Prevention of Newcastle disease – past, present and future

by Marcelo Tafuri Paniago, director global technical services – poultry, Ceva Santé Animale.

Without a doubt, Newcastle disease is one of the most economically damaging diseases for the poultry sector. Moreover, despite being recognised 85 years ago, having as etiological agent one single serotype of avian paramyxovirus (APMV-1) and the availability of several types of commercial vaccines, Newcastle disease has continuously challenged veterinarians and farmers all around the world.

In the early days of the poultry industry, producers' main objective was to prevent the high mortality rates caused by this disease. As the scientific knowledge on the disease progressed, the poultry industry started to look not only for efficacious vaccines but also to aim at products safe enough to avoid the negative impact of post-vaccination reactions on birds' performance usually associated with the use of live Newcastle disease vaccines.

This article attempts to briefly review the history of the development of Newcastle disease vaccines from the first advances some 80 years ago up to the most recent introduction of molecular technique-based biologicals.

Mesogenic strains

Since the initial outbreaks of Newcastle disease reported in Java Island, Indonesia, and Newcastle upon Tyne, England, in 1926, a tremendous amount of scientific investigations on the prevention and control of the disease by vaccination has been carried out.

The first studies involved injection of inactivated viral material, but problems in production and standardisation discouraged its use on a large scale. Then, attenuation of virulent strains was attempted in different parts of the world.

In England, during the 1930s, Iyer and Dobson did sequential passages of the Herts' 33 isolate through embryonated eggs and produced a virus of lower virulence, named Hertfordshire (H) strain, that could be used as a reasonably safe antigen for mass immunisation. Later on, Iyer submitted the Ranikhet isolate from India to the same attenuation process and developed the Mukteswar mesogenic strain. In Palestine, another similar mesogenic strain was produced by Komarov after serial intracerebral passages of a field isolate in ducklings.

In the USA, Beaudette screened 105 isolates of Newcastle disease and selected a strain known as Roakin which was considered suitable as vaccine antigen.

In 1948, the Roakin strain was commercially introduced in that country for wing web administration in birds older than four weeks.

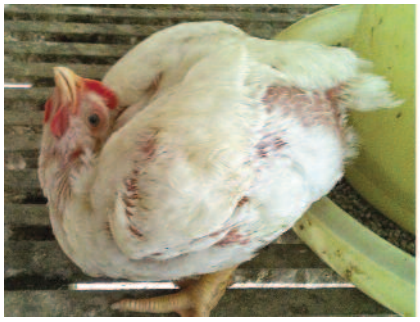
Although these vaccines induced very good protection against field challenge, their problem was that, while attenuated to a certain extent, they were still capable of causing disease and high mortality in fully susceptible birds.

Moreover, these vaccines had to be applied to birds older than four weeks of age. Because of the very variable passive immunity in day-old chicks, part of the flock would still need to be vaccinated before that age. This fact created a strong demand for safer vaccines that could be applied earlier.

Virus strain	ICPI	Classification
V4	0.0	Apathogenic enteric
PHY.LMV.42	0.0-0.16	Apathogenic enteric
Ulster 2C	0.0 (0.14-0.23)	Apathogenic enteric
VH	0.15	Apathogenic enteric
Hitchner B1	0.20	Lentogenic
F	0.20	Lentogenic
VG/GA	0.35	Lentogenic
Clone LaSota	0.36	Lentogenic
LaSota	0.40	Lentogenic
Mukteswar	1.40	Mesogenic
Komarov	1.41	Mesogenic
Roakin	1.45	Mesogenic

Table 1. Newcastle vaccine strains.

Broiler with torticolis (twisted neck).



Lentogenic vaccines

In the USA, during the 1940s, the search for a live vaccine against Newcastle disease was among the priorities in some research institutes. In 1947, at the Virginia Polytechnic Institute, Hitchner, working with virus strains received from Beaudette, Poultry Pathologist at the New Jersey Agricultural Experiment Station, developed the B1 strain which was licensed for commercial production in 1950.

Due to the strong demand for milder vaccines, Beaudette revised his records on those 105 strains he had screened to try to identify any candidate with some possibilities to be of low virulence.

Finally, he selected three of them and, after several months of additional trials done at Vineland Poultry Laboratories, one single strain was selected.

It had been isolated from Adam LaSota's farm and the vaccine strain was named after him (LaSota strain).

On the other side of the Atlantic Ocean, in 1952, Asplin reported the results of a study on a Newcastle disease virus strain that had been isolated some years before from an

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outbreak of a mild respiratory disease in young chicks in England. This virus was similar to B1 strain in virulence and immunogenicity and it was designated F strain.

However, as the poultry industry evolved worldwide, the level of vaccine reaction became a very important issue for intensive poultry production companies.

One of the attempts to produce vaccine strains which would induce less post-vaccination reactions (PVR) was through the selection of a subpopulation from a given Newcastle disease strain and then growing a homogenous population from it. Such new virus population would give less vaccinal reactions while retaining its immunogenicity. An example of this kind of development is the 'clone 30' selected from a LaSota strain.

These cloned Newcastle disease vaccines were initially introduced on the market in the 1980s and had a very good acceptance by producers.

