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Avian and Pandemic Influenza (API): A Prevention-Oriented Approach

Muhiuddin Haider and Jared Frank
School of Public Health, University of Maryland College Park, Maryland, USA

1. Introduction

The current public health approach to avian influenza focuses on control and management after an outbreak has already occurred. While control methods have numerous benefits and have played a large role in containing outbreaks, although not until some days, weeks, and/or months following the initial infection(s), this approach does have its limitations. Not only is a focus on control following an outbreak very costly, but during the time after initial infection and the subsequent spread, recent research has found issues with the control of diseased bird/poultry populations, the sanitary removal of the diseased carcasses of deceased birds/poultry, and the treatment of AI among infected humans. Through focus groups and observational studies, researchers have also found lapses in the training and outreach provided to those individuals most at risk of exposure and contamination by HPAI H5N1.

A prevention-oriented approach, one that utilizes multiple prevention-oriented measures, including the research of new vaccinations, the further development of health regulations and standards, a strong focus on the One Health Initiative, and improved training programs and awareness campaigns, should be utilized to address the issues associated with AI, especially bird-to-human transmission. This chapter aims to inform about the similarities and differences between control and prevention measures and the benefits of a prevention-oriented approach.

2. What is Avian Influenza?

Throughout the development of civilization, researchers have continuously discovered the means to prevent, treat, and/or control diseases that have plagued mankind. However, there are still many diseases, both those recently presented among human populations and some that have adversely affected health outcomes for years without effective treatment, that have yet to be successfully addressed and eradicated. AI, a relatively new emerging infectious disease of zoonotic origin, has caused upwards of tens of millions of deaths among domestic poultry and wild bird populations globally. Even more problematic is that numerous regions have seen scattered outbreaks, some with dozens of deaths recorded,

* The authors recognize the assistance of Zandra H. Andre

among human populations. Further, the disease continues to spread in spite of measures implemented by governments and various world health agencies to control such outbreaks.

AI, otherwise known as avian flu or bird flu, is an influenza type A virus. Although there are a variety of sub-types of influenza virus, due to the many combinations of the two components that comprise the virus, haemagglutinin (H) and neuraminidase (N), H5N1 is well known for its past and current virulence among both avian and human populations. As for the components of the virus, "haemagglutinin is a protein found on the surface of influenza viruses which is responsible for binding the virus to the cell that is being infected; neuraminidase is also found on the surface of influenza viruses" (FAO, 2011). In addition, when discussing the disease itself, there are two types of AI known as low pathogenic avian influenza (LPAI) and highly pathogenic avian influenza (HPAI). "While prevalent in many regions, LPAI poses very little danger to birds and almost zero threat to human populations" (Haider, Frank, & Noreen, 2010, p. 323). However, HPAI, the category in which H5N1 falls, has a much higher capacity for causing disease than LPAI, as shown by its virulence among birds and its impact on human health once transmitted.

2.1 History and transmission

Over the course of human experience with AI, as is the case with many other diseases, researchers have heavily documented all instances and factors surrounding outbreaks of the disease. Outbreaks among animals, transmission to humans, and negative effects on the environment have been recorded as to their duration, scale, and the total number of resulting cases and subsequent deaths among both birds and humans. In addition to these measureable aspects of outbreaks, researchers have also kept a comprehensive timeline of every case of animal and human infection as reported by countries across the world. From the initial isolation of the H5N1 virus in 1996 in the Guangdong Province of China to the recent outbreak of H5N1 in the Banteay Meanchey Province of Cambodia (September 12, 2011), the World Health Organization (WHO) has compiled a timeline, entitled *H5N1 avian influenza: Timeline of major events*, which consists of all the significant points in history to date regarding AI (WHO, 2011).

As mentioned, AI affects both domestic poultry and wild bird populations in many countries. Outbreaks, due to transmission between these various populations, can occur in the wild, at commercial farms and personal farms, and at live bird markets. Although everyone is at varying degrees of risk of contracting AI, there are particular actions that result in higher chances of infection. In fact, those who keep or sell poultry are at a high risk of bird-to-human transmission of AI. Specifically, "some of the factors that contribute to spread of HPAI from birds to humans include slaughtering poultry and preparing the meat in the home, direct contact with sick or infected birds, and the consumption of infected poultry" (Haider & Applebaum, 2011, p. 20). Often, many individuals lack education and training concerning the proper handling of poultry and the temperature at which meat should be cooked to prevent infection. As it relates to animal-to-human transmission, many are even unaware that they should minimize contact with the feathers, intestines, blood, saliva, and droppings of diseased or dead birds.

Unfortunately, not only are farmers and poultry workers contracting the disease through improper handling and cleaning of poultry, but, due to low hygiene conditions and close

quarters, the disease continues to spread unchecked throughout domestic poultry and wild bird populations. If one domesticated bird has the strain, it can spread to other birds in the flock quickly, well before culling or other measures of containment can be effectively implemented. Fortunately, the virus has not yet mutated into a form that has high potential for human-to-human transmission.

