The role of vaccination in the eradication of virulent Newcastle disease in Australia particularly in relation to the egg industry

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SUMMARY

Australia claimed freedom from Newcastle disease (ND) in 2001 following the successful eradication of virulent ND from infected farms. The virulent virus was shown to have been derived from a series of mutational changes of the F protein cleavage site in endemic lentogenic virus, with a pronounced increase in virulence from the precursor virus. However, the detection of further precursor ND viruses in 2001 and outbreaks of virulent ND in NSW and in Victoria in 2002 again associated with mutated endemic viruses, prompted the formation of a ND National Management Group and a Steering Committee. Those committees developed a ND Management Plan. An integrated risk management approach was taken involving five operational projects. A control project involving biosecurity plans, strategic vaccination together with a national surveillance project to detect the presence of precursor and virulent ND virus (vNDV) were the major components of the Plan. Because of the potential for vNDV re-emergence, a vaccination strategy was developed that aimed to out-compete precursor viruses that have sequences close to that of the sequences of vNDV. The only live vaccine permitted is the lentogenic V4 strain. Vaccination uptake in states where vaccination is compulsory has been high although there has been some resistance amongst smaller layer farmers due to the cost of inactivated vaccine. The extent to which vaccination can prevent the spread of precursor virus seems paramount to the success of the program. Failure to communicate with the fringe sector of the industry on the need to vaccinate and to uphold high levels of biosecurity could allow precursor viruses to persist and prevent total eradication.

INTRODUCTION

The occurrence of virulent ND in Australia due to the mutation of previously endemic lentogenic ND viruses was reviewed for the 48th meeting of this conference (5). Further outbreaks of virulent ND occurred in two poultry production areas in NSW in 2000. A national serological and virological survey in 2000 failed to identify any precursor or virulent viruses. Following slaughter of poultry on the infected farms, Australia was declared free of ND in 2001. However, one isolated outbreak in Victoria in 2002, followed by three further outbreaks in NSW later that year, prompted the introduction of ND vaccination with the V4 strain of all commercial chicken farms in the Sydney area. These outbreaks also prompted the National Management Group (NMG), a high level government-industry committee responsible for emergency response plans, to request the development a National ND Management Plan. The Steering Committee of the NDNMG recommended an integrated risk-managed approach. This paper provides an outline of the operational projects created to meet the set objectives of the program with particular emphasis on ND vaccination and the egg industry.

NATIONAL ND MANAGEMENT PLAN

The integrated risk management approach was aimed to deliver the following goals:

a) Minimise the risk of ND outbreaks from Australian-origin virulent viruses
b) Protect the status of non-infected flocks and regions; and
c) Reduce the social, economic and trade impact of ND at farm, regional and national levels.

The operational projects to deliver these goals comprised:

1. A control project involving biosecurity plans, strategic vaccination and other agreed standard operating procedures (SOP).
2. A national surveillance project to detect the presence of precursor and virulent ND viruses.
3. A communication project to promote awareness in the poultry industry.
4. A research and development project to support the Plan.
5. A management and evaluation project to provide co-ordination and review implementation of the Plan.

LEGISLATIVE BACKING TO THE PLAN

The commonwealth and state governments have enacted legislation in the past to support exotic disease control in their respective jurisdictions. This enables regulations to be adopted in relation to compulsory vaccination. By early 2004, it is anticipated that five of the six states will have made ND vaccination compulsory.

VIRULENT ND IN THE LAYER INDUSTRY

Although the majority of outbreaks have occurred on broiler farms, 21 of those 27 cases in broiler chickens probably arose through transmission from nearby broiler farms. One outbreak occurred in an isolated broiler breeder flock. Ten of 13 ND outbreaks on layer farms occurred in isolated flocks without clear epidemiological connection to each other. On each occasion, the outbreak was associated with the introduction of naive pullets (NDV antibody negative) onto a multi-aged layer farm. Therefore, it was considered that virulent ND precursor virus, persistent in ND antibody positive older birds on these sites, mutated during propagation through the newly introduced pullets, resulting in a clinical outbreak.

RISK-BASED VACCINATION OF THE LAYER INDUSTRY

Because of the potential for vNDV re-emergence, a vaccination strategy was developed that aimed to out-compete precursor viruses that have a fusion protein gene sequence similar to that of the virulent virus. A risk-based approach was developed that allowed states or areas to claim an exemption from compulsory vaccination based upon surveillance data. Only one State, Western Australia made a successful case to avoid compulsory vaccination but will undergo intensive surveillance. A risk management approach requires all other commercial flocks in Australia to be vaccinated according to prescribed SOPs.

