EU thinking on Newcastle vaccination

Recently the EFSA published its report on Newcastle disease, focusing on vaccination worldwide in order to determine its optimal use for disease control, that it undertook for The European Union. We will now summarise its findings and recommendations.

In its background section the report highlights the recent outbreaks of Newcastle disease that have occurred since 2002 in Denmark, Austria, Finland, Sweden, Cyprus, France, Greece, Portugal, Slovakia, United Kingdom, Greece and Hungary.

Vaccination of poultry flocks against Newcastle disease is practised in most countries of the EU. The exceptions are Finland, Sweden and Estonia. Denmark has only recently introduced Newcastle disease vaccination.

The report focused on three areas:

- A review of vaccines and relevant vaccination programmes worldwide.
- The role of wild/racing pigeons and other species in the spread of Newcastle disease.
- The current definition of Newcastle disease and the need to classify Newcastle disease virus strains in a similar way to the way that avian influenza strains are classified in order to support the implementation of control measures through the revision of the EU Council Directive.

In the viral classification Newcastle disease virus is an Avulavirus belonging to the family Paramyxoviridae. There are nine avian paramyxoviruses and all pathogenic strains of avian paramyxovirus-1 (APMV-1) are called Newcastle disease virus.

The heterogeneity within APMV-1 has been based on the observation that different viruses have a varying ability to cause disease in chickens. This resulted in virus definitions such as viscerotropic velogenic and neurotropic velogenic Newcastle disease.

Estimation based on various lethal effects resulted in defining parameters such as mean death time (MDT), intracerebral pathogenicity index (ICPI) and intravenous pathogenicity index (IVPI). Heat inactivation (56°C for five minutes) revealed that there are two types of lentogenic virus with many of the strains from wild birds not being inactivated. Comparison of these parameters is shown in Table 1.

Pathotype	ICPI	IVPI	MDT	Thermostability
Velogenic	>1.5	>2.5	<60 hours	Yes
Mesogenic	0.7–1.5	0.0	60-72 hours	Yes
Lentogenic/avirulent	<0.7	0.0	>90 hours	Yes/No

Table 1. Correlation between the results of in vivo and in vitro methods.

However, since the late 1970s direct virus investigation has been possible using methods such as monoclonal antibody techniques.

One of the key molecular techniques used detects viral RNA and this has become the routine method since the development of traditional and real time RT-PCR systems capable of targeting conserved regions of the F or M genes of the virus. This provides valuable characterisation data in just hours.

This technology is able to unambiguously identify lentogenic vaccine strains (LaSota and B1) and has meant that the confirmation of lentogenic viral isolates from vaccinated flocks as genuine field isolates or derivatives of vaccinal strains used in a region is now possible.

It has now been shown that an ancient division in the primordial (wild water bird species) led to two sister classes of Newcastle disease viruses – Class I and Class II (see Table 2).

A second major division occurred in the 20th Century in the chicken (secondary) host and this gave rise to the branching off of a group of genotypes including V – VIII. Non-pathogenic members of recent genotypes have never been detected.

Viruses isolated from outbreaks in or before the 1950s are all members of genotypes II to IV and these were gradually replaced worldwide by genotypes V – VIII in recent times.

Poultry are regularly vaccinated with live vaccines produced from LaSota, V4, Mukteswar, B1 and F strains belonging to earlier genotypes I – III but outbreaks caused by these genotypes still occur quite regularly in developing countries.

Genotypes IX and X and country specific subgenotypes such as VIIc and VIId are continuously being identified in south east Asian countries and it has been suggested that the genetic divergence between vaccine stains and recent genotype strains of Newcastle disease virus is increasing because of immune pressure induced by inappropriate vaccine practices.

In addition, genetic, and probably antigenic, divergence between vaccine and field strains is probably also contributing to the fruitless control of Newcastle disease in endemic regions.

Recently the capacity of genotypes to break through early genotype vaccine induced protection has been regularly demonstrated, but these vaccines are significantly more effective in preventing the shedding of early genotype viruses.