2.2 Global impact of Avian Influenza

Along with the increasing numbers of deaths within domestic poultry and wild bird populations throughout numerous countries in the Middle East, Africa, and Asia, human deaths have also steadily continued to occur in spite of measures designed to control the spread of this disease. In fact, there are fifteen (15) countries that have reported human cases and/or deaths from HPAI H5N1. These countries are ordered from highest to lowest number of human cases/deaths through August 2, 2011 in Table 1:

Country of Impact	**Human Cases**	**Human Deaths**
Indonesia	178	146
Egypt	144	48
Vietnam	119	59
China	40	26
Thailand	25	17
Cambodia	16	14
Turkey	12	4
Azerbajin	8	5
Bangladesh	3	0
Iraq	3	2
Pakistan	3	1
Lao People's Democratic Republic	2	2
Djibouti	1	0
Myanmar	1	0
Nigeria	1	1

Data obtained from World Health Organization (WHO, 2011)

Table 1. Countries with HPAI H5N1 Human Cases & Deaths

As indicated in Table 1, AI has had a substantial impact on human populations in Southeast Asia (i.e. Indonesia and Vietnam) and an equally large effect in Northern Africa (i.e. Eygpt). Further, instances of the disease in such countries as Turkey, Iraq, Djibouti, and Nigeria indicate a potential trend in the spread of the disease further east through countries in both the Middle East and Africa. This potential trend may be further shown by the outbreaks of HPAI H5N1 among birds in countries including Israel, Japan, Republic of Korea, Mongolia, and the Palestinian Autonomous Territories [West Bank] (FAO, 2011). Should measures not be taken, as mentioned above, AI may continue to spread along this path through

commonly utilized transportation routes for poultry, potentially threatening new, unsuspecting populations.

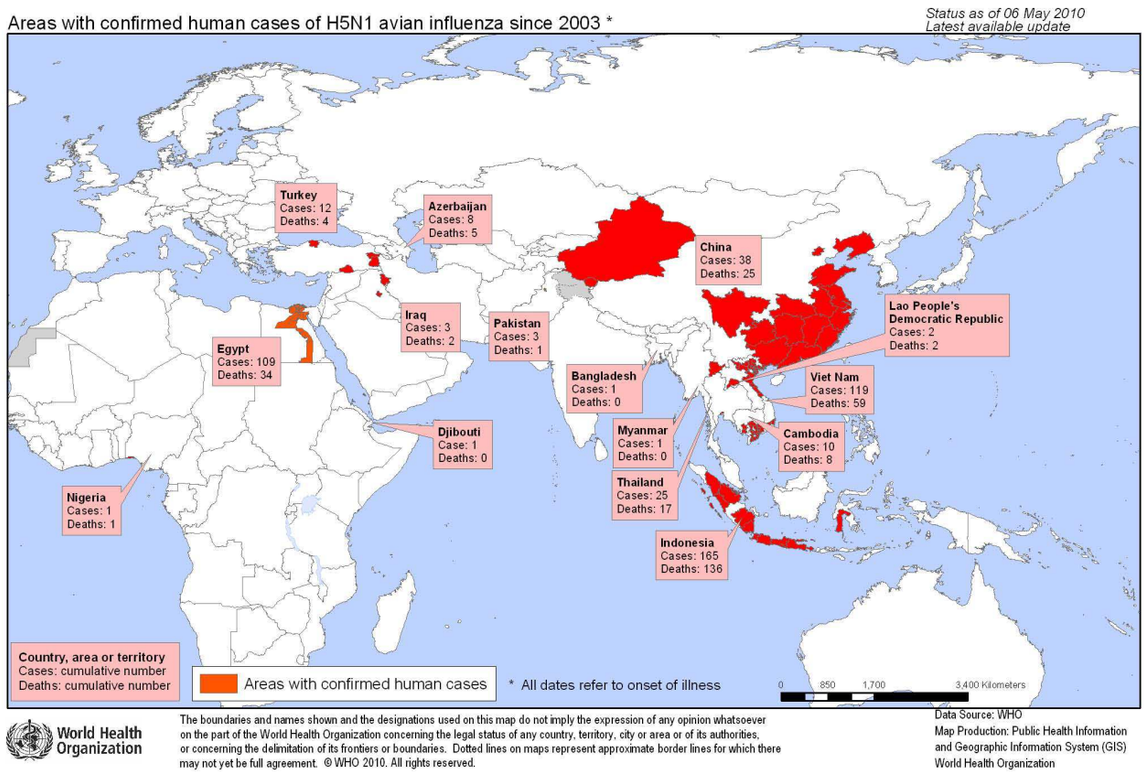
In their mid-year review of AI in 2011, the FAO found that within "countries in Asia and Africa—The People's Republic of China in East Asia, Vietnam in the Greater Mekong sub-region, Indonesia in Southeast Asia, Bangladesh and India in the Indo-Gangetic Plain, and Egypt in North Africa—H5N1 HPAI remains entrenched, and these countries are considered endemic for the disease" (FAO, 2011, p. ix). Three countries, Bangladesh in South Asia, Indonesia in South East Asia, and Egypt in the Middle East, have been increasingly representative of areas that have focused heavily on control methods.

In fact, as recently as June 22, 2011, The Ministry of Health of Egypt reported a human case of H5N1, which was confirmed by the "Egyptian sub-national laboratory for Influenza in Aswan and the Central Public Health Laboratories in Cairo, a National Influenza Centre of the WHO Global Influenza Surveillance Network" (WHO, 2011). In this instance, the individual developed symptoms, which were recognized, and they were placed in the care of a nearby hospital. While the individual received medical care, through treatment with oseltamivir, otherwise known as tamiflu, which slows the spread of the influenza virus between cells, there was a nine day delay between the development of symptoms and treatment, with death following a day after the first treatment. Unfortunately, it appears that in this case, as present in many communities that have little to no access to education or up-to-date medical facilities, that the symptoms were recognized much too late, the treatment was given long after symptoms were presented, and the exposure incident had not been fully discerned.

