VACCINATION PROGRAM FOR NEWCASTLE DISEASE CONTROL IN JAPAN

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Chronological review of Newcastle disease outbreak in Japan, and statistical evaluation of vaccination effect in control of the disease

An outbreak of Newcastle disease (ND) was first confirmed in Japan in 1930, but the accurate numbers of affected fowl up to 1935 have not been recorded. Three different periods have been observed in which different forms of the disease were predominant.

During the first period extending from 1936 to 1945, the acute lethal form of ND was predominant. During the second period, extending from 1951 to 1964, the pneumoencephalitic form of ND was predominant. During the third period, extending from 1965 up to now, outbreaks of the acute lethal form were again observed. The outbreaks in this period were quite severe and spread rapidly throughout the country. In 1967, outbreaks were recorded in 42 of Japan's 47 prefectures. The total number of affected fowl approximated 2,000 thousand or 0.583 per cent morbidity.

One of the most important causes of such severe outbreaks is the fact that a majority of the nation's poultry raisers knew little about ND and did not take any protective measures against the disease.

Following the rapid increase in the number of vaccinated chickens, an effective control of the disease was achieved within only two years. The incidence recorded in 1969 was reduced to 154

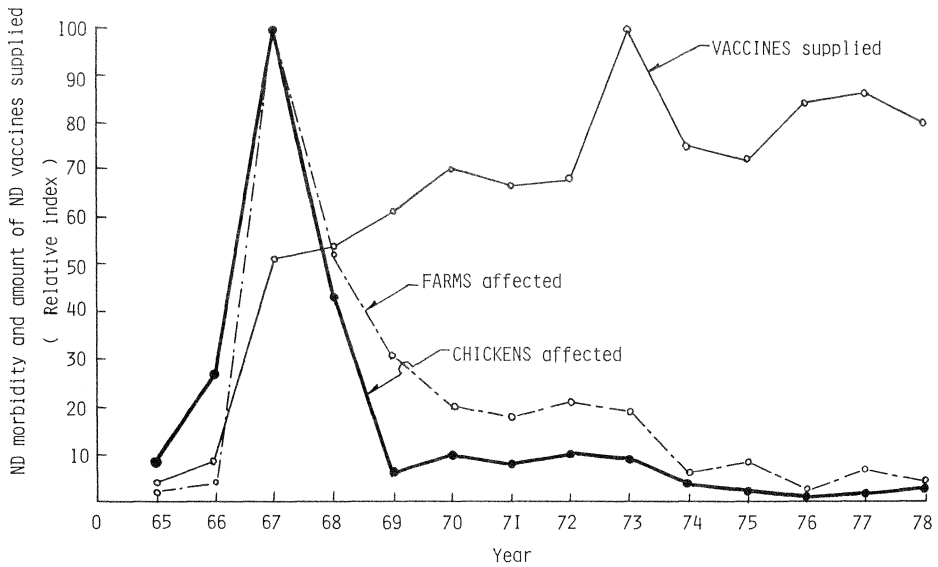

Fig. 1 Morbidity of newcastle disease and amount of total ND vaccines supplied during the years 1965–1978 in Japan

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thousand cases indicating about a 5 per cent morbidity compared with the figures recorded in 1967, and such a low level of ND outbreak has been maintained throughout a decade up to now.

Undoubtedly continuous supply of enough vaccines and vaccination carried out nation-wide in fowl population has contributed to the successful control of ND in Japan (Fig. 1). The amount of ND vaccine supply has greatly increased since 1965 when the acute lethal form of ND occurred. In 1965, only 74 million doses of killed vaccine were used throughout the country. After 1966, when ND live vaccine became used the amount of total ND vaccines supplied has shown a rapid increase up to 1,100 million doses in 1969. In parallel with the increase in the population of poultry raised the amount of total ND vaccines' supply has continued to increase for these 10 years reaching a level of 1,500 million doses. During these years, five kinds of combined vaccines such as ND-IB live, ND-FP live, ND-IB killed, ND- Infectious coryza (IC) killed and ND-IB-IC killed have been added. However, Hitchner B1 strain live ND vaccine has continued to be the major vaccine among those used alone or in combination.

Decisive factors for programming of vaccination

Programming of vaccination plays an important role in engendering a solid and lasting immunity in vaccinated chicken flocks.

Therefore, a great deal of effort must be made to seek and select a vaccination program effective in each chicken flock. However, the actual programming of vaccination is complicated owing to the numerous factors affecting it. These can be grouped in three categories as shown in Figure 2, namely factors depending on the vaccine, chicken and environment surrounding chicken raising. In each category several aspects should be considered as major decisive factors for programming of vaccination as seen in the Figure. Each of them is centered on such three main elements as safety, immunization efficiency and labor efficiency. The final vaccination program will take into account these factors for its implementation.

