NEWCASTLE DISEASE (ND) VACCINATION PROGRAMS FOR AUSTRALIAN BROILER CHICKENS

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**Summary**

The results of a number of laboratory and field trials on the efficacy of an experimental live ND V4 vaccine have been discussed in relation to their impact on the current ND eradication program in Australia. Evidence for reduced efficacy associated with ND maternal antibody (Mab) and when used in combination with infectious bronchitis (IB) vaccines raised concerns about the likely outcomes from the eradication program. Whilst some additional studies could assist in further evaluation of the now preferred day-old spray vaccination method, several alternate vaccination programs could be adopted in the interim.

I. INTRODUCTION

Evidence has been obtained that Australian broiler chickens can be protected against virulent ND virus challenge by vaccination from one week of age with the V4 strain of NDV (Bell, 1990; Arzey and Arzey, 2000). However, those studies were mainly undertaken in broiler chickens derived from parent flocks that had been exposed to endemic lentogenic field strains of NDV, which therefore had low levels of maternally-derived antibody (Mab). Recent use of inactivated vaccines as part of the current ND eradication program in Australia designed to provide long term protection to breeder flocks has resulted in high levels of ND Mab transfer to most broiler flocks. Vaccination of progeny from such flocks, particularly at day-old has resulted in lower than desirable levels of active ND antibody. This paper describes experiments that confirm this observation and makes suggestions as to how best to interpret responses to ND vaccination.

II. INTERFERENCE TO EFFECTIVE VACCINATION

Vaccination of chickens with live ND vaccines in the presence of ND Mab has been contra-indicated by a number of studies undertaken overseas (Allan, 1973; Westbury et al., 1984). These contra-indications were based largely upon the poorer development of active antibody following use of live lentogenic vaccines. Studies on the response to V4 vaccine virus have produced similar results (Kim et al., 1978; Westbury et al., 1984). Generally it was found that maternal antibody HI titres above 2\(^3\) would delay and depress the active antibody response to the live V4 vaccine. However, it was also generally concluded that young chickens vaccinated by the oro-tracheal/spray routes were more resistant to challenge than non-vaccinated or parenterally vaccinated chickens due to a combination of passive antibody and local/ cell-mediated immunity (CMI). Holmes (1979) presented evidence that stimulation of local immunity can bypass interference by maternal antibody. More recently, Reynolds (2000) showed that whilst CMI may play a role in protection in the face of ND Mab, it also requires neutralising antibody to be present.

Further studies by Reynolds (2000) demonstrated that local secretory antibody at the mucosal surface provided protection when chickens with high levels of maternal antibody

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were challenged with virulent virus. Hence, protection may be obtained in the absence of significant levels of active ND antibody.

Hatcheries are also under pressure to apply infectious bronchitis (IB) vaccines concurrently with the live ND vaccines at day-old. Overseas, concurrent administration of these two vaccines has remained controversial despite the marketing and wide sale of combined IB and ND vaccines. Vaccine manufacturers have generally followed recommendations by Winterfield (1984) to increase the ND vaccine component some 2 to 3 log_{10} over the titre of the IB vaccine component.

III. REGULATORY VACCINATION REQUIREMENTS

Removal of current ND vaccination exemptions for Western Australia and the implementation of legislation in Tasmania will result in all states and territories obligated to mandatory vaccination programs by the end of 2004 as described in a set of Standard Operating Procedures (SOPs) developed by the Technical Working Group (TWG) of the ND Management Group (NDMG). The SOP for ND vaccination of broiler chickens recommends that chickens be preferably vaccinated with live V4 strain ND vaccine at 7-14 days of age. However, the SOP also allows farmers the option of vaccinating at day-old provided they can show evidence of equivalence to the preferred program. Adequacy of the response to vaccination is defined as the mean haemagglutination inhibition (HI) titre of the flock being at least log 2 \(^3\) with at least 66% of the individual samples reaching a HI titre of 2 \(^3\) by 35 days of age. The latter program retains control of ND vaccination in hands of the hatchery where it has been claimed that improved uniformity (coarse-aerosol spray vaccination) and lower cost can be achieved than through administration by drinking water undertaken by broiler growers.

IV. STUDIES BY BIOPROPERTIES PTY LTD (BPL)

Over the past two years, as part of the application for registration, BPL has undertaken a series of laboratory and field studies on the safety and efficacy of a new seed of the V4 vaccine virus in chickens. It has used the existing registered live V4 vaccine as a benchmark in many of the trials. Whilst the trials were designed towards satisfying the regulatory requirements, they also touched on many of the variables described above that can impact on the success or failure of the live ND V4 vaccine relative to SOP requirements.