As another country which has been heavily impacted by HPAI H5N1, Indonesia currently has the most recorded human cases and deaths from the disease and thereby serves as a very important area in terms of controlling and/or preventing disease. Unfortunately, problems such as "the complex and weakly regulated structure of the poultry sector has hampered the control and prevention of avian influenza in Indonesia" (FAO, 2011, p. 66). After years of trying to control outbreaks on a case-by-case basis, the FAO along with the Ministry of Agriculture of Indonesia and private sector market-traders have begun to team up to implement prevention-oriented measures. A specific example includes initiating "a cleaning and disinfection program for poultry transport vehicles at collector yards" (FAO, 2011). Instead of having to cull large numbers of poultry to control the spread of the disease and subsequently losing money, preventive measures are beginning to be recognized as both necessary and economical. In case of an outbreak, the FAO Emergency Centre for Transboundary Animal Diseases' Avian Influenza Programme has provided funding to help the government of Indonesia "to implement a host of avian influenza prevention, surveillance, response, control, research and communication activities nationwide" (FAO, 2010).

Bangladesh is also seen as a hotspot for AI. To date, there has been much done by the international community in the way of supporting the government of Bangladesh to control outbreaks of HPAI H5N1.

In order to further emphasize the global impact of HPAI H5N1, Figure 1 below gives a global geographic representation of the spread of AI over the past eight years:



As seen in Figure 1, the areas colored in red on the map are those areas with confirmed human cases of H5N1 since 2003, as of the date May 6, 2011 (WHO, 2011). The number of deaths attributed to the disease among humans within each country at this particular point in time has also been provided.

Fig. 1. Areas with confirmed human cases of H5N1 avian influenza since 2003*

While the tables and figures above have examined the distribution of cases and deaths by country, Figure 2 gives a total of the same information for the years 2003 through the present:

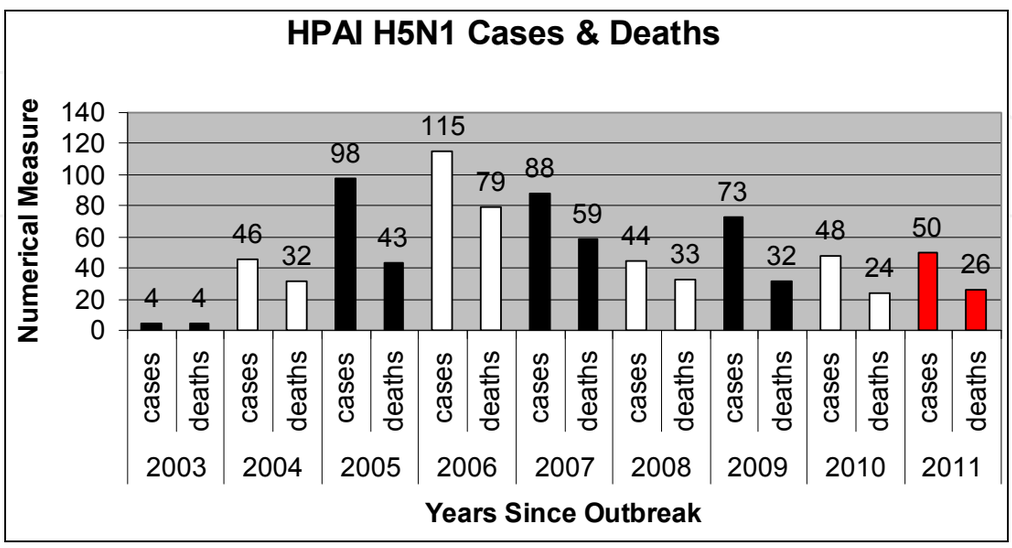


Fig. 2. HPAI H5N1 Cases & Deaths

Based on Figure 2, following a rapid increase in the number of human cases and deaths over the first few years of AI's reemergence, the numbers seem to have since declined. However, regardless of any decline in HPAI H5N1 human cases and deaths, the fact remains that, as reported by the WHO as of August 2, 2011, there have been approximately 566 human cases of AI globally, with 332 total deaths (WHO, 2011).

2.3 Current status & future risk

Presently, due to widespread outbreaks of AI among poultry, especially within numerous developing countries, there has been a large focus on the utilization of control methods, such as through the culling and/or quarantine of diseased birds. Unfortunately, as will be further examined in this chapter, methods of control are often expensive, countries lack up-to-date training and facilities, and resources are often unavailable as needed to control outbreaks. Instead, the authors believe a prevention-oriented approach can reduce the impact of AI going forward. In fact, through the utilization of mass education, development and implementation of regulations provision of vaccines, and a collaborative approach taken through the One Health Initiative, we believe prevention, as compared to control, has a major role to play in combating this disease. However, we are not so quick as to dismiss the benefit of control methods. As such, current control methods will be examined, followed by a comparison of control and preventive methods, and then a thorough review of effective prevention methods.

3. Control of Avian Influenza

In an effort to deal with outbreaks of AI, health organizations, governments, and local and state agencies within numerous countries have been working to develop and implement control measures to prevent further loss due to the disease. Currently, there is no treatment for AI among humans beyond treating the symptoms, such as a cough, fever, or trouble breathing, associated with the disease. Unfortunately, animals that become infected with the disease are not so treatable. In fact, "control measures such as rapid culling, extensive quarantines, and sanitary measures have been taken" (Haider et al., 2010, p. 324). Additional methods for control include the rapid removal of the fecal matter, blood, and other bodily fluids from diseased/infected birds so as to prevent runoff. These measures, however, are not considered truly effective as the quarantined birds often die, the culling must encompass some not yet diseased birds because they may carry the virus and infect others, and any sanitary measures taken may not encompass all areas where the outbreak occurred. However, the FAO has reported that "good husbandry, proper nutrition, and broad spectrum antibiotics may reduce losses from secondary infections" (FAO, 2011).