The only live vaccine permitted is the lentogenic V4 strain (6). Whilst V4 vaccine has some inherent limitations in relation to efficacy in the face of NDV maternal antibodies (9) and in layer flocks in cages (1), the proposed surveillance program involving auditing for compliance and serological monitoring will permit necessary amendments to the SOPs. Minimum serological haemagglutination inhibition (HI) titres were set at $\geq 2^3$ in rearing, and $\geq 2^5$ in production, following a single live vaccination in floor-reared flocks, or two live vaccinations for cage-reared flocks, followed by an inactivated vaccine at 12 –18 weeks of age.

Currently (2003), only one live V4 vaccine is available for use in Australia. Two other Australian vaccine manufacturers are trialing live V4 vaccines prior to making application for registration. One of those vaccines has undergone back-passage in chickens to attempt to improve infectivity (2). A recent report by Underwood and De Laney – unpublished) indicated that the Bioproperties Vaxsafe ND V4 Vaccine was able to produce comparable levels of protective antibody to that of the currently registered vaccine.

BIOSECURITY AND QUALITY ASSURANCE IN THE LAYER INDUSTRY

The Australian egg industry has undergone considerable contraction in ownership over the past five years with over 80% of production now under the control of three poultry companies. The total number of egg producing farms is estimated to be approximately 900, however, only about 270 of these contain more than 10,000 hens. This intensification of the industry has allowed the development of improved biosecurity programs (4) and the extension of this into a Quality Assurance Program incorporating food safety, biosecurity, welfare and product labelling. However, a considerable number of smaller producers remain refractory to biosecurity programs and continue to pose a risk to larger producers. Therefore, the ND control strategy incorporates monitoring of biosecurity programs. To increase incentives to implement biosecurity, an attempt is being made to link compensation for the cost of eradication to the level of biosecurity procedures adopted by the farmer.

FUTURE PROSPECTS OF ERADICATION

Australia would appear to have experienced a rather unique event in terms of the mutation of vNDV from an endemic lentogenic strain (7). The factors that encourage precursor and vNDVs to emerge are not well understood, although flock immunosuppression due to concurrent MDV, IBDV or CAV infection has been suggested to alter selection pressure during virus propagation through the flock, assisting evolution to virulence. Alternatively, Westbury (8) has suggested that vNDV may have

emerged slowly in accordance with the quasi-species concept (3) with evolutionary selection pressures on a heterogeneous population of NDVs causing those sub-populations to emerge that are best adapted to the changing poultry growing environment.

Knowledge of the epidemiology of the precursor viruses and the capacity of live V4 vaccination to eliminate the precursor viruses is not well understood. A research project on the latter aspect has been initiated at the Australian Animal Health Laboratory (AAHL). Some evidence that the initial use of live V4 vaccine in one broiler growing area in NSW resulted in no re-occurrence of vNDV suggested that live V4 vaccine was beneficial. A nationwide survey conducted in 2000 found no evidence of precursor viruses on farms where V4 vaccination was undertaken. However, a further outbreak of vND and the detection of precursor viruses in 2002 on non-survey farms, indicated that unvaccinated poultry farms were still at risk. Whether vNDV did spread between distant poultry growing areas in Australia is not known. However, it is known that precursor viruses existed in each of the outbreak areas and therefore had the potential to mutate into vNDV.

In those states where vaccination has become compulsory, there has been a high uptake of the live vaccine, however there remains resistance to the use of inactivated vaccine, particularly on small layer farm units. There also remains concern that the interference of vaccine replication by ND maternal antibody in broiler flocks, and the poor response to vaccination of layer pullets reared in cages, which may allow continued circulation of precursor virus in broiler and layer flocks, ultimately leading to further outbreaks of vND. A serological surveillance program has been established to monitor the response to vaccination in the layer industry to determine the current status of these flocks.

Whether the risk-based strategy proposed by the industry-government NDMG will succeed will depend upon a number of factors, some of which are related to the biology of the virus, and others dependent upon the enthusiasm with which the poultry industry and government face the problem. The extent to which vaccination can prevent the spread of precursor virus seems paramount to the success of the program. Failure to communicate with the fringe sector of the industry on the need to vaccinate and maintain high levels of biosecurity could allow precursor virus to persist and prevent total eradication.

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