

# A Comparison of the Different Vaccines Available for the Control of Newcastle Disease in Village Chickens

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## *Abstract*

This paper briefly reviews the advantages and limitations of the different vaccines available for use against Newcastle disease in village chickens. Inactivated vaccines give very good immunity without vaccinal reactions and have been widely used, but are relatively expensive and require training to apply. Live vaccines are easy to apply and relatively inexpensive, and give moderately good immunity. Vaccinal reactions to them vary according to the vaccine strain. Among the live vaccines, the heat resistant vaccines have the significant advantage for village use of easy transportation, and they have also been widely used in villages. Recombinant vaccines have the advantage that they can be serologically detected independently of the wild virus.

FIFTY years or more have passed since vaccine was first used to protect village poultry against Newcastle disease (ND) (Placidi and Santucci, 1952). During this time, a wide variety of types of vaccine has been developed. Many, but not all, have been tested on village poultry. It is the purpose of this paper to present a brief review of the different kinds of vaccine available. It is not the intention to recommend a particular vaccine, but rather to try to outline the relative advantages and limitations of each kind with particular reference to its use in the village situation. Examples will be given of the use of the different vaccines, but this does not pretend to be a comprehensive review of all the work in the field.

The principle of vaccination against a viral disease is well known: to elicit an immunological response against the virus in such a way as not to cause the disease itself. The simplest way to do this is to take the virus, kill it, and then inject into the bird. This is an inactivated vaccine. Another approach is to select a naturally occurring virus that is not virulent enough to cause serious disease, and infect the birds with this virus. This is a live vaccine. This approach can be taken further by taking a non-virulent natural virus and selecting a clone from the virus population with desirable properties, such as lack of vaccinal reactions, or heat resistance. This is a cloned live

vaccine. Finally, it is possible to specially genetically engineer a vaccine by, for example, taking part of the genetic material of the virus that codes for a surface antigen, and inserting this in another, different, virus to produce a recombinant vaccine.

We will now look in more detail at how these different approaches to vaccination have been applied to ND.

## **Inactivated Vaccines**

Inactivated vaccines are produced by growing a virulent virus in eggs, and then treating it with an inactivating agent, such as beta propiolactone. An adjuvant, such as an oil, is then usually added to make the virus more immunogenic. After inactivation, the vaccine is no longer capable of replication or spread. This means that it has to be individually injected into every bird to be vaccinated. It is normally injected into the back of the thigh muscle, using 0.3 or 0.5 mL per bird. This requires some training, and cannot be done by every keeper of chickens without prior demonstration. Inactivated vaccine produces very high levels of antibodies against ND virus (NDV), and provides a good level of protection against the virulent virus. In intensive poultry production, it is applied after an initial priming vaccination with a live vaccine. In village poultry, we have found that it gives good results in

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the absence of an initial vaccination with live vaccine (Bell et al. 1990). The reason for this is probably that, as serological surveys have shown where they have been carried out (Bell and Mouloudi 1988), some antibodies to the virus are already present in the village poultry as a result of previous infection by the wild virus.

Inactivated vaccines have already been used extensively in village poultry. One of the best examples is in Bangladesh, where 'village vaccinators' have been trained to go around villages in their area vaccinating the family poultry, achieving a high degree of coverage. Burkino Faso is another example of a country where inactivated vaccine has been used in a successful project (Verger 1986).

Although inactivated vaccine gives good protection, it is relatively expensive to produce. It also carries a slight risk to the user of accidental self-injection. While it is heat sensitive, it is much less so than conventional live vaccines making its transport to villages more feasible. It is produced by all commercial vaccine companies, and some regional and national government facilities.

### Live Vaccines

Live vaccines differ from inactivated vaccines in that they can replicate in the host. This is both an advantage and a disadvantage. It is an advantage in that it is not necessary to vaccinate every bird individually; the vaccinal virus can spread on its own from one to another. It is, however, a disadvantage in that since an infection with a live virus is involved, the birds can react to the vaccination in manifesting some of the signs of the disease. The severity of this reaction depends on the particular vaccinal strain used (Westbury et al. 1984) and the presence or otherwise of concurrent infection with other pathogens.

Another advantage of live vaccines compared to inactivated vaccines is their ease of application. They can be applied in drinking water or by putting a drop of the virus suspension from a dropper bottle into the eye of the bird while holding the head so that the eye is horizontal. Although drinking water application is the method widely used in intensive poultry farms, the eye drop method is probably the method best adapted to village poultry, since the drinking water supply is often irregular, and it is difficult to ensure that the vaccine is consumed while the virus is still active.