Among the decisive factors those dealing both with vaccine and chicken are the most important ones.

1 Decisive factors depending on vaccine

Kind or type of vaccine, and administration method are the main decisive factors. Since both the factors correlate closely to the original properties of vaccine, known characters of killed and live ND vaccines have to be considered at first.

In this country both killed and live vaccines are authorized at present. All killed vaccines are prepared from infected chicken embryo materials, but used with various seed virus or adjuvant in different vaccines. There are two types of live ND vaccine, one is Hitchner B1 strain vaccine prepared from chicken egg materials, the other is TCND vaccine which originated from Bankowsky's strain and is prepared in swine kidney cultured cells. Moreover, three combined killed vaccines and two combined live vaccines are also licensed.

One of the important characteristics of ND killed vaccine is that all vaccines contain adjuvant which is known to have important effects on potency and stability of vaccine. Killed vaccine has a particular ability to develop a booster effect in those chickens which have received the second shot of the vaccine within an appropriate interval after the initial vaccination with the same vaccine (Hofstad, 1953a, 1953b, 1954; Waller and Gardiner, 1953; Nakamura *et al.*, 1956; Miyamoto *et al.*, 1957b). A similar booster effect with killed ND vaccine has been independently confirmed in those chickens which had received initial vaccination with either lentogenic F or B1 strain of ND virus (Nomura, 1969).

Live vaccines prepared with lentogenic strain have not so much potency in their duration of immunity as a rule. Generally, effective immunity lasts only two or three months, and individual difference in its duration is more conspicuous than immunity developed by vaccination with killed vaccine (Hitchner and Johnson, 1948; Van Waveren, 1955; Miyamoto *et al.*, 1957b; Winterfield and Seedale, 1957a; Richey and Schmittle, 1962; Nomura, 1969). The fact that the efficiency of

"vaccine take" in chicken is greatly influenced by the route of administration was clarified in maternal antibody-free baby chicks experimentally inoculated with lentogenic F or B1 strain of ND virus. By means of comparing 50 per cent immune doses by each of three different administration routes, it was shown that the ocular route is the most efficient followed by intramuscular and drinking water administration. The virus amount required for developing an immunity corresponding to one ImD_{50} by ocular administration was less than one tenth that by intramuscular inoculation and less than one hundredth that by drinking water administration (Nomura *et al.*, 1964).

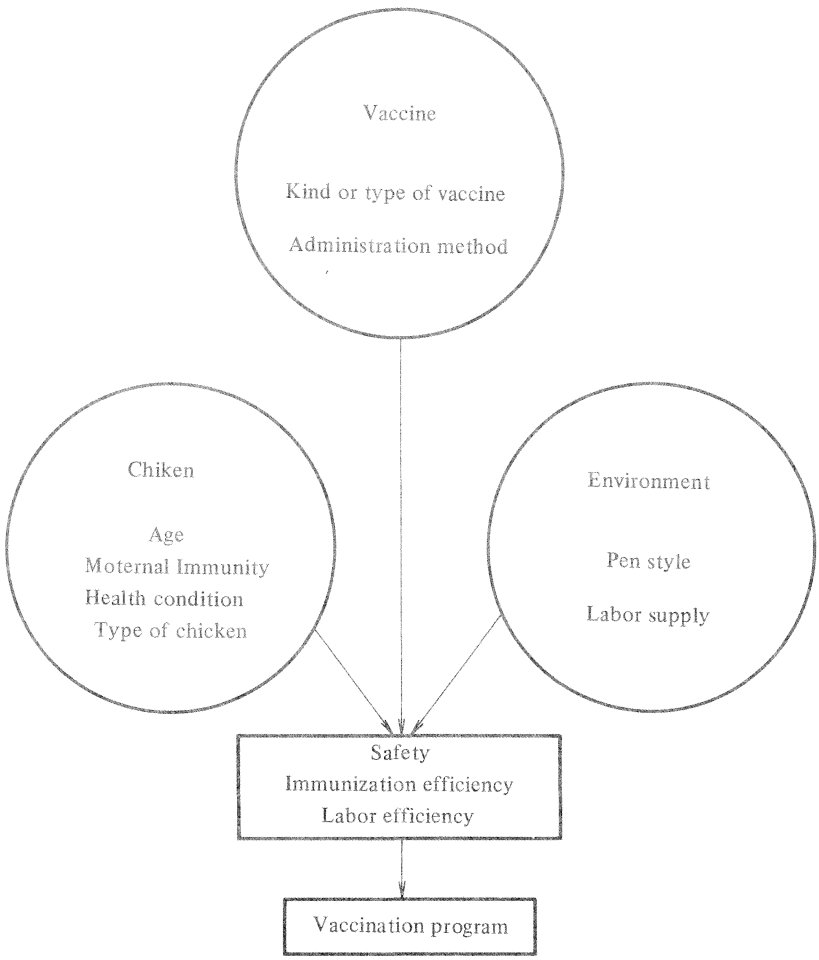

Fig. 2 Decisive factors for programming of vaccination

The most striking difference existing between live and killed ND vaccine is the pattern of immunity developed in vaccinated chickens. Although killed vaccine gives only a systemic immunity to chickens vaccinated by ordinary intramuscular route, live vaccine has an immune capacity by which not only the systematic but also a local immunity is developed regardless of the administration route employed.

