostrils of birds, along with dark coloration of comb and wattle, imbalances in the nervous system along with diarrhea. There is decreased egg production of layer poultry flocks, affected birds lay weak shelled, shell less eggs, along with uneven surface of egg shells. In case of attack of Highly Pathogenic Avian Influenza (HPAI) virus infection there may be very high rate of mortality of 90 – 100% in birds, on the other hand in case of attack of LPAI the birds only exhibit clinical signs and symptoms of flu and coryza of low category. The birds dying of AI exhibit swelling of head, face, legs and neck. The clinical signs of AI are highly variable. In HPAI, some time birds dye without showing any clinical sign (Ficken *et al.,* 1989), birds exhibit nervous signs (Kobaayashi *et al.,* 1996), edema of the face and comb region (Acland *et al.,* 1984). The differences in signs and symptoms of AI may be attributed to the difference in virulence of the infecting strains. In per acute cases birds also found dying without any predisposing illness along with edema of the face and comb region, vesicles and necrosis of the comb (Ficken *et al.,* 1989; Cheema *et al.,* 2011). Some times AI causes an asymptomatic infection, and some time an acute, fatal disease of chickens, turkey and many other avian species. LPAI virus occurs naturally in wild birds and in most cases causes no signs of infection or only minor symptoms in birds. HPAI is often fatal in chicken and turkeys and has importance of economic concern. The disease due to HPAI has sudden onset (after incubation period of 2 – 3 days) in birds. Fever, depression, decrease or loss of feed intake, prostration, lethargy, coughing, sneezing along with the nasal discharge, nasal discharge along with blood comes out while pressing the nose, gasping, muscle tremors, drooping wings, swelling and edema of head, eyelids, comb, wattles and neck, inflammation and discoloration of hock joint, purple discoloration of the wattles, combs and legs, progressive inflammation of the respiratory mucous membrane, lack of coordination, paralysis, resulting death of birds, and some times death without any clinical signs may be common sings and symptoms of AI infection. Symptoms of varying degree can be observed based on the type or subtype of infecting AI virus in poultry birds. In case of layer birds there is rapid drop in egg production. Production of soft-shelled, misshapen or shell less eggs may also be evident of AI infection.

IX. Gross Leisions of AI

The effected birds exhibited hyperemic trachea and congested lungs while in the complicated cases other lesions like peritonitis, enteritis and hepatitis can also be observed (Muhammad *et al.,* 2001; Numan *et al.,* 2008). The meat becomes darkened. The internal organs become inflamed and blood spots can also be seen in them.

X. Steps for Prevention and Control of AI

While dealing with live poultry birds or poultry meat following measures can be adopted for prevention and control of AI.

A. Strict biosecurity

The general cleanliness and hygienic conditions of poultry farm must be maintained and biosecurity measures should be strictly adopted. The interaction between poultry and other birds should be reduced so that spread of AI may be reduced from wild and free flying birds. The entry of sparrows inside the poultry farm may be stopped which contaminate the feed and water and may cause the spread of AI in birds. There should be strict bio-security at the farm, the access of rodents, and other wild birds should be avoided. The dead birds should be buried, burned or disposed off properly. Eggs from the infected flock of poultry should be destroyed. Establishment of protection zone of three kilometers and surveillance zone of five kilometers around the farm with confirmed diagnosis of AI virus in the birds, along with killing of all poultry at the spot should be done. The poultry farm where AI has already broke out that should be visited after visiting a healthy poultry farm because due to clothes, hands and other ways the virus of AI is transmitted from one place to another place and can infect healthy birds. The trucks used for transport of feed can also cause the spread of AI from one farm to the other and can cause the spread of disease.

B. Raising of similar age poultry flocks

At one time the birds of similar age groups should be raised at the farm so that after selling of birds the farm should be properly cleaned. The raising of similar age poultry flocks also helps in efficient management of poultry flocks regarding arrival and sale of poultry birds at the same time and giving maximum down time (time between successive flocks) for proper disinfection and cleanliness of farm.

C. Disinfection

For efficient control of AI all the feeding and watering utensils of infected flock should be kept separate or disinfected (Rushton *et al.,* 2005). All the utensils should be disinfected which have contact with the raw meat (Anaeto and Chioma, 2007). Commonly and commercially available detergents in market i.e. formalin, virkon, zeptin, kepcide, etc. can easily destroy AI virus at recommended concentrations (Shahid *et al.,* 2009). Dead stock, instruments or contaminated surfaces with feces, feathers, blood etc should be avoided especially the iron cages along with those utensils used for transportation of infected birds. The cutting instruments and utensils for poultry meat and other food items should be kept separate. Disinfection of all contaminated utensils and instruments should be carried out. Before entry of new flock inside the farm the building of farm should be properly cleaned from inside and with white wash and spray so that all the germs and viruses could be destroyed.

