Vector vaccines – the new approach to Newcastle disease control

At the recent Ceva Vector Vaccine's Symposium in San Diego, USA the interesting subject of vector vaccines for Newcastle disease control was considered.

Thierry van den Berg from Belgium reviewed the use of vaccines in Newcastle disease control. He started by reviewing Newcastle disease which first appeared in Java and Newcastle (hence its name), England in 1906.

Highly devastating disease

Newcastle disease is a highly contagious and devastating viral disease and over 250 bird species are susceptible. Morbidity and mortality vary significantly but can approach 100% in chickens.

The disease is either enzootic or occurs frequently in most of central America, Africa, southern and south eastern Asia and China. Recent outbreaks are detailed in Table 1.

Clinical signs range from mild respiratory signs, diarrhoea and prostration through to high mortality. In layers egg drops are seen and some strains of the virus induce nervous signs. Newcastle disease viruses can be classified by severity and clinical signs into:

- **Velogenic:** High mortality of 80-100%. Velogenic neurotropic viruses cause nervous and respiratory signs and are genotypes II, whereas velogenic viscerotropic viruses causes haemorrhagic lesions in the gut (III-IX).
- **Mesogenic:** These usually induce mortality of <10% but can cause up to 50% mortality in young chickens. Respiratory signs are common and nervous signs are occasionally seen (II, IIa and III).
- **Lentogenic:** These viruses are tracheotropic and cause mild or inapparent respiratory disease and reduced growth rate (II and IIa).
- **Apathogenic:** These viruses are enterotropic and cause an inapparent enteric infection (I and Ia).

Year	Country	Outbreak
2000	Italy	Industrial and village poultry
2005-7	Greece	Broilers
2006	UK	Partridges
2006	Japan	Broilers and village poultry
2007	Honduras	Semi-industrial layers
2007	Sweden	Layers
2008	Japan	Broilers
2009	Sweden	Layers
2009-10	Israel	Layers and broilers
2009-10	Peru	Village poultry and fighting cocks
2009	Honduras	Village poultry
2009	Spain	Pheasants

Table 1. Recent outbreaks of Newcastle disease.

Currently vaccines are mainly made from strains of Newcastle disease virus isolated before 1960 (genotypes I-III) and are divided into attenuated and inactivated vaccines.

Attenuated vaccines

The attenuated are the routinely used milder lentogenic (II) and apathogenic (I) vaccines and the mesogenic vaccines (II-III) which will cause adverse reactions and are only used if Newcastle disease is endemic or to boost vaccination. Mesogenic vaccines are banned in the EU.

Modern poultry production has a large number of birds in a single space so we need effective and efficient methods of vaccination that vaccinate a high proportion of the birds in the flock.

Goals of vaccination

Vaccination's goals are to give the bird/flock resistance to infection, prevent the clinical signs of disease and reduce viral shedding from infected birds.

Current Newcastle disease vaccines reduce but do not eliminate field infection and viral shedding and many have a residual pathogenicity of their own.

There are some issues of maternally derived antibody interfering with the establishment of good protective immunity and there is no serological differentiation between vaccinated and infected birds (DIVA).

In addition, there is a poor correlation between HI humoral antibody response and protection due to the low sensitivity of the HI test and this test only detects antibody against the HN antigen.

There is no direct correlation between the HI test and viral shedding nor cell mediated immunity which plays an important role in protecting birds from this disease.

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Table 2. Year on year (August-October) results for 2007-2009.

Year	Vaccine	Age	Mortality (%)	Weight (lb)	FCR	Condem. (%)
Small birds						
2007	B1	40.45	3.5	4.40	1.80	0.35
2008	Vect.	39.0	2.6	4.50	1.74	0.39
2009	Vect.	37.8	2.0	4.51	1.70	0.07
Regular birds						
2007	B1	53.8	5.5	6.33	2.04	0.34
2008	Vect.	53.3	3.4	6.77	1.98	0.22
2009	Vect.	49.8	2.6	6.35	1.94	0.12

Table 3. Three year comparison (August-July).