Recently, the FAO has recognized that implementation of various control measures "based around early detection and stamping out, appears to have reduced the number of cases but the virus has not been eliminated" (FAO, 2011, p. 51). Concerning potential issues with control, the FAO has recognized various constraints for disease control and responses (FAO, 2011, p. 55):

- The requirement of a government order before culling delays early response

- The quality of post-outbreak disposal, cleaning and disinfection is substandard
- The location of commercial farms in densely populated areas makes movement control of people and animals difficult
- Borders are long and porous
- The source of infection is unknown
- Tracing infection forward or backward is difficult

On the other side of the argument, however, it is noted that these control measures have resulted in a decrease in the time required for detection, laboratory testing, and culling (i.e. stamping out) after infection. Regardless, the focus on AI has seen a shift in methods towards a preventive approach. Currently, regulations are being developed, such as those originating from the Animal Slaughter and Meat Quality Control Act of 2010, and education/training is being provided to help ensure faster diagnosis of the disease so control measures can be implemented.

As of 2007, the Third Global UNSIC-World Bank (pg. 67) Progress Report found overall improvement in the ability of numerous countries to respond to HPAI outbreaks by way of new surveillance techniques, updated laboratory systems, and an increased capacity of health systems, though varying by region, to handle potential and real threats to human health. However, this same report found multiple issues such as an "insufficient joint working of animal and human health surveillance and response networks" and lack of significant translation into behavior change among individuals and communities of the "increasing awareness of the threat posed by HPAI H5N1" (UNSIC & World Bank, 2008, p. 67). With proven measures of control already in place, future efforts must now be placed on the development, build up, and implementation of prevention-oriented measures.

3.1 Costs of control

Since the outbreak of HPAI H5N1 in 1996 and the subsequent outbreaks across the world, billions of dollars have been pledged and globally distributed by numerous countries in an effort to control and prevent the rapid spread of this disease. As noted by the United Nations (UN) System Influenza Coordinator & World Bank, in their document, *Responses to Avian Influenza and State of Pandemic Readiness*, the rapid spread of HPAI has resulted in "significant socioeconomic losses, numerous human deaths, and the potential threat of a human pandemic influenza" (UNSIC & World Bank, 2008, p. 8).

There have been many advances in control measures such as the development of surveillance techniques, updating health care facilities, such as hospitals and laboratories, and improving upon health systems and outbreak response networks. In fact, the ability of a country to carry out effective disease management in cases of an outbreak is highly dependent upon such constructs as capacity building, the training of workers and volunteers and provision of commodity supplies, and infrastructure development. Further, logistics management focuses on "issues pertinent to implementing disease management strategies such as space and equipment availability, staffing and human resource skills, supplies of relevant commodities, recordkeeping and reporting, and transportation" (Haider & Applebaum, 2011, p. 9). Additionally, there is an ongoing need for the provision of clean water and cleaning supplies, such as sprayers, detergents, masks, and gloves, especially in live bird markets, and ongoing surveillance/monitoring. As expected, however, there are

high costs associated with infrastructure development, especially in (low income) developing countries, and training of staff and volunteers to successfully implement biosecurity measures and carry out an effective outbreak response.

Though government, and international, assistance is often provided in cases of an outbreak, it is incumbent upon each country to develop, fund, and implement their own disease management programs. As an example, the United States Agency for International Development's (USAID) Stamping Out Pandemic and Avian Influenza (STOP AI) provides assistance, such as through training and public-private partnership development, in order to better prepare countries for responding to and recovering from HPAI H5N1 outbreaks. Along with providing technical assistance, STOP AI "aims to mobilize public and private sector partners as well as NGOs to implement systematic and sustained behavioral changes that will result in measureable improvements in biosecurity" (Haider & Applebaum, 2011, p. 6). However, such collaborative efforts are often limited by issues including opposing political views and the time involved concerning the political process, private sector motivation (i.e. direct benefit), public sector oversight and regulation, and cost-sharing. Going forward, it is important to note that efforts involving capacity building, logistics management, and communication for behavior change are not only measures used to manage (control) and/or eradicate AI in live bird populations, but can play a significant part in outbreak, and subsequently disease, prevention (Haider & Applebaum, 2011, p 8).

As noted above, while there are numerous methods for controlling the spread of influenza, the costs associated with control of an outbreak, such as rapid mobilization of a global health response, mass production of treatments and other health services, and related efforts, are very high. However, a focus on prevention has shown a decrease in the overall cost associated with disease. Concerning past experience with multiple outbreaks of influenza, though not on the scale of a potential outbreak of AI at the level of human-to-human transmission, the "WHO recommends annual immunization of at-risk persons as the best and most cost-effective strategy for reducing influenza-related morbidity and mortality" (WHO, 2011). Similarly, on a more basic level, the benefits received and costs avoided as a result of strong hygiene practices cannot be overlooked. "Of these practices, hand hygiene and surface cleaning are among the simplest and most cost-effective ways to prevent transmission of the highly pathogenic avian influenza virus" (WHO, 2011).

4. Control & prevention

Although control and prevention appear to be two different methods for addressing the same problem, it should be noted that researchers, agencies, and governments can approach AI successfully utilizing measures from both areas simultaneously. In fact, the FAO Emergency Centre for Transboundary Animal Diseases (ECTAD) produced a document in January 2007 called *Protect Poultry – Protect People: Basic advice for stopping the spread of avian influenza*. This document provides a quick, but thorough, review of current prevention and control measures when dealing with potential and real cases of AI among wild birds, domestic poultry, and humans, and how transmission may be prevented between animal-to-animal and animal-to-human (ECTAD, 2007). Further, Figure 3 below examines measures of control and prevention and the overlap between both approaches.

