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National Vaccination Campaigns Against Highly Pathogenic Avian Influenza Outbreaks in Developing Nations

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Abstract: Highly Pathogenic Avian Influenza Type A H5N1 subtype is a viral zoonotic disease that has infected and killed birds and humans since late 2003. Vaccination is a disease mitigation measure with varying results depending on specific conditions pertaining to the affected locations. Vaccines can decrease viral excretion rates and transmission dynamics, increase infection resistance and reduce clinical disease symptoms. There are 7 critical points to consider in a national vaccination campaign. This measure is applicable after a comprehensive multifactorial situation-based assessment has been performed. These campaigns require well coordinated and properly resourced animal health services, regional and local logistical support and sufficient quantities of high quality, site-specific strain vaccines and trained labour.

Key words: Vaccination, bird flu, highly pathogenic avian influenza, HPAI, H5N1

Introduction

Influenza is an acute, highly contagious viral disease caused by three types of influenza viruses: A, B and C. Type A affects avian species, particularly poultry and it is most commonly known as Avian Influenza (AI). AI can be divided into highly pathogenic (HPAI) and lowly pathogenic (LPAI) depending on its ability to cause disease symptoms and fatality. Type A Influenza viruses are further divided into subtypes on the basis of antigenic relationships of two viral capsid surface proteins: haemagglutinin (H) and neuraminidase (N). There are 16 H types and 9 N types and these can occur in H_xN_y combinations. The combination causing global animal and human health concerns is H5N1.

H5N1 strain has infected numerous species of birds in Asia, Europe and Africa since late 2003. It has not been found in birds in North or South America, including the Caribbean. In 2006, a total of 47 countries reported HPAI outbreaks: 24 in Europe, 15 in Asia and 8 in Africa (FAO, 2007). From November 2003 to June 29, 2007 there have been a total of 317 confirmed cases with 191 deaths, resulting in a 60.25% mortality rate (WHO, 2007). In poultry, this transmissible disease is characterized by sudden onset (after incubation period of 2-4 days), loss of appetite, fever, prostration, lethargy, swollen hocks, nasal discharge, oedema of the neck and head, progressive inflammation of the respiratory mucous membrane and most likely, death. HPAI has a high mortality rate in chickens, often reaching 90-100% within 48 hours.

Rationale behind vaccination campaigns: There is ample scientific and empirical evidence that high quality, site-specific strain vaccines applied under appropriate conditions can decrease viral excretion rates and transmission dynamics, increase infection resistance and reduce clinical disease symptoms and in doing so, are able to dramatically decrease the probability of infection in poultry, other susceptible animal species (i.e., swine and cows) and ultimately, to humans (OIE, 2007a).

Components of a vaccination plan: The basis for successful animal disease control lies on high quality, efficient veterinary services. Therefore, it should be recognized that countries with weak veterinary services where it is already difficult and cumbersome to implement classical control methods it will also be difficult to implement a good, broad national vaccination campaign. Regardless of veterinary service differences in developing nations, an effective national vaccination campaign should encompass seven components, which are described in detail below:

Risk assessment: Vaccination campaigns are onerous, expensive, labour intensive and logistically demanding, therefore, a careful, comprehensive risk assessment that considers the advantages and disadvantages of such an endeavour in any particular country is of utmost importance. Zoonotic disease risk assessment tools have been furnished and can be found elsewhere; however, before it is performed, there needs to be full knowledge of current disease situation in the country to determine priority and urgency. Usually, a multifactor

epidemiological briefing provides useful information with regards to disease status. Additionally, knowledge of current on-farm biosecurity measures in all poultry production system is critical to determine locations and units at high risk of infection. It is widely accepted that low biosecurity levels increase the risk of primary introduction into farming systems. In countries were poultry farming is mainly a backyard/garden sideline activity, these biosecurity measure may be non existent and almost impossible to assess their contribution to infection risk. Due to cultural and geographical differences within and between countries, poultry rearing is not solely chicken based, but also includes turkeys, geese, ostriches, ducks and quails. This adds another level of complexity to vaccination programs as post-vaccination protective titres have only been fully documented for chickens and some turkey lines and there is evidence that protection in ducks and geese decreases quicker than chickens, thus requiring more frequent vaccinations. An initial risk assessment of these and many other issues should provide better tools for decision making regarding the breath, depth and scope of vaccination campaigns (Bruschke *et al*., 2007; OIE, 2007b).

Preparatory procedures: After assessment of risks has been performed and a decision made with regards to possible control measures (i.e., classical and non-classical), there needs to occur a conscientious appraisal of economic-financial feasibility and logistical viability. This is a significant step that puts magnitude of tasks to be achieved into a realistic perspective to all parties involved. Some preparatory procedures to consider, among others, before embarking in vaccinations are: reliable, motivated and trained manpower, secondary personnel resources, hypodermic syringes, vehicles for transportation, plenty of fuels, identification badges and uniforms, availability of funds for wages, salaries and procedural expenses, supervision of vaccination handling, cold storages for vaccine deliveries and geographical distribution of human/non-human efforts (Bruschke *et al*., 2007; OIE, 2007b).

Vaccine choices: There is no one-size-fits-all strategy to vaccination as there are H_xN_y site-specific virus strains that take over poultry populated regions to which standardized vaccines could not provide any degree of protection. A vaccine should always be of high quality, produced according to internationally established quality control standards and licensed by national authorities. It should be selected based on evidence that its application significantly reduces viral excretion and provides protection against recurrent infections. The haemagglutinin (H) capsid protein is the most immunogenic part of the virus and it should be homologous between field and purchased vaccine strains. If only one H-type is circulating, a monovalent vaccine may be used; however, bivalent vaccines containing both, H5 and H7 strains can provide more thorough protection. A heterogonous N-type strain vaccine can be used to facilitate serological viral detection (Bruschke *et al*., 2007; OIE, 2007b).