The following studies have been undertaken with BPL V4 vaccine:

1. The ND antibody response of SPF chickens vaccinated at 14 days of age
2. The ND antibody response of SPF chickens vaccinated at 14, 42 and 70 days of age
3. The ND antibody response of SPF chickens vaccinated at day-old.
4. The ND antibody response of ND Mab negative broilers vaccinated at day-old.
5. The ND antibody response of ND Mab positive broilers vaccinated at day-old
6. The ND antibody response of Mab positive commercial broilers vaccinated at either 7, 12 or 17 days of age.
7. The ND antibody response of commercial broilers vaccinated at day-old and 17 days of age compared to vaccination at 17 days of age only
8. The ND antibody response of SPF chickens vaccinated at day-old with combined ND V4 and IB vaccine compared to ND V4 and IB vaccines alone.
9. The ND antibody response of SPF chickens vaccinated three weeks after vaccination with Infectious bursal disease virus (Strain V877)
10. Field trials of ND V4 vaccines in commercial broiler chickens in two states.
V. SUMMARY OF RESULTS FROM THE STUDIES

SPF and Mab negative broiler chickens responded rapidly (within 14 days) and exceeded the SOP titre requirements by a wide margin (>2.0 Log₂ HI units). However, the ND antibody response in Mab positive broilers was delayed and inferior to Mab negative broilers. Antibody levels declined with age to approximate the SOP minimum level where they remained before increasing marginally by 35 days of age. Unvaccinated in-contact chickens exceeded the SOP minimum level by day 28 post-vaccination. Commercial broiler chickens responded more rapidly and exceeded the SOP minimum requirements when Mab titre levels were lower at the time of vaccination. Mab levels above $2^7$ were associated with delayed and lower active antibody responses. A single ND V4 vaccination at 17 days of age gave a superior active antibody response to a day-old vaccination followed by vaccination at 17 day of age. The ND antibody of SPF chickens to a combined ND + IB vaccine exceeded the SOP minimum titre by a wide margin. However, the antibody response was lower than that of ND V4 given alone. The ND antibody response in SPF chickens that had been previously vaccinated with an IBD vaccine exceeded the SOP minimum titre by a wide margin. In field trials involving some 36 broiler flocks (2.5 million birds), the experimental BPL vaccine provided active antibody levels that exceeded the minimum SOP titre in 91% of flocks compared to 64% following the administration of the reference ND V4 vaccine. Broiler flocks were vaccinated at 10 days of age when the mean Mab titre was $2^2$.

VI. RECOMMENDATIONS FOR BROILER VACCINATION IN AUSTRALIA

The studies undertaken by BPL produced results that were consistent with data previously observed overseas and in Australia on the efficacy of ND V4 vaccines. Interference by ND Mab was clearly evident with ND V4 vaccines particularly when they were administered in the face of high levels of ND Mab. The delayed and lower humoral response observed in these studies due to the presence of high Mab levels suggests the possibility that field viruses more virulent than V4 may have a greater opportunity for replication in these flocks if they are able to replicate in the presence of higher levels of Mab than the V4-strain vaccine. Concurrent administration of IB vaccine with ND V4 vaccine at day-old could further reduce the active antibody response. This could be particularly so when arbitrary proportions of the two vaccines are chosen rather than use of a correctly formulated combined vaccine.

As vaccination at day-old has now become the currently preferred program by most companies, the results described above should raise concerns as to the overall efficacy of this type of program. Whereas, broiler chickens with low levels of ND Mab could respond adequately and possibly seed the broiler shed, a high level of transfer from breeder flocks could well lead to inadequate humoral antibody responses. In the absence of adequate humoral antibody responses from day-old vaccination, dependence on local antibody and CMI for life-long broiler protection is contrary to well established overseas recommendations (MAFF 1974). These overseas programs normally recommend a second vaccination at about 18-21 days of age to stimulate high levels of neutralising antibody.

The control of endemic virulent and precursor viruses in Australia following the 1998-2002 outbreaks is partly dependent on the objective of the ND V4 vaccine out-competing those viruses. Although there is evidence that ND V4 vaccine will reduce the excretion of precursor viruses (Daniels, 2003), the level and frequency of challenge from such viruses is not well understood. The continued application of sub-optimal programs could well encourage the evolution of further precursor or virulent endemic strains.
VII. FUTURE DIRECTIONS

The TWG of the NDMG should consider whether the current recommended SOPs meet the overall objectives of the eradication program. Additional information on the response to vaccination under field conditions is urgently needed. Evidence of protection following day-old vaccination should be obtained through challenge studies or through evaluation of CMI/local immune responses to ND V4 vaccine.

In the interim, a number of alternate programs could be considered, as follows:

a) Delay primary vaccination until mean flock ND Mab levels fall below 2
b) Following day-old spray vaccination, revaccinate at about 18-21 days of age
c) Reduce ND Mab levels in broiler progeny by reducing the administration of inactivated vaccines to breeding stock.
d) Optimise the application of ND V4 and IB vaccines when used together.

REFERENCES