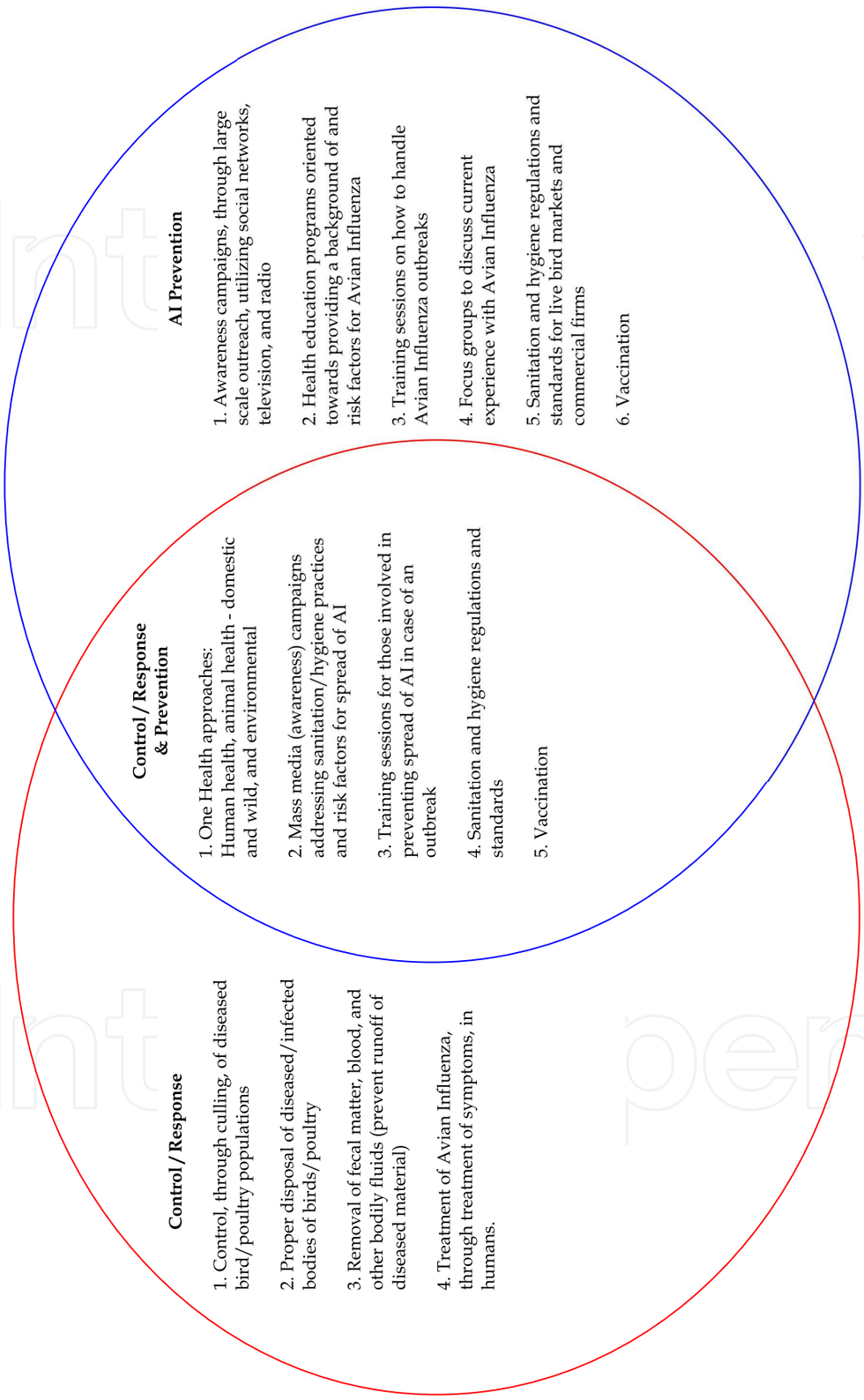


Fig. 3. Control vs. Prevention: Compare & Contrast

5. Prevention of Avian Influenza

Although control and prevention both have a role in dealing with AI, as shown in Figure 3, the majority of the focus should be placed on prevention. While control aims to prevent further spread of a disease in a region in which an outbreak has already occurred, prevention seeks to address potential vulnerabilities ahead of time in order to prevent an outbreak from occurring in the first place.

As seen by the examination of past and present control measures utilized for handling AI outbreaks, it is necessary to implement new strategies to address the issues faced as a result of this disease. Recent research has shown that it is possible to utilize resources more strategically by adopting a prevention-centered approach, especially in those areas currently at a high risk of an outbreak of AI. In fact, to date there have been lapses in training and outreach, inadequate education, and poor dissemination of health information. Researchers have also noted that "overall, knowledge is necessary, but NOT sufficient to produce behavior change. Perceptions, motivation, skills, and factors in the social environment play important roles" (Glanz & Rimer, 1995). Therefore, education programs and interventions going forward should incorporate comprehensive health education with related behavior change methods so that individuals are not only knowledgeable about what needs to be changed, but they can also have the self efficacy to carry out the healthy behaviors.

As it pertains to defining a country's risk status, all countries are at varying levels of risk of AI due to reasons including improper procedures and lack of food and agriculture standards. High risk areas may be defined as those that are currently experiencing or have already experienced an outbreak. Similar to the manner in which control measures are currently being implemented to combat AI, potential preventive measures can also be implemented and then analyzed as to their effectiveness. If successful interventions can be found to produce significant results, the intent would then be to widely disseminate these measures in other high risk areas, areas considered to be at low risk (those which have had limited outbreaks of the disease), and even in those regions that have had no previous experience with AI, so as to prevent the possibility of a future outbreak.