A measurable level of virus neutralizing antibody titer in trachea was demonstrated in chicks vaccinated with B1 strain live vaccine following intranasal, intratracheal, intramuscular or drinking water administration (Yoshida *et al.*, 1971a). A high level of protection against respiratory challenge with velogenic field ND virus was manifested in chickens which had been vaccinated intranasally with B1 live vaccine at the age of four weeks. But only limited number of birds vaccinated with killed vaccine at the same age manifested the protection. A marked increase in neutralizing antibody titer in serum and trachea was also demonstrated in those chickens revaccinated with killed vaccine at 15 weeks of age after the first shot with B1 live virus administered at 12 weeks of age. However, such effect was not observed in the chicken group of the same age which had received the same primary shot but had been revaccinated with B1 live vaccine (Yoshida *et al.*, 1971b).

A local resistance against ND virus infection was demonstrated in the intestine of chicks following the oral administration of an enterotropic avirulent Ishii strain of ND virus, consisting of the development of copro-antibody in their feces. Since a suppression of the local immunity was observed in bursectomized chicks but not in thymectomized ones, it was assumed that the local resistance might be caused by the bursa-dependent immune system (Kono *et al.*, 1969).

On the other hand, it is known that lentogenic ND vaccine virus strains are found in the feces of vaccinated chickens during the first few weeks following the administration. This indicates the possibility of pollution of poultry field with the vaccine viruses though these essentially lack pathogenicity to chickens of any age.

TCND vaccine is characterized by the fact that it has still a pathogenic effect against young baby chicks but develops its own immunogenicity only following intramuscular inoculation in chickens of more than 4 weeks of age. Thus the initial use of the vaccine should be limited to those chickens which have received the first shot of B1 live vaccine.

2 Decisive factors depending on chicken

Age, maternal immunity, health condition and type of chicken are important factors to consider.

Generally, young baby chicks show a comparatively poor immune response against ND vaccination. It takes a fairly long time for acquiring effective immunity when those chicks have been vaccinated with killed vaccine (Brandly *et al.*, 1946a; Hitchner, 1950; Waller *et al.*, 1953; Nakamura *et al.*, 1956; Miyamoto and Nagashima, 1957; Keeble *et al.*, 1963). In an experiment using B1 strain live vaccine administered through drinking water, both HI antibody response and protection against challenge in four-day-old chicks were obviously poor and not uniform compared with the results obtained in chicks more than four-week-old (Tsubahara).

Evidence that chicks having maternal antibodies are passively immune for a short period of time and are protected from debilitating infection has been obtained by several investigators. A similar confronting effect of maternal antibodies against the "take" of both killed and live ND vaccine has also been confirmed by many authors (Brandly *et al.*, 1946b; Box, 1965; Stone and Boney, 1968; Miyamoto *et al.*, 1977; Alberts and Miller, 1950; Beaudette and Bivins, 1953; Winterfield and Seadale, 1957; Lancaster *et al.*, 1960; Richey and Schmittle, 1962; Nomura, 1969).

Persistence of maternal antibodies in chicks is correlated with the initial titer of antibodies at birth. Generally, maternal antibodies in chicks derived from hens immunized by vaccine disappear at the age of four or five weeks when measured by mean titer of the flock. However, differences in initial antibody titer among chicks in flock are often encountered even if these belong to the same hatching from the same breeder stock, making it difficult to carry out a program of vaccination in

newborn chicken flocks. To solve the problem, repeated vaccination two or three times during the early few weeks is preferable.

Health condition of chickens at vaccination time greatly affects the effectiveness of immunization with live vaccine. When live ND vaccine is used in chicken flocks suffering from other diseases or from debilitating conditions, undesirable effects such as induction of other disease occurrence or respiratory reaction may often be encountered (Gross, 1961; Hoekstra, 1961; Garside, 1962; Omuro *et al.*, 1971; Suzuki *et al.* 1971). It has never been reported that these undesirable side effects occurred in chicks vaccinated with killed vaccine even if suffering from other diseases.

Type of chicken ie., layer or broiler and breeder or commercial, is able to become a significant decisive factor for programming of vaccination. Killed vaccine is preferably used for the vaccination of breeder flock owing to its safety and boostering activity.

On the contrary, poultry raisers like to use B1 live vaccine for commercial flocks, especially for broiler flocks because of its convenience for massive vaccination.

