*Artykuł przeglądowy* *Review*

# Specific immunoprophylaxis of infectious avian diseases

ANDRZEJ KONCICKI

Division of Avian Diseases of the Chair of Infectious and Invasive Diseases, Faculty of Veterinary Medicine, University of Warmia and Mazury, ul. Oczapowskiego 13, 10-718 Olsztyn, Poland

**Koncicki A.**

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Summary

**The article presents the goals and recommendations for specific immunoprophylaxis in poultry flocks reared in Poland. The types of vaccines applied in the immunoprophylaxis of avian diseases as well as benefits and drawbacks of live and inactivated vaccines are discussed. Emphasis is placed on the fact that the efficiency of vaccinations is determined, to a significant extent, by the route of vaccine administration and that the period between two consecutive vaccinations should not be shorter than 10-14 days. In order to achieve the desired immunizing effect, it is necessary to determine a vaccination program optimal for a given flock, farm, or rearing area of the birds. Exemplary vaccination programs used in Poland for individual bird species, taking into account the current epizootic situation, are presented. Attention is also paid to the fact that the programs of specific prophylaxis are effective on condition that avian rearing is carried out in compliance with the designed technology, age-adjusted feeding and recommendations for bio-safety measures.**

**Key words: specific immunoprophylaxis, vaccination poultry**

The intensification of bird farming on such a large scale, both worldwide and in Poland, would not be possible without advances in immunology as well as the elaboration and implementation of prophylactic vaccinations into avian practice. The undergoing rearing practices are aimed at creating new breeds, strains and genetic lines of birds different in terms of conformation, physiological and production traits. The selection of birds towards the traits of significance in laying and fattening performance has led to a considerable increase in their yield. Nowadays, birds reach higher body weights in a shorter time span, thus utilizing less feed per kg of body weight gain. In the production context, that birds' improvement and rearing advances are not in line with an increase in the birds' immunity. Today, the birds reared are much more susceptible to the activity of detrimental factors, which results in a frequent inability to use their genetic potential. Infections of birds with a number of pathogens, even without evident pathological changes induced, may considerably decrease profits due to worse feed utilization, the necessity of applying chemotherapeutic agents and extending the rearing period, increased mortality and reduced laying production.

Achieving high production yield is determined by multiple factors, including organization of rearing and feeding, biosecurity measures, and the application of appropriate programs of prophylactic vaccinations (immunoprophylaxis).

The specific immunoprophylaxis is aimed at:

– preventing or reducing problems that are likely to occur in the case of infections with highly pathogenic wild-type pathogen strains;

– protecting chicks against effects of infection in the first weeks of rearing through maternal antibodies transmitted transovarially by immunized laying hens;

– protecting chicks against the negative effects of factors inhibiting the development of the immune system of birds through maternal antibodies and further vaccinations;

– protecting against pathogens transmitted transovarially.

Of all avian diseases, infectious diseases are of the highest significance due to the fact that – if possible – they are included into the program of specific immunity. The number of vaccines for poultry available in Poland is very high. The activity of all preparations is similar and is based on specific properties of the immune system of birds. Advances in this field have resulted in extended possibilities of specific prophylaxis covering an increasing number of diseases (tab. 1).

In the immunoprophylaxis of avian diseases, use is made of live vaccines – containing a live modified germ (attenuated) – and killed vaccines – containing an inactivated germ. Both the vaccines have their benefits and drawbacks (3). An advantage of the live vaccines is their much higher efficiency compared to the inactivated ones. To some extent, we are able to obtain an

**Tab. 1. Diseases of birds in Poland included into the program of specific prophylaxis**

| Name of disease entity | Bird species under the prophylactic program |
|---|---|
| Marek's Disease (MD) | hens, turkeys |
| Infectious Bursal Disease (IBD) | hens |
| Newcastle Disease (ND) | hens, turkeys, pheasants, Japanese quail, ostrich |
| Avian Paramyxovirus 3 Infection (APMV-3) | turkeys |
| Infectious Bronchitis (IB) | hens |
| Reovirus Infection (REO) | hens |
| Pneumovirus Infection (TRT/SHS) | hens, turkeys |
| Egg Drop Syndrome (EGS) | hens |
| Hemorrhagic Enteritis (HE) | turkeys |
| Infectious Laryngotracheitis (ILT) | hens |
| Avian Encephalomyelitis (AE) | hens, turkeys |
| Fowl Pox (FP) | hens, turkeys, pigeons |
| Chicken Infectious Anemia (CA) | hens |
| Derzsy's Disease | geese, Muscovy ducks |
| Ornithobacterium rhinotracheale Infection (ORT) | turkeys, hens |
| Fowl Cholera | turkeys |
| Mycoplasmosis | hens, turkeys |
| Salmonellosis | hens |
| Colibacteriosis | hens, turkeys |
| Erysipelas | turkeys |
| Coccidiosis | hens |

effect analogous to that after bird's infection, which provides a high level of immunity although immunity from live vaccines is generally short-lived. Those vaccines demonstrate a high capacity for inducing cellular and local immunity. In general, the live vaccines are less expensive and more easily applicable. They can be administered *in ovo* (8), as a coarse spray (day-old birds) and a fine spray (older birds), as intraocular or nasal droplets, in drinking water, in subcutaneous or intramuscular injections, in follicle administration or with the wing-web method. In contrast, the inactivated vaccines are used solely in the form of injections. Due to the fact that an infectious agent present in the live vaccines multiplies in a bird's body, no high concentration of the germ is necessary in a dose applied, which consequently reduces the production costs of such vaccines. They induce a state of „dissemination of vaccine microbes". This is the great advantage of these preparations, since due to the pathogen's presence in the environment, birds which failed to become immunized upon vaccination are re-vaccinated, which substantially increases the efficiency of immunization in a flock. Sometimes, the dissemination of those germs can be disadvantageous, as it affords the possibility of transferring the pathogen into susceptible flocks. Some vaccines are completely safe for older birds, still they can induce diseases in chicks and young chickens (e.g. the vaccine against Avian Encephalomyelitis (AE)).

The major negative effects of the live vaccines include the possibility of a vaccine strain reversion to a virulent form. In live vaccines, the vaccine strains are likely to demonstrate virulence against birds in the immunosuppression state.

The advantages of the inactivated vaccines include a lack of germ reversion to a virulent form as well as long shelf life and stability at use. The killed vaccines are not contaminated with other live germs, hence, there is a little likelihood of their immunosuppressive activity. Nevertheless, they are usually more expensive and laborious at use. Although upon their administration the immunity is higher, more balanced and long-lasting compared to the live vaccines, they require prior immunization with live vaccines. The inactivated vaccines are incapable of inducing local immunity. In order to increase their activity, use is made of adjuvants (9, 14). Sometimes autovaccines are also applied in the specific prophylactic of avian disease.

Both the live and inactivated vaccines activate similar immunological mechanisms. However, the quality of the postvaccinal immunity is determined by the efficiency of the immune system. All factors impairing the immune system reduce the efficiency of vaccinations. Typical infectious immunosuppressors include viruses, e.g. Infectious Bursal Disease virus (IBDV), Marek's Disease virus (MDV), reoviruses (REO), Chicken Infectious Anemia virus (CAV), Avian Leukaemia viruses (ALV), and Hemorrhagic Enteritis virus (HEV), whereas the non-infectious immunosuppressive effects are evoked by mycotoxins, stress and poor rearing conditions (6, 11). Apart from the efficiency of the immune system of birds, the protective value of vaccines, i.e. protection, is determined by the quality of vaccines and correctness of a vaccination technique. Vaccines should always be administered to healthy birds, as only an efficient immune system is capable of inducing a complete immunity. Necessary vaccinations performed occasionally in an infected flock apply only to healthy birds that do not demonstrate clinical symptoms of a disease.

In the immunoprophylaxis of avian diseases, use is made of both single vaccines (containing antigens of one pathogen) and complex ones (containing a few germs). Immunologists have elaborated rules of combining individual microbes in order to obtain a high immunity against all pathogens contained in a preparation in the case of the linked vaccines. Preparations containing more than four antigens of various pathogens are, however, rarely applied in practice. In contrast, use is often made of concurrent vaccinations, i.e. when two different vaccines are administered in two injections, e.g. in turkeys – simultaneous immunization against Fowl Cholera (one injection) and infections with Newcastle Disease virus (NDV), Avian

**Tab. 2. The immunoprophylactic program for parental flocks of meat lines of hens**

| Vaccination term | Disease under the prophylactic program | Type of vaccine | Administration |
|---|---|---|---|
| 1 day of life | Marek's Disease (MD) | Live frozen | Subcutaneous or intramuscular injection |
| | Newcastle Disease (ND) | Live | Coarse spray |
| | Infectious Bronchitis (IB) (classic strain) | Live | |
| 6-10 day of life | Reovirus Infection (REO) | Live | Subcutaneous injection |
| 10-14 day of life | Infectious bronchitis (variant strain) | Live | Coarse spray |
| 16-18 day of life | Infectious Bursal Disease (IBD)* | Live | In drinking water |
| 24-28 day of life | Infectious Bursal Disease (IBD) | Live | In drinking water |
| 32-35 day of life | Newcastle Disease (ND) | Live | Fine spray or in drinking water |
| 6 week of life | Reovirus Infection | Live | Subcutaneous injection |
| 8 week of life | Infectious Bronchitis (IB) (classic strain) | Live | Fine spray |
| | Infectious Bursal Disease (IBD) | Live | In drinking water |
| 10 week of life | Pneumovirus Infection (TRT/SHS) | Live | Fine spray or in drinking water |
| | Infectious Bronchitis (IB) (variant strain) | Live | |
| 11 week of life | Reovirus Infection (REO) | Live | Subcutaneous injection |
| | Chicken Infectious Anemia (CA) | Live | Subcutaneous injection or wing-web or in drinking water |
| 12 week of life | Avian Encephalomyelitis (AE) | Live | In drinking water |
| 13 week of life | Newcastle Disease (ND) | Live | In drinking water or fine spray |
| | Infectious Bronchitis (IB) (classic strain) | Live | |
| 16-17 week of life | Pneumovirus Infection (TRT/SHS) | Inactivated | Subcutaneous or intramuscular injection |
| 18 week of life | Reo, IB, ND, IBD | Inactivated | Subcutaneous or intramuscular injection |
| | Egg Drop Syndrome (EDS) | Inactivated | |

Explanations: * date of vaccination should be determined based on a serological examination

In the case of a high epizootic risk:

1. vaccination against Infectious Laryngotracheitis (ILT) should be performed in the 5-6 and 15-16 week of life in intraocular drop;

2. vaccination against infection with *S. enteritis* and/or *S. typhimurium* and *S. gallinarium* should be performed in the 8-10 and 14-16 week of life in subcutaneous or intramuscular injection;

3. vaccination against acute infections with enteric respiratory strains (ERS) should be performed in the 11 and 18 week of life simultaneously with vaccination against reoviruses of 1133 strain, in subcutaneous or intramuscular injection;

4. vaccination against infection with *M. gallisepticum* should be performed in healthy individuals, without antibodies against the above-mentioned mycoplasma. Birds are immunized with a single dose of the vaccine (in spray) between 6 and 16 weeks of life, depending on the risk. Two weeks before and after the vaccination, the birds should not be immunized with any other live vaccines.

**Tab. 3. The immunoprophylactic program for parental flocks of laying lines of hens**

| Vaccination term | Disease under the prophylactic program | Type of vaccine | Administration |
|---|---|---|---|
| 1 day of life | Marek's Disease (MD) | Live frozen | Subcutaneous or intramuscular injection |
| | Newcastle Disease (ND) | Live | Coarse spray |
| | Infectious Bronchitis (IB) (classic strain) | Live | |
| 10-14 day of life | Infectious Bronchitis (variant strain) | Live | Fine spray or in drinking water |
| 17-21 day of life | Infectious Bursal Disease (IBD)* | Live | In drinking water |
| 24-28 day of life | Infectious Bursal Disease (IBD) | Live | In drinking water |
| 32-35 day of life | Newcastle Disease (ND) | Live | Fine spray or in drinking water |
| 8 week of life | Infectious Bronchitis (IB) (classic strain) | Live | Fine spray |
| | Infectious Bursal Disease (IBD) | Live | In drinking water |
| 10 week of life | Pneumovirus Infection (TRT/SHS) | Live | Fine spray or in drinking water |
| 11 week of life | Infectious Bronchitis (IB) (variant strain) | Live | Fine spray or in drinking water |
| | Newcastle Disease (ND) | | |
| 12 week of life | Avian Encephalomyelitis (AE) | Live | In drinking water |
| 16 week of life | Pneumovirus Infection (TRT/SHS) | Inactivated | Subcutaneous or intramuscular injection |
| 17 week of life | IB, ND, IBD | Inactivated | Subcutaneous or intramuscular injection |
| | Egg Drop Syndrome (EDS) | Inactivated | |

Explanations: * as in tab. 2

**Tab. 4. The immunoprophylactic program for hen broilers**

| Vaccination term | Disease under the prophylactic program | Type of vaccine | Administration |
|---|---|---|---|
| 18 days of incubation | Marek's Disease (MD)* | Live frozen | In ovo |
| | Infectious Bursal Disease (IBD)* | Live complex | |
| 1 day of life | Marek's Disease (MD)** | Live frozen | Subcutaneous or intramuscular injection |
| | Infectious Bursal Disease (IBD)** | Live complex | |
| | Newcastle Disease (ND)* | Live | Coarse spray |
| | Infectious Bronchitis (IB)* (classic strain) | Live | |
| 5-6 days of life | Newcastle Disease (ND)** | Live | Coarse spray or in drinking water |
| | Infectious Bronchitis (IB)** (classic strain) | | |
| 16-18 days of life | Infectious Bursal Disease (IBD)*** | Live | In drinking water |
| 22-25 days of life | Infectious Bursal Disease (IBD)*** | Live | In