The prevention of AI can be defined as hindering both the outbreak and spread of the disease. As seen by the various preventive measures to be examined, there will be a focus placed on the Social Ecological Model of Prevention, developed by the Centers for Disease Control and Prevention (CDC), which aims for better health outcomes through a tiered approach, at the individual, community, and societal levels, for identifying areas for prevention activities. This model can be best characterized as an 'upstream approach' where, as one moves upstream, one makes their way to larger streams, which then lead to rivers, and ultimately, to the source of the problem.

This is a proactive, systemic approach, though fairly complex, which better enables researchers to get to the core of the problem. The overall aim is to reduce morbidity and mortality rates. By preventing an outbreak before it occurs, resources can be directed toward broader improvements in sanitation and hygiene practices that will positively affect not only AI control efforts, but those of many other communicable diseases.

5.1 Awareness campaigns & training sessions

One of the main prevention oriented efforts currently in place in many countries and utilized by world organizations is the mass utilization of education programs through awareness campaigns and targeted training sessions. The idea behind the use of education programs, whether at the individual, group, or community level, is to provide information on handling the spread of AI, especially concerning how the outbreak of the disease can be prevented in the first place. Research indicates that the aforementioned awareness campaigns, including targeted training sessions and health information dissemination, should aim to prevent AI by focusing on a variety of aspects including how to:

- Maintain a sanitary environment
- Maintain the overall health of poultry/livestock on the farm
- Properly handle diseased birds
- Properly dispose of the diseased bodies of dead birds
- Properly cleanse birds/poultry and cook the meat appropriately before consumption
- Transport poultry/livestock under conditions which prevent the spread of disease in case of an outbreak

While these methods are very helpful, there are additional measures that may be taken by farmers and commercial businesses to prevent virus transmission, and resulting issues, among their poultry and other at risk populations. These additional methods include meeting the regulations and standards set forth by local, state, and federal governments and the provision of vaccinations.

The manner in which education is provided is crucial and depends on the audience of interest. The primary way in which information should be disseminated, which could reach a wider audience and in a more cost effective manner, is through awareness campaigns (media) by way of television, radio, and social networks, where available. Through these methods, information can be provided on sanitation and outbreak control measures, new policies and regulations, and vaccine dissemination. For a more direct approach, community oriented training sessions would educate the population at a more personal level and potentially result in greater behavior change as the community works together to ensure prevention. Key limitations of these methods include availability, especially in the developing countries, and cost.

When considering these widespread education programs, the focus should primarily be on training farmers since flu transmission occurs primarily during bird/poultry handling and cleansing process. If the lay population comes into contact with avian flu, the interventions then become control-oriented. However, in addition to farmers, training sessions and education-oriented campaigns should target both men and women, especially the wives of the farmers. Although the most likely recipients of this information would be [male] farmers, recent focus groups among women in Pakistan find that, "to ensure a faster spread of awareness of Avian Influenza throughout the various regions, training sessions and related health education programs should focus on incorporating both genders" (Haider, Frank, & Noreen, 2010, p. 329). As Haider et al. discovered, after conducting focus groups with two groups of women in Pakistan, many of whom had husbands whose occupation was farming and/or had knowledge about AI through their husbands going regularly to

live bird markets, it was apparent that there was a lack of education within the various communities in the region of study. As a result of this study, "more training sessions should be scheduled, and the information covered should be more extensive, especially regarding the transmission of the virus and the most recent preventative measures" (Haider et al., 2010, p. 332).

5.2 Development & provision of vaccinations

The utilization of educational outreach and training sessions covers one aspect of the prevention-centered approach. However, an integral part of these awareness and information driven campaigns is the focus on spreading awareness of current AI vaccination measures. Specifically, the method of vaccination has been proven to be an effective tool for preventing disease by enabling resistance, thereby reducing the chance of becoming infected during an outbreak. Similarly, vaccination of poultry and humans helps to control disease in both populations by stalling or stopping the spread of the disease in question. In fact, "in developing countries, vaccination programmes in avian species have been recommended recently, however it will require concurrent management of local husbandry practices and industry compliance to eradicate the disease rather than the establishment of an endemic situation" (Capua, 2007, p. 5645). While developed countries have had lower levels of risk of an outbreak of AI, as indicated by both the lack of animal and human cases and deaths from the disease and the architecture currently in place, including regulations and standards, health education programs, and health services, many of these countries are not taking any chances. "In developed countries vaccination is being used as a means of increasing resistance of susceptible animals to reduce the risk of introduction from the reservoir host or to reduce secondary spread in densely populated poultry areas" (Capua, 2007, p. 5645).

Officials, researchers, and businessmen/farmers, are aware that control measures such as depopulation through massive culling is not feasible when both food supplies and economic stability are at risk of upset due to the spread of disease. By focusing on vaccinations, the health and safety of domestic poultry can be maintained as long as the efficacy of the vaccine is constantly monitored, infected birds are managed appropriately to prevent infection of healthy populations, and most importantly, regulations and standards are met and exceeded such that HPAI H5N1 is prevented from gaining a foothold in any region. Of course, some major questions still need to be answered concerning the utilization of vaccines. As mentioned above, the current and future effectiveness of vaccine use is reliant on monitoring and continuous study. Another potential problem is the question of whether the vaccine will be developed, produced, and distributed by a government organization or private entities, specifically who will be responsible for the provision of the vaccine. Finally, an issue that still needs to be addressed is that regardless of the research showing prevention to be far less expensive than control, the mass production and distribution of vaccines is very costly for both the developer/manufacturer and the individual businesses and farmers aiming to prevent any outbreaks of the disease by vaccinating themselves and their populations of livestock. A more in-depth analysis of cost control measures and the additional resources necessary for successful implementation of vaccine campaigns is especially warranted.