Year	Vaccine	Age	Mortality (%)	Weight (lb)	FCR	Condem. (%)
Small birds						
2007-08	B1	40.7	4.4	4.45	1.81	0.63
2008-09	Vect.	39.0	2.8	4.56	1.76	0.23
2009-10	Vect.	38.2	2.6	4.47	1.73	0.12
Regular birds						
2007-08	B1	52.9	5.8	6.30	2.03	0.34
2008-09	Vect.	51.2	3.5	6.50	1.98	0.23
2009-10	Vect.	49.6	3.4	6.49	1.95	0.21

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So this provides an ideal opportunity for the use of a live vector vaccine which is both safe and efficacious.

Safe in terms of the vector virus' inability to revert to a virulent form and because it is free of adjuvant and efficacious because these vaccines bestow a broad immunity, have a rapid onset after a single administration and there is no interference with maternal Newcastle disease antibodies.

In addition, the vaccine is bivalent if the vector is also a vaccine as is the case when HVT is used and the vaccine is flexible in that the adapted gene can be adapted to the situation. Also, the vaccines allow a differential diagnosis between field and vaccinal challenge (DIVA).

Newcastle disease immunity is general (humoral), cell mediated and local (HALT – head associated lymphoid tissue, BALT – bronchus associated lymphoid tissue and GALT – gut associated lymphoid tissue).

Recombinant vaccines

Newcastle disease vaccination can be further improved by improving the immunological parameters that could correlate with clinical protection and reducing viral shedding.

This can be achieved by using recombinant vaccines and by using a combined vaccination strategy, for example, primary vaccination with a live vector vaccine (rHVT-ND – Vectormune HVT-NDV) in ovo or at day old) and secondary vaccination with a live attenuated vaccine (Cevac Vitapest L).

Successful trials

Trials with layer chicks showed that this gave 100% protection, whereas Vectormune HVT-NDV on its own only gave 90% and Cevac Vitapest L on its own only gave 70% within a week of vaccination.

In addition, the dual vaccinated birds showed significantly less viral shedding by the oropharyngeal and faecal routes earlier than the other vaccinations did. Better immunity was also produced.

In another study the birds were challenged at six and 10 weeks of age with a Mexican field strain of Newcastle disease virus. All vaccine regimens detailed above gave protection at six weeks but at 10 weeks only the Vectormune HVT-NDV + Cevac Vitapest L gave full protection.

Dr Tom Holder from US integrator Allen's Family Foods then shared his field experiences with HVT vector Newcastle disease vaccines.

Before using the vaccine he had several questions that he wanted answers for. These were:

- Would it replace the standard B1 programme?
- Would it provide protection for both Marek's and Newcastle disease?
- Would a booster be needed?
- What dosage was needed to give protection?
- Which product to use?
- What was the cost?

To address these questions he set up a field trial in which two products were compared and their results were compared to the B1 programme that had been previously used.

Very quickly it became apparent that the Ceva product was better and produced less early mortality so the Ceva programme was instigated in the company before the trial was completed and it has run ever since.

The company produces small and regular birds and an analysis of year on year figures shows the benefits obtained (Tables 2 and 3). In the winter of 2008-09 respiratory noise was heard in some flocks but no Newcastle disease virus was isolated. No live Newcastle disease vaccines have been used for over two years. What was interesting was the history of respiratory virus isolations from birds showing respiratory signs (Table 4).

NDV vaccine	Sampling period	IBV positive flocks		NDV positive flocks	
		No.	%	No.	%
NDV B1	Jan-May 08	38/115	33	34/115	30
rHVT-ND	June-Nov 08	11/37	30	0/37	0

Table 4. Virology data.

Conclusion

So now the company regularly uses the HVT vector Newcastle disease vaccine because of the following factors:

- Less stress.
- No interference with IB vaccination.
- Lower mortality and condemnations.
- Better bird uniformity.
- Elimination of Newcastle disease virus from broiler houses.
- Lower cost of production. ■