It is suggested that new vaccines based on more recent genotype viruses might be necessary for the future control of Newcastle disease.

As non-pathogenic recent genotype strains have not yet been found this might necessitate the use of recombination techniques in their development.

Newcastle disease is a notifiable disease in the EU and in most other countries. The occurrence of this

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Class	Genome size (nucleotides)	Genotypes	First isolates	Main reservoirs	Typical symptoms	Pathogenicity for chicken
I	15198			Water birds	Asymptomatic	Apath.
II	15186	I		Water birds	Asymptomatic	Apath.
	15186	II	N America	Poultry	Neurotropic	L,M,V*
	15186	II	Asia	Poultry	Viscerotropic	M,V
	15186	IV	Europe	Poultry	Viscerotropic	V
	15192	V	S & C America	Poultry, cormorants	Viscerotropic	V
	15192	VI	Asia/Middle East	Poultry, pigeons	Viscerotropic	V[1]
	15192	VII	Far East	Poultry, geese	Viscerotropic	V
	15192	VIII	Africa	Poultry	Viscerotropic	V

*L = lentogenic, M = mesogenic and V = velogenic [1]PPMV-1 viruses may appear as L or M at beginning of outbreak in chickens

Table 2. Phylogenetic relationships between APMV-1 viruses.

Table 3. The survivability of APMV-1 viruses.

Sample	Time	Temperature (°C)
Skin and bone marrow of chicken carcases	5-6 months	1.1-1.7
	10 months	-15.5
On eggshell	24 hours	36.6
Feathers	123 days	20.0
Dried on glass	396 days	1.1-1.7
Soil (humidity 100%)	22 days	20.0
Soil (humidity 15%)	8-15 days	20.0
Contaminated lake water	11-19 days	

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disease greatly influences production and trade in poultry and poultry products. As a consequence, outbreaks of Newcastle disease will result in control measures to confine this pestilence.

Although APMV-1 viruses are enveloped they have proved to be relatively stable outside the host and this property opens up routes for indirect infection through contaminated materials and fomites as well as via humans and other animals. The survivability of the virus is summarised in Table 3.

For the spread of APMV-1 the commonly implicated sources of APMV-1 infection are summarised in Table 4.

The typical clinical signs of APMV-1 infection in chickens are summarised in Table 5.

- Movement of poultry/chicks for restocking.
- Feral birds, pet/exotic birds, game birds, racing pigeons.
- Movements of people and equipment.
- Movement of poultry products.
- Airborne spread.
- Contaminated poultry feed.
- Contaminated water.
- Vaccines.
- Contact with other animals.

Table 4. Common sources of APMV-1 infection.

Sign	Velogenic Viscerotropic	Neurotropic	Mesogenic	Lentogenic	Asymptomatic enterotropic
Diarrhoea	Fierce	–	–	–	–
Respiratory	–	Fierce	Intermediate	Mild*	–
Nervous	Intermediate*	Fierce	Intermediate*	-	–
Drop in eggs	Fierce	Fierce	Intermediate	Mild*	–
Morbidity	Fierce	Fierce	Intermediate	Mild*	–
Mortality	Fierce	Intermediate	Mild	Mild*	––

*Clinical signs only in compromised or young birds.

Table 5. The typical clinical findings in APMV-1 infections in chickens.

The report then went on to consider prevention and intervention strategies. Firstly, hygiene and biosecurity was emphasised. Biosecurity has two roles – preventing disease getting into the farm in the first place and, should this fail, preventing disease from spreading from an infected farm.

However, the importance of some routes of infection, such as the airborne one, have not been adequately scientifically quantified.

Basically biosecurity's role is to create a barrier between the farm's stock and the outside world. It is impossible in free range farming and society is demanding more of this type of production!

Biosecurity is not just a farm issue. The outbreak of Newcastle disease in the UK in the 1980s was caused by infected pigeons accessing feed stores in Liverpool Docks.