Vaccination strategies: The implemental strategy to follow depends on the prevalent disease situation encountered in the field and these are divided into *routine*, *preventive and emergency*. All three strategies can be applied in a targeted or mass manner. The former implies all birds in a country, the latter only a specified at-risk population group (Bruschke *et al*., 2007; OIE, 2007b).

Routine: It is an appropriate method in locations where the disease is endemic and where the classical control cannot be effectively implemented to eliminate the virus. Its overall goal is to reduce disease spread and eradicate the virus. A determinant factor to consider is the costs of maintenance of a routine vaccination program and its logistics; nevertheless, this vaccination strategy is very effective to drastically minimize mortality and production losses. Very rarely do poor, developing nations can afford to implement routine vaccinations, but on some instances, as in Thailand during 2004-2005, this was justified due to their high poultry populations and livelihood reliance on poultry-derived income.

Preventive: It is an appropriate method in locations where there is a high risk of HPAI introduction, especially when outbreaks are being reported in neighbouring borders. This strategy is usually localized initially at country limits (frontiers), thus it is imperative to distinguish animals that have been vaccinated from the ones that have not, as this will help avoid repetitions, better virus identification and to determine efficacy of other measures.

Emergency: It is an appropriate method in locations where it is acutely essential to create a buffer zone for areas most at risk in a near epidemic situation. It is often implemented as a ring-like vaccination around a defined area to prevent the virus spreading further. However, it remains critical to cull birds in a flock even when this strategy is applied, as it should not be considered as a stand-alone measure, but more so as a complement to classical stamping out/culling. This method is common at the beginning of infection reports due to its rapid response nature.

Implementation procedures: A task schedule is necessary to establish when, where, what and how vaccination is to be covered and as a time line to be able

to supervise progress. This schedule needs to be distributed amongst all stakeholders in order to ensure frictionless implementation of vaccination programs. In case an outbreak situation is reported, this schedule program needs to be flexible to relocate resources into more urgent needs. Before sending manpower to vaccinate birds, there needs to occur capacity building events showcasing correct procedures to vaccinate poultry. Additionally, a cold storage and distribution chain is inevitably required as there are no available vaccines that are thermo-stable or able to withstand drastic temperature and humidity variations (Bruschke *et al.*, 2007; OIE, 2007b).

Monitoring and follow up: AI vaccination does not always fully protect against infection and transmission of field virus strains, so there is a possibility of undetected infective virus circulation within a vaccinated population. With this in mind, it is strongly advised to consider a post-vaccination monitoring or surveillance system to provide data about circulation of field viruses. This is now seen as critically important because when field viruses are not isolated for laboratory analysis, genetic mutations cannot be detected, thus virulence can strengthen and vaccines are no longer useful. Within monitoring practices, proper collection and dispatch of field samples to reference labs will provide data concerning virus strains, mutations, vaccine effectiveness and vaccination progress. Furthermore, to monitor vaccination compliance, serum samples should be taken regularly to determine the level of vaccine-induced antibodies in vaccinated poultry. In field situations when birds show clinical signs of AI, tracheal and cloacae samples should be tested immediately for the presence of virus and all mortality should be tested for HPAI as well. Follow-ups to prior outbreak areas, processing plants and live bird markets serve as targeted surveillance sites (Bruschke *et al.*, 2007; OIE, 2007b).

Exit strategy: Every disease control measure has its limitations and vaccinations are characteristically a labour intensive, expensive option that can only extend up to resource availability and length of disease invasions. Nevertheless, a plan for cessation of activities must be in place immediately after manageable control of disease dispersion has been accomplished. Classical control methods should take over vaccinations as a control measure in order to avoid further disease outbreaks. An exit strategy outlines how this cessation process occurs (Bruschke *et al.*, 2007; OIE, 2007b).

Other considerations: Some issues that do not particularly fit any of the above items can be found here and these are only applicable depending on particular disease situations in each country:

1) Blanket vaccinations may be envisaged where HPAI has become endemic;
2) Immediate in-field risk analysis addresses biosecurity levels of poultry producing holdings, flock values, affected livelihoods and infection threats;
3) The number of vaccine doses ordered will depend on the vaccination strategy selected, the estimated number of poultry to vaccinate, the number of follow-up vaccinations necessary and on the capacity of the veterinary and health services to implement a vaccination campaign under exacting circumstances.

Conclusions: AI vaccinations, as a proven effective tool, should not be used as a stand-alone measure but it should always be combined with other classical control measures; therefore, vaccination plans should be an integral part of emergency and contingency preparedness plans, but it can only be applied on the basis of a comprehensive multifactorial risk assessment analysis of the location and disease situation.

Complementarily, in case HPAI outbreaks, it is recommended the implementation of the following principles: early detection in flocks, rapid confirmation of suspects (at reference labs), rapid and transparent notification and rapid responses via increased biosecurity, containment, culling of infected animals and disinfection of facilities.

This paper briefly describes HPAI and its animal-human consequences, but mainly outlines seven components of a national vaccination campaign to be considered in developing nations. The specific details of the components can only be defined after considering the precise set of conditions and circumstances faced at the time.

Successful disease mitigation episodes in several HPAI-infected countries provide an example of how private-public partnerships can work towards public good. In SE Asian countries, a first immediate round of vaccination was paid by public resources, but for the long term maintenance of vaccination programs, private sector has funded a good part of these expenditures, lowering financial burdens on local governments.

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