5.3 Policy & regulations

Another important aspect of prevention is the development of regulations. These regulations should foremost address sanitation and hygiene among live bird markets and commercial businesses in an effort to prevent and control future outbreaks. By setting forth responsibilities for the applicable parties to follow, governments aim to maintain the safety, well-being, and overall health of a population. As an example, for areas such as the United States which have had no first-hand experience with AI, the United States Department of Agriculture (USDA), in an interim rule, prohibited the import of wild birds/poultry and poultry products (i.e. meat) from any and all regions where a subtype of HPAI, such as H5N1, exists.

Unlike in developed countries, which have a modicum of control over outbreaks of AI and related diseases due to health regulations and significant oversight of the food production industry, developing countries have a different set of concerns. Specifically, regulations that should receive focus in these countries include those that better protect the food protection process such as processes for handling and transporting poultry products and registering the farms responsible for both of these tasks. Currently, the FAO, as part of their Animal Production and Health Paper, *Approaches to controlling, preventing, and eliminating H5N1 Highly Pathogenic Avian Influenza in endemic countries*, notes key areas, specifically biosecurity measures, which need to be addressed through regulations for the small commercial businesses and personal farms that are found throughout those countries affected by AI. The regulations should address the fact that (FAO, 2011):

- Live bird markets need to be improved
- Poultry slaughter houses need to be modernized
- Decontamination procedures are not sufficiently monitored
- Infrastructure in poultry production needs to be upgraded including building poultry processing plants
- Limited integration of small-scale farming into larger corporate farming enterprises
- Animal Slaughter and Quality Control Act will be revised but uncertainty around its implementation
- Existing regulations are not well executed or enforced

Sanitation is one of the most important aspects of maintaining the health of a large animal population in close quarters, which in this case refers to domestic poultry. Infrastructure, specifically poultry slaughter houses and live bird markets, needs to be updated in terms of procedures, tools, and oversight. Furthermore, in case of an outbreak, "there should also be a standardisation of reporting procedures for outbreaks of disease to internationally accepted standards" (The World Bank, 2006). The World Bank notes that the development of an operational manual would not be unwarranted, one that addresses 1) how to react in the event an outbreak occurs, 2) which individuals, organizations, and/or entities are responsible for certain tasks to control further outbreak or response to human infections, and 3) how will coordination be handled. By ensuring the health of the environment and sanitary living conditions for the poultry under care, especially through well thought out, approved regulations, there is a better chance that the H5N1 virus may be resisted and/or the spread and impact of the virus is decreased.

5.4 The One Health Initiative

The above mentioned prevention strategies are key components of preventing the outbreak and spread of AI. However, these efforts need to be utilized together in order to increase their effectiveness. Specifically, these prevention strategies should be incorporated into the One Health Initiative. This initiative, which is carried out in collaboration by many agencies including the American Medical Association (AMA), the CDC, and the USDA, is "dedicated to improving the lives of all species—human and animal—through the integration of human medicine, veterinary medicine and environmental science" (One Health Initiative, 2011). The One Health Initiative, which is a concept aimed at increasing interdisciplinary collaboration "in all aspects of health care for humans, animals and the environment" is based on the premise that the health of these three areas as a whole are linked, whereby a detrimental effect on the health outcomes of one area could have negative outcomes for that of another.

In order to truly push AI prevention measures into the realm of One Health, some components need to be addressed. A major component to be expanded upon, as mentioned above, is comprised of a dual focus on both human and animal health research, such as through the development of new vaccinations and antiviral drugs, including the promotion of alternative administration measures to make widespread vaccination feasible within each population. Another component of interest is the improvement upon these methods and the addition of new human health behavior interventions focused at the individual, community, and population levels. Furthermore, enhanced wildlife surveillance techniques along with additional funding for such endeavors would serve to prevent the spread of infection along migratory paths. As noted, the migration of wild birds can quickly and efficiently spread disease from one region to the next if the proper steps are not taken immediately, assuming an availability of the appropriate resources. Another key issue addressed by the One Health Initiative is the increased involvement of animal health professionals, including veterinarians, alongside those physicians, scientists, etc. focused on human health. Finally, as discussed under the methods for prevention and control of the disease, there should be more of an emphasis placed on ecosystem health. This includes such aspects as proper disposal of carcasses to maintain clean water supplies, sanitary living conditions for humans and animals, and sustainable production of poultry.

Efforts to support a prevention-centered approach to pandemic AI, particularly HPAI H5N1, can be used to strengthen a nation's public health infrastructure, which will ultimately result in greater public health and security gains than any reactionary response could possibly hope to address. While the necessity has previously been to control and mitigate outbreaks once they have occurred, we are in a strategic position to move towards a more sustainable focus on prevention. It is time to seize the opportunity to get ahead of the threat and to focus resources on stopping outbreaks before they occur. Success can no longer be measured strictly by the control of outbreaks and minimization of the associated human cases and deaths, but by the ability of each and every country to save the lives of animals and humans alike through an effective, efficient, prevention-centered approach.

6. The innovation of a prevention-oriented approach

Instead of predominantly focusing on containment, through quarantine and culling, or related control measures, countries should implement prevention-oriented methods in regards to HPAI H5N1. By preventing future outbreaks, not only will we see a reduction in the number of deaths of both humans and animals, but the economic burden of many countries and health organizations can be decreased.

