A practical look at the future of vaccination in poultry

At the recent Ceva Vector Vaccines Symposium in San Diego, California, USA, Ceva's Yannick Gardin gave a succinct and thorough overview of poultry vaccination.

Yannick opened by highlighting that our industry's successful past means that nowadays we need to produce more and more poultry products for consumers who are more and more demanding. In addition, the future will be characterised by an increased human population, an improvement in life style for many and a global further standardisation of consumption behaviour.

All of this will lead to even stronger demands for poultry products for human consumption in the years ahead.

Poultry is very much to the fore among meats because of its nutritious 'healthy' status; it has no religious barriers; technologically it is very versatile and it has lower production costs. In essence, there is a need for more intensive production.

Better sanitary risk control

As a consequence of larger farms, genetic selection, standardisation of farming and management techniques, mechanisation of hatcheries and better, more cost effective feed there will be a need for even better sanitary risk control. This is especially so as larger units represent a higher sanitary risk and should disease get in its economic impact will be greater.

In addition, customers are becoming increasingly concerned about chemical residues, antibiotic resistance, the risk of zoonoses, environmental impact of farming practices and, of course, animal welfare.

Unfortunately, reliance on antibiotics will have to reduce and so greater emphasis will be placed on biosecurity and the routine use of vaccines.

One approach to disease control is eradication, but the 2002-3 outbreak of very velogenic Newcastle disease in California has shown how expensive this can be (Table 1).

Future disease management systems will place increasing reliance on surveillance programmes, genotyping pathogens, evaluating their pathogenicity and assessing potential geographical spread and risk evaluation.

The use of antibiotics will decline and reliance on vaccines will increase as will the use of disease management strategies.

Historically, vaccines were either live attenuated or inactivated adjuvanted vaccines. Live vaccines had varying levels of pathogenicity/attenuation (Table 2) and this was associated with varying levels of side effects. Thus, the scene is set for new vaccines. Various factors have favoured this. Firstly, globalisation has meant that generally similar genetics and management systems exist around the world with movements between areas that firstly spread pathogens and ultimately result in a global uniformity of pathogens.

Secondly, the industry has repeatedly requested simpler vaccines that are easier to use, more efficacious and cheaper.

So, if we look at the molecular basis of pathogens very simply virulence genes produce virulence and protective genes produce protective factors or protection.

Table 1. Key statistics for the 2002-3 Californian Newcastle disease outbreak.

- 7,000 Government personnel involved.
- 10 months to control.
- Cost of $US168 million.
- 21 commercial poultry farms affected.
- 100 or so fighting cock 'farms' affected.

ND	IBD	MD	Pox	IB	ILT	MG
Apathogenic	Mild	Serotype 3	Pigeon pox	High egg passage	TCO	6/85
Lentogenic	Intermediate	Serotype 2		Medium egg passage		ts-11
Mesogenic	Intermediate plus	Serotype 1	Chicken pox	Low egg passage	CEO	F-strain

Table 2. Live, attenuated vaccines.

Deleted vaccines

The first option this then gives us is to delete the latter genes and leave the former ones to produce what is known as a 'deleted vaccine'.

This is a virus that has lost its virulence gene and hence its ability to cause disease but retained its protective gene(s).

Alternatively, we can take the protective gene and insert it and its ability to provide protection into a harmless virus, thereby producing the so called 'vector vaccine'.

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Table 3. Comparing 'new' and 'old' vaccines.

	Live	New	Killed
General immunity	-/++	++	+++
Local immunity	+++	+++	-
Cellular immunity	+++	+++	-/+
Onset of immunity	+++	+++	+
Interference with MDA	+/+++	NO	++
Duration of immunity	+	+++	+++
Antimicrobial activity	-/+	++	-
Local lesions	-/+++	NO	+/+++
Post vaccinal reactions	-/++	NO	-/++
Spreading	-/+++	NO	-
Genetic stability	-/++	+++	-
Cost	+	+/++	++

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Another option is to take the protective factor out of the virus and make what we call a 'sub-unit vaccine' just from this protective factor.

Vector vaccines have the advantage that they are live, whereas sub-unit vaccines are inactivated which provides benefits in terms of mass vaccination for the vector vaccine.

Sub-unit vaccines require individual bird administration. Other options are possible. However, if we compare these new vaccines with the traditional live and killed vaccines (Table 3) we can see that on most parameters they are superior.

Up to now the two main problems associated with vaccination of poultry were the interference between vaccines and maternally derived antibodies and the quality of (uniform) vaccine administration. The first of these is highlighted by the trade off between breeder protection and vaccine take in their progeny chicks. In fact, the key problem is interference between vaccine and passive immunity because, if it is not present, vaccination in the hatchery is possible and the problem of quality of vaccine administration is virtually solved.

Vaccination	Protection (%) against 2007 H5N1 isolate	2008 H5N1 isolate
No vaccine	0	0
Inactivated H5N2	100	0
Vectormune HVT-AI	100	100

Table 4. The Egyptian HPAI story.

The key advantage of vector vaccines is their capacity to break through passive immunity. For example, if we take a live Newcastle disease vaccine (Hitchener B1) and administer it at day old by eye drop and then challenge the birds every five days with a very velogenic Newcastle disease virus the outcome is 100% protection by 20 days if there is no interfering maternal immunity, but <60% protection if maternally derived antibodies are present.

Similar results for a killed vaccine would be 85% and <60% respectively. If a vector vaccine (Vectormune HVT-NDV) is used, the protection is 100% even in the face of maternally derived antibodies.

In addition, results have shown that vector vaccines give a longer immunity – a recent Thai trial showed birds vaccinated with Vectormune HVT-NDV at day old to be fully protected against a Newcastle disease challenge 17 weeks later. In Egypt the value of vector vaccines against highly pathogenic avian influenza has recently been highlighted in the field. In 2007 an inactivated vaccine based on avian influenza virus H5N2 adequately protected birds, but a year later the H5N1 HPAI virus had changed and the results were very different . However, on both occasions a vector vaccine (Vectormune HVT-AI) worked (see Table 4).

A look into the future

Yannick concluded by looking into the future. He forecast that within 10 years the majority of poultry vaccines will be derived from molecular biology and will be applied in the hatchery and that from now on the limit to innovation will be imagination and relevance and not technique.

Vector vaccines, which can be polyvalent, will enable fewer and more customised vaccines to be used so there will be less vaccinations giving better protection.

The availability and success of these new vaccines will depend on:

- Means dedicated research.
- Concept and design of vaccines.
- Relevance and adaptation to the market.
- Freedom to operate and adequate protection from patents.
- The attractiveness of the poultry market to the vaccine producer.

However, even with new vaccines it will still be important to have good quality chicks going into a good environment and being fed good quality feed! ■