The spread of Newcastle disease is boosted by the structure of the poultry industry and the report feels that any form of compartmentalisation of the poultry industry and its suppliers will reduce the spread of Newcastle disease. This would especially be the case with non-virulent forms of the disease which tend to spread imperceptibly. Hobby poultry and pet birds are generally kept in small flocks and, as such, do not shed much less virus than large commercial flocks.

In addition, contacts between such flocks and commercial poultry operations tend to be accidental. It is therefore thought that the contribution of pet and hobby flocks to the spread of Newcastle disease during epidemics may not be that great.

Interestingly, in the Newcastle disease outbreak in Holland in 1992 hobby flocks were not implicated even though they were not vaccinated.

In the 2002 outbreak of velogenic Newcastle disease in backyard flocks in California , it is believed that the disease was brought into the USA via illegally imported fighting cocks. Very few outbreaks occurred in commercial flocks and in one such case it was proven that a worker had links with fighting cocks.

The report emphasises the importance of surveillance systems based on clinical signs to detect a Newcastle disease outbreak early on.

Serological monitoring will not detect Newcastle disease in its early stages because it takes 7-10 days for antibodies to develop. In addition, the frequency and number of samples required for serological monitoring to detect the disease reasonably early are cost prohibitive.

It must be noted that 'free from Newcastle disease' can not be guaranteed in absolute terms and so 'free' implies that the prevalence of the disease is below the level specified in the monitoring programme.

In many situations Newcastle disease is best controlled by prompt detection coupled to the prompt culling of infected flocks followed by thorough cleaning and disinfection of the farm and its equipment.

Vaccination will protect poultry against the disease and mortality but, depending on the level of immunity, not against infection and subsequent viral shedding.

Therefore, in a vaccinate population one can no longer rely on surveillance for clinical signs and mortality to detect the disease.

In addition, serological monitoring is ineffective because vaccination induces antibody production!

If prophylactic vaccination is to be used in a poultry dense area against highly pathogenic avian influenza it was calculated that all poultry within a 35-50km radius around the infected farm should be vaccinated.

A similar distance would appear to be reasonable for an outbreak of very velogenic Newcastle disease.

When it comes to vaccination strategies in Newcastle disease control there are great variations between countries and these are detailed in the report.

However, the report stresses that the capabilities of vaccines is often overestimated and some of the factors that can reduce the efficacy of Newcastle disease vaccination are detailed in Table 6. The report goes on to cite preferred vaccination regimens for various bird types, future developments in vaccine technology, the reasons for vaccination failure and the criteria for evaluating the efficacy of vaccination.

The difference in Newcastle disease viral lineage is interesting (see Table 7).

Finally, the report highlights the variations that occur across the EU in case definitions, the reliability of reporting systems and the impact this has on comparing outbreaks in different countries.

It is recommended that data should be collected in a systematic fashion with a specific aim and at the outset that that aim is clearly defined. Over 30 key pieces of information about each case outbreak are defined. ■

Lineage	Pigeons/ captive	Poultry
4b	27	4
4d	0	1
5b	0	262
5e	4	0
Unknown	1	37
Total	32	304

Table 7. Comparison of virus lineages in pigeons and other birds in captivity from outbreaks in Western Europe in the last decade.

Table 6. Factors which may reduce the efficacy of Newcastle disease vaccination under field conditions.

Complex	Individual factors
Individual	Genotype, phenotype, age, tenacity.
Immunocompetence and state of health	Nutritional conditions, inocuability, maternal antibodies, immunosuppression, infections (for example parasites), transport stress, hygiene.
Vaccination management	Vaccination intervals and programme, date of vaccination (for example during lay), choice of vaccine, vaccination during incubation of the disease or after first disease outbreaks, wrong usage/administration of vaccines, errors in storage and transportation.
Disease/immunity	Flock immunity, virulence of field strains, multifactorial disease.
Season and climate	Seasonal start of vaccination, humidity, temperature.
Husbandry/housing	Housing conditions, husbandry and production technology, environment and hygiene in the poultry house, stocking density, number of houses, flock rotation, productivity requirements.