Although NDV has essentially only one serotype, there is a wide difference in the pathogenicity of different strains, ranging from strains which cause virtually no detectable signs to those that kill within a few days. These have been classified, in order of increasing pathogenicity, into lentogenic, mesogenic

and velogenic strains. These categories do not represent distinct groups, but rather divisions within a continuum of pathogenicity. The majority of live vaccines are derived from lentogenic strains, although there are, perhaps surprisingly, some vaccines derived from mesogenic strains.

We will now consider in more detail the different kinds of live vaccine.

### Conventional lentogenic vaccines

Some well-known examples of this kind of vaccine are Hitchner B1 (HB1) and La Sota. HB1 has very mild vaccinal reactions and is widely recommended for the initial vaccination of intensively farmed poultry. In a controlled trial in village poultry it provided effective protection against ND (Bell et al. 1990). La Sota produces moderate vaccinal reactions, and is thus in theory unsuitable for vaccinating a multi-age population including young chicks such as is inevitably seen in the village situation. This is because the virus spreads and it is not practical to isolate the adults from the chicks. I say 'in theory' because it does in practice depend on the residual level of antibodies from prior infections with virulent virus, which could protect the birds from vaccinal reactions, and to the extent of other concurrent infections, such as mycoplasmas, pathogenic *E. coli*, or infectious bursal disease virus, which can exacerbate the vaccinal reactions.

These lentogenic vaccines have been cloned by taking a single infectious virus and growing a homogenous population from it with the aim of selecting a virus which gives less vaccinal reactions than one like La Sota, while retaining its superior immunogenicity compared to one like HB1. An example of this kind of vaccine is 'clone 30'.

All these conventional live vaccines suffer from the disadvantage of requiring to be kept at low temperatures to maintain their efficacy. This is not a problem for intensive poultry production in an industrial setting, but the maintenance of the 'cold chain' during distribution can be very difficult in village settings, particularly in settings of high ambient temperature.

Another problem that is often encountered when using these vaccines in the village situation is that they are sold in vials containing 1000 or 500 doses, many more than the average village farmer needs. In fact, the packaging is a major component of the cost of manufacturing them, so that a vial containing a smaller number of doses would not reduce the cost proportionally.

Oil adjuvant, normally used with inactivated vaccines to improve immunogenicity, has also been tested with live vaccines and found to improve

immunogenicity (Peleg et al. 1993), but this combination has not been tested in village chickens.

### **Heat resistant vaccines**

Lentogenic viruses have also been cloned by selecting heat resistant clones to produce heat resistant vaccines. These have the distinct advantage in the village situation that it is possible to transport the vaccine without necessarily having refrigerators along the way. The most extensively used has been the NDV4-HR vaccine. This was pioneered in Malaysia, where eventually a significant proportion of the village poultry was covered by this vaccine (Ibrahim et al. 1992). The route of application was on feed, which it was possible to pre-coat with the vaccine, given its thermostability. This has the advantage that it is not necessary to catch the chickens before vaccinating them. The same vaccine has also been extensively tried in other countries in Southeast Asia. Tests of its application on a variety of feedstuffs have produced variable results. (Spradbrow 1992). It has been tested in some African countries, applied by eye drop, and has given good protection against the virulent virus (Saglid and Spalatin 1982; Bell et al. 1995). Given the difference between African and Asian feeds, the variety of feeds within Africa, and the variable results with some feedstuffs in Asia, it does seem as though application of this type of vaccine is best done by eye drop. It can be argued that the additional security provided by the vaccine is an incentive to invest in some form of housing, in which case catching the chickens is no longer a problem. More recently a similar vaccine to NDV4-HR, called I-2, has been made available for local production in developing countries, which adds the significant advantage of low cost. In a trial in Vietnam where village chickens were vaccinated with I-2, chickens were protected against artificial challenge (Tu et al. 1998).

### **Mesogenic vaccines**

Mesogenic strains have long been used for vaccination in the village situation. These would produce severe vaccinal reactions in a naive population, and the only reason that they can be used without having a severe pathogenic effect is that the velogenic virus circulates sufficiently frequently to ensure that there are always some residual antibodies. The use of this kind of vaccine would not be advisable anywhere where chickens could be found without any immune protection against the virus, on account of the vaccinal reactions. Normally they are used after a first vaccination with a lentogenic vaccine. The Komarov vaccine is an example.