3 Factors depending on environment

Both pen style and status of labor supply are factors which must be considered for the programming of vaccination. Cage style of raising is suitable for vaccination with killed vaccine but rather inconvenient for vaccination with B1 live vaccine owing to collective administration in drinking water or spraying. On the contrary, floor style of raising is advantageous for massive vaccination with B1 live vaccine, but it does not fit the individual administration of either killed or live vaccine.

From the view-point of labor efficiency, B1 live vaccine is most convenient whereas killed vaccine can not be applied.

When characteristics of killed and live ND vaccines mentioned above are compared from the view-point of safety, immunogenicity and labor efficiency, each vaccine can be evaluated as shown in Table 1.

Table 1 Comparison of characteristics of killed and live Newcastle disease vaccines

Characteristics		Killed vaccine	Live (B1) vaccine
Safety	Possibility of		
	Respiratory reaction	–	+
	Induction of other disease	–	+
	Field pollution	–	+
Immunogenicity	Booster effect	+	–
	Quality of immunity	Systemic	Systemic & local
	Uniformity of immunity	Uniform	Not uniform
	Duration of immunity	3 months	2 – 3 months
Labor efficiency	Administration procedure	Inferior	Superior

Advantages of killed vaccine can be found in its safety and boostering activity. On the other hand, owing to immunogenic capacity for developing local immunity and labor saving live B1 vaccine is more advantageous.

Vaccination programs currently applied in Japan

As already mentioned above, the most profitable vaccination program has to be designed for each chicken flock by scrutinizing the decisive factors. There are a number of ND vaccination programs proposed by vaccine manufacturers or public and private institutions.

Among those, the vaccination program recommended by the Japanese Society of Poultry Disease (JSPD) which had been designed initially in 1967 and finally revised in 1975 has continued to play a functional role as the most representative one in these years (JSPD, 1975).

The program aims at high risk and low risk areas. Moreover, each program is divided into four independent programs which are adapted to the use of either vaccine alone and to that of live and killed vaccine combined. The high risk area program is presented in Table 2. All independent programs, using killed vaccine alone, B1 live vaccine alone, B1 live and killed vaccine combined and B1 live and TCND live vaccine combined, consist of basic and reinforced vaccination respectively. The basic vaccination consists of three shots applied within four to five weeks of age to match the disappearance of maternal antibodies. By this basic vaccination procedure, any of chicks in a flock can be successfully immunized with the shot meeting the disappearance of its maternal immunity.

The reinforced vaccination comprises several shots so as to maintain immunity throughout the whole life of the chickens. In the low risk program, one or two shots in the basic vaccination are omitted and intervals between each reinforced shot are also extended to some extent in any of the independent programs.

When required to use any combined vaccines instead of sole ND vaccines, they can be employed in the same manner as each corresponding sole vaccine in each of the programs.

Evaluation of vaccination programs for ND control

From the results of different vaccination programs carried out in laboratories and under field conditions throughout the country, the most favorable immunity has been obtained in those chickens vaccinated by programs similar to those recommended by JSPD.

Table 2 ND vaccination program recommended by JSPD
(1) High risk area program

Program	1st	2nd	3rd	4th	5th	Following vaccination
	Basic			Reinforced		
1. Killed	7 day-old	2 week-old	4 week-old	2 month-old	4 month-old	at 3-month intervals
	Basic			Reinforced		
2. Live (Bl)	1–4 day-old	2 week-old	4 week-old	2 month-old		at 2–3-month intervals
	Basic (Bl)			Reinforced (K)		
3. L(Bl)–K	1–4 day-old	2 week-old	4 week-old	2 month-old	4 month-old	at 3-month intervals
	Basic (Bl, TCND)			Reinforced (TCND)		
4. L(Bl)–L(TCND)	1–4 day-old (Bl)	2 week-old (Bl)	4–5 week-old (TCND)	2–3 month-old	4–5 month-old	at 3-month intervals

Combined vaccines can be employed in the same manner as each corresponding ND vaccine. *Jap, Soc, Poult, Dis,* (1975)

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Discussion

Gupta B.K. (India): 1. Do you have any experience with nasal or drinking water administration of Komarov strain of Newcastle disease virus (NDV)? 2. Do you advocate the use of mixed live viruses, for example B1 and Komarov strains?

Answer: 1. No we don't. 2. Komarov strain of ND virus is not allowed in Japan.

Horiuchi T. (Japan): Is B1 live vaccine strain effective enough to control the disease? Should we also use Komarov or Mukteswar strains?

Answer: I believe that B1 strain live or killed vaccine can control ND. I have no experience with the use of Komarov strain. As for the Mukteswar strain (mesogenic strain), I wonder whether the introduction of such strains may not make it difficult to differentiate between actual outbreaks in the field due to the virus and the effect of the vaccine.