D. Proper cooking of poultry

Cooking of poultry meat should be proper and in case of eggs, these should be boiled properly. As AI virus is easily killed by heating (Shahid *et al.,* 2009), it is better to use pressure cooker for cooking of poultry meat. Raw meat and cooked meat should be kept separate and any cross contamination should be avoided.

E. Strict Quarantine

The strict quarantine measures for the transport of poultry birds globally and within the country be adopted and implemented. Globally there should be ban of import of poultry, birds, meat and eggs from the countries endemic with AI virus. Screening and confirmation of AI should be done at every stage on the movement of poultry birds. Use of laboratory techniques should be sought for confirmatory diagnosis. After outbreak of AI the birds should not be shifted from affected area and the surrounding area of the farm should be declared a danger zone and the movement of people should be restricted in the affected area.

F. Vaccination

Use of vaccines against AI can decrease viral excretion rates and transmission dynamics, can increase infection resistance and reduce clinical symptoms (Burgos and Burgos, 2007). Vaccines can be used to prevent the spread of disease due to HPAI (Naeem, 2007). The breeder flocks vaccinated against both H_7 and H_9 subtypes of AI becomes immune to AI (Cheema *et al.,* 2011). Passive immunization is also one of the tools for control of economically important viral diseases in poultry birds. The viral diseases in highly valued commercial level parent or broiler breeder poultry flocks can be controlled through passive immunization (Pansota *et al.,* 2013).

G. Minimizing risk of exposure of AI virus

Direct contact with the domestic, wild, dead or live birds should be avoided during an out break of AI. All domestic and wild birds infected with AI should be sacrificed. Contact with the feces of infected birds should be avoided and fecal manure should not be used as fertilizer. Workers should wear mask during working in the farms and exposure of mucous membranes to shed environment especially eyes and oral cavity should be avoided. All eggs and chicks should be purchased from disease free hatcheries (Anaeto and Chioma, 2007).

H. General cleanliness and hygienic measures

If proper cleanliness of premises of poultry farm, vehicles, footwear, equipment, etc is not carried out the infection of AI may persist in poultry farm area and outbreak of AI may occur. Hands should be properly washed with soap after dealing with the poultry and poultry products, like, meat or eggs. The food should be properly cooked along with strict hygiene measures. All personals working with poultry birds should maintain good general health by eating healthy and disease free poultry products.

I. Awareness programs

Awareness programs about the predicted hazards caused by AI and its zoonotic importance for general public, poultry farmers and laborers should regularly be conducted by health officials for the control of this disease in poultry and human population. Awareness program about prevention and control of AI include provision of clean drinking water to birds, regular washing of feeding

instruments, drinkers, disinfection of egg nests, chick boxes, hatcheries, etc.

J. Regular Surveillance

The birds should be regularly surveyed for the presence of AI virus and the tracheal swabs, blood serum and cloacal swabs should be taken and sent to laboratory so that presence of AI virus in birds could be monitored. There should be regular surveillance of poultry farms and reporting of disease should be done (Hafez, 2005).

K. National Program for Control and Prevention of Avian Influenza (NPC&PAI)

There is constant need to carry out surveillance of AI in poultry and humans along with vaccination (Naeem *et al.,* 2003; Cheema *et al.,* 2011). The government of Pakistan had launched the NPC&PAI with the aim to develop avian influenza (AI) surveillance, reporting system and handling AI outbreaks, strengthening diagnostic capabilities and AI vaccine quality control. The samples were collected and sent to provincial level disease laboratories for the observation of presence of AI virus. The whole of the country was divided into different regions and regional surveillance units and rapid response units were established for sero-surveillance of AI. According to NPC&PAI no outbreak of AI was recorded in poultry flocks during the duration of the project (2007-2010) and Pakistan is declared avian influenza free since 2008 (GOP, 2010).

The avian influenza has become a major risk for poultry producers of developing countries. Apart from economic loss the AI has become havoc for human health. Through regular screening and monitoring social mobilizing of general people about signs and symptoms of disease the spread AI can be prevented. Moreover through adopting good biosecurity measures, vaccination and routine surveillance the avian influenza can be prevented. The strict quarantine measures and establishment of protection and disease free zones can also help control in any geographical area. By controlling and preventing AI in poultry the losses due to AI can be minimized and more production from poultry flocks can be obtained resulting in overcoming of the shortage of eggs and poultry meat in developing country like Pakistan.

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