### **Recombinant Vaccines**

NDV has two surface glycoproteins, called F for fusion, and HN for haemagglutinin neuraminidase. The genes coding for either of these can be inserted into a different kind of virus to make a recombinant vaccine. For example, the fusion gene inserted in herpes virus of turkeys produced a vaccine that gave good protection against virulent NDV (Morgan et al. 1993). One advantage of this technique is that the host virus can have a better stability than NDV. Another advantage is that antigens for multiple different pathogens can be inserted into the same host virus to produce a single vaccine against several different diseases. Perhaps its most significant advantage for use in the field is that it is possible to monitor the response to the vaccine independently of the wild virus but in its presence, and conversely it is possible to detect antibodies against the wild virus in the presence of vaccination. This is done by using an enzyme linked immunoabsorbent assay (ELISA) that uses a purified antigen, and comparing the results with those of an ELISA using a whole virus antigen. For example, Makkay et al. (1999) prepared an ELISA using only nucleocapsid protein of NDV as antigen. This detected antibodies against wild virus, but not antibodies against a recombinant fowlpox virus expressing HN glycoprotein. A parallel ELISA using whole virus as antigen detected antibodies against the vaccine.

However, this type of vaccine has not yet, to the author's knowledge, been tested in village poultry. A disadvantage of recombinant vaccines is that where they have been developed commercially the cost will be high.

### **Discussion**

The most immunogenic of the vaccines is the inactivated vaccine, given the residual antibodies that exist anyway in the village chicken population, that in effect take the place of the priming vaccination that is done in naive intensive flocks. The next most immunogenic are the live mesogenic vaccines, at the expense of possible vaccinal reactions.

The inactivated vaccine also has the advantage of not inducing vaccinal reactions, which it shares with the recombinant vaccine. The heat-resistant clones in practice produce almost no vaccinal reactions, whereas the other live vaccines produce slight to moderate reactions, depending on the vaccine strain and the immune status of the population vaccinated.

The inactivated vaccine is however the most difficult to apply: some sort of training is necessary before the injection required is mastered. All the live vaccines and the recombinant vaccines are, by

comparison, easy to apply. Feed application, which has been used for the heat-resistant vaccines, is even easier than eye drop vaccination. However, as discussed above, the variable results obtained and the variation in feed in different places argue against this route of application.

For transportability, the heat-resistant vaccine is best. It can be transported to even remote villages under high ambient temperatures without a chain of refrigerators. The inactivated vaccine is next best, having a better heat tolerance than the live conventional vaccines.

In choosing a vaccine for use in the village situation, one factor to take into consideration is previous experience with that type of vaccine. There has been extensive village experience in the use of both heat-resistant and inactivated vaccines. Live mesogenic vaccines have also been used in villages, particularly in Asia. The other live vaccines, with the possible exception of some clones, have at least been formally tested in villages.

The recombinant vaccines are the only ones that can be monitored serologically independently of wild virus.

Finally, cost is an important factor to consider. All the live vaccines are relatively cheap, and can be even cheaper if they are produced locally. Inactivated vaccine is more expensive, and the recombinant vaccine is likely to be very expensive when produced commercially.

These advantages and limitations of the different types of vaccine are summarised in Table 1. The assessments given are only estimates, and are not meant to be definitive. By 'spreadability' I mean the capacity of the vaccine to immunise individuals other than those that were individually vaccinated. By 'seromonitorability' I mean the capacity for antibodies to the vaccine to be detected independently of antibodies to the wild virus.

The choice of which vaccine to use is going to depend not only on the preceding factors, but also on the conditions pertaining to a particular region, such as the structure of veterinary services, previous experience, the population distribution, the communication infrastructure and the climate.

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**Table 1.** A summary of the advantages and limitations of the different vaccine types.

	Vaccine type					
	Inactivated	Live				Recombinant
		Lentogenic		Mesogenic		
		Conventional	Cloned			
	Conventional	Heat resistant				
Example	Newcavac	La Sota	Clone 30	I-2	Komarov	HVT/F
Immunogenicity	Very good	Moderate	Moderate	Moderate	Good	Moderate
Vaccinal reaction	None	Moderate	Slight	V. slight	Severe	None
Ease of application	Difficult	Easy	Easy	Easy	Easy	Easy
Transportability	Good	Poor	Poor	V. good	Poor	Moderate
Previous village use	Extensive	Some	No	Extensive	Yes	No
Spreadability	No	Yes	Yes	Yes	Yes	Yes
Seromonitorability	No	No	No	No	No	Yes
Cost	Moderate	Low	Low	Low	Low	High

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