Apathogenic enteric vaccines

Even though cloned lentogenic vaccine strains proved to induce less reaction than the original virus population, these strains still caused significant damage to the respiratory system and, with time, started to be considered undesirable in intensive production systems.

More recently, Newcastle disease vaccine strains that replicate not only in the respiratory tract, but also in the intestine and therefore preserve the respiratory system were introduced into the market and gained wide acceptance among producers.

They are classified as apathogenic enteric and the most common commercially available vaccine strains are Ulster 2C, PHY.LMV.42 and V4.

These apathogenic strains have a very low Intracerebral Pathogenicity Index – ICPI (Table 1), hence they induce negligible post vaccination reactions. Because of their safety, they can be applied to day-old chicks in the hatcheries.

However, there is the inconvenience of the partial interference with maternally derived antibodies, therefore the necessity of revaccination in the farms in case of heavy Newcastle disease challenge.

It was also observed that some apathogenic enteric viruses have greater heat resistance than lentogenic viruses. This property was further enhanced by selection and cloning in the laboratory to produce heat tolerant vaccines.

This kind of strain has a distinct advantage for backyard flocks because it is possible to transport the vaccine without an established cold chain and apply it in the feed.

The most extensively used vaccine has been the Newcastle disease V4-HR vaccine, which was pioneered in Malaysia. The same vaccine has also been tried in other countries in South East Asia and Africa with different degrees of success.

Oedema around the eye.

Live and inactivated vaccines

In the 1970s, the association of live and inactivated vaccines against Newcastle disease applied to day-old chicks was extensively investigated. The results show that higher HI titers, better protection against challenge and longer persistence of immunity can be achieved when the combination of live and inactivated vaccines is used as compared to live or inactivated alone.

The benefit of the combination of live and killed vaccine at hatchery is particularly clear in a context of strong viral pressure as it strengthens and prolongs the protection by combining the local immunity provided by live attenuated vaccine with humoral immunity (circulating antibodies) conferred by inactivated vaccines.

Even though this combination does strengthen the protection against ND, interference with maternal derived antibodies reduces its efficacy and therefore booster(s) in the farms is clearly recommended in locations where there is a strong ND pressure.

Genotype-matching vaccines

Although strains of Newcastle disease virus are antigenically considered to be of a single serotype, they can be separated into genotypes due to genome differences.

Based on this characteristic, vaccines produced from Newcastle disease strains closely related to field isolates have been attempted. Indeed, in some countries in Asia where the field challenge is rather strong, vaccines produced from Genotype VII using the reverse genetic technology have been developed and the preliminary results are encouraging. Moreover, it was reported that a recombinant La Sota strain in which fusion (F) and haemagglutinin-neuraminidase (HN) genes were replaced with those of a contemporary genotype VIId virus has been developed.

According to the authors, this live vaccine seems to be a promising strain in terms of antigenicity, productivity, safety, and pathogenic stability. Nevertheless, further studies are still necessary in order to confirm whether these new vaccine strains and tech-

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nology will actually provide a breakthrough in the prevention of the losses due to Newcastle disease (clinical signs, egg drops, shedding).

Vector vaccines

Vector vaccines can be briefly defined as the product originated from the process where one or more genes from a micro-organism (called donor) are inserted into the DNA of another micro-organism (called vector).

In this way, the immune relevant antigens of the two organisms are presented to the immune system of the animal by replication of the vector antigen. Therefore, immunity against both the vector and the donor (pathogen) will be induced.

Currently, there are two different types of vector vaccines against Newcastle disease on the market.

The first one uses the fowl pox virus as a vector and genes which will encode the HN proteins are inserted into its DNA. This product has been commonly used in turkeys. The second construct inserts genes which will be translated into F protein into the DNA of herpesvirus of turkeys (HVT) and it is used in chickens.

The vector HVT-NDV vaccines induce very strong protection against Newcastle disease and therefore reduce significantly the shedding of the challenged virus. They are extremely safe as they do not expose the chickens to live Newcastle disease virus. Besides, there is no interaction with other respiratory live vaccines such as infectious bronchitis.

Due to the periodic replication cycles of the HVT, the immunity against Newcastle disease is constantly boosted and therefore a long lasting protection is achieved.

Ultimately, the vaccine completely overcomes the problem of interference with MDAND, which other live and inactivated Newcastle disease vaccines face when they are applied in hatcheries.

Conclusions

Since the early days of the poultry industry, bird mortality prevention has been of key importance to producers.

In Newcastle disease endemic areas, the prevention of this disease assumes a key role in any vaccination programs. Several different types of live vaccines are commercially available to cope with this challenge.

From highly reactive mesogenic strains to extremely safe vector Newcastle disease vaccines, this evolution clearly shows that researchers have always kept an eye on the producers' demands.

Nevertheless, even having very efficacious vaccines on the market, vaccination alone is insufficient to control Newcastle disease. Strict biosecurity rules and proper hygiene procedures are essential to any effective prevention program against this disease.

Finally, it is also important to mention that the results of any vaccination can be deeply affected by mycotoxins, environmental factors and concurrent immunosuppressive viral infections like Gumboro disease, Marek's disease and/or chicken infectious anaemia virus.

All of these factors must be taken into account in order to induce the best protection against Newcastle disease challenge. ■

Oedema in velogenic viscerotropic Newcastle disease.

References are available from the author on request