The successful implementation of a prevention-oriented approach, one that has a comprehensive, and targeted, focus on prevention, would have the potential for measureable gains in the struggle against AI. As such, an approach which addresses the aforementioned major areas of prevention, specifically education and mass awareness, widespread vaccination campaigns, implementation of regulations on private sector sanitation and hygiene, and the One Health Initiative, has not yet been seen. Further, once proven control measures, such as targeted education and training sessions and the provision of antibiotics and related commodities in response to outbreaks, have been incorporated into this approach, the potential exists for reducing the impact of HPAI H5N1 worldwide. However, to date, there has not been the availability of, or funding for, such an all encompassing approach. In regards to many developing countries, and even some developed countries, another question concerns the diffusion of the numerous aspects of this approach, assuming funding, approval, and subsequent implementation.

As it relates, FOMENT, a communications tool developed by Dr. Muhiuddin Haider to compliment the well known and often utilized Diffusion of Innovations Theory (DOI), should be employed in this case. In order for this prevention-oriented approach to be effective, all aspects must be adopted and successfully implemented from the government level down to the individual level. FOMENT includes six components, which complement those of DOI, that could be effectively utilized to encourage the adoption of such an approach. Specifically, as noted by Dr. Haider, FOMENT consists of the *Focus* on a specific behavior change, the *Organization* of the behavior change program, *Management* which supports and approves of the behavior change plan, an *Environment* which is conducive to behavior change, a *Network* in which to diffuse innovations at both individual and organizational levels, and the *Technology* available to diffuse innovations (Haider, Pal, & Al-Shoura, 2005). FOMENT offers a broad view of the various change agents, the advocate for the innovation and the potential adopters, the relationships between and environment for all interactions, and especially the technology that may facilitate or hinder successful implementation (i.e. diffusion).

7. Determination / Conclusion

Without sufficient education, awareness campaigns, and targeted training sessions, including the promotion of behavior change, many individuals will remain unaware of sanitary ways to handle and transport poultry and how to properly cook meat. Similarly, vaccination campaigns for both animals and humans can prevent at-risk populations from contracting the disease through animal-to-animal or animal-to-human transmission. The development of regulations will also serve to set standards that must be met concerning quality of health and the provision of a sanitary environment. By acting upon the

aforementioned methods to prevent disease, especially as part of the One Health Initiative, by focusing on animal, human, and environmental health in all aspects of addressing AI, the world as a whole may indeed see the end of AI.

Following the successful implementation of a prevention-centered approach, a major goal is making prevention 'sustainable'. Key goals following the utilization of preventive measures include the retention of lessons learned from the training provided, the continuation of processes in place, and the adherence to rules and regulations. Specifically, training programs should be maintained going forward, especially in cases where H5N1 appears to have been nearly eradicated. Health education programs should be continued and expanded upon regarding AI response and prevention information, and the education given should be as up-to-date as possible. Concerning regulations, butchers and farmers who prepare their own meat receive education and farms and slaughter houses should be inspected for sanitation and proper disposal. Hygiene regulations should be increased and there should be properly enforced penalties for those who violate proper hygiene in regards to handling infected poultry along with incentives for those who maintain/exceed standards. Furthermore, assistance should be provided to the governments to potentially help those who rely on poultry as a source of income so that they do not need to sell infected meat in desperation and will dispose of it properly without worrying about losing a significant amount of money, thus ensuring adherence to the regulations set forth. In the end, the need for clinical management of H5N1 may be decreased and potentially eliminated by managing H5N1 ahead of an outbreak, especially through a focus on live birds. Each country should ensure they are working on increasing awareness and informing the population of the significance of the disease, especially through working with the government to implement more programs, providing public service announcements, and particularly by education villages/communities.

As we have seen, when outbreaks occur, countries want to control and respond on an emergency basis, thus using more resources than would have been necessary had the outbreak been prevented. By taking a proactive, instead of a reactive, approach towards AI, countries will see less utilization of essential resources, create more awareness, which leads to a better educated populace, and ultimately better control and prevent the spread of AI.

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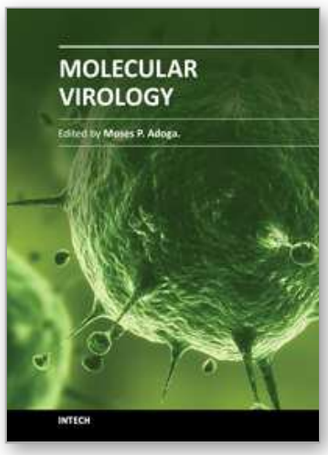

Molecular Virology

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This book covers various aspects of Molecular Virology. The first chapter discusses HIV-1 reservoirs and latency and how these twin phenomena have remained a challenge to eradication. Aspects regarding the molecular evolution of hepatitis viruses including their genetic diversities with implications for vaccine development are treated in the second chapter. Metabolic disorders that are a consequence of hepatitis C virus infection are discussed in the succeeding chapter. The following two chapters discuss influenza C virus and the applications of viral vectors in therapeutic research. Avian influenza is handled in the sixth chapter and the therapeutic potential of belladonna-200 against japanese encephalitis virus infection is discussed in the succeeding chapter. The last two chapters discuss baculoviruses and their interaction with polydnaviruses. Researchers, lecturers and students will find this book an indispensable companion.

InTech Europe
University Campus STeP Ri
Slavka Krautzeka 83/A
51000 Rijeka, Croatia
Phone: +385 (51) 770 447
Fax: +385 (51) 686 166
www.intechopen.com

InTech China
Unit 405, Office Block, Hotel Equatorial Shanghai
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中国上海市延安西路65号上海国际贵都大饭店办公楼405单元
Phone: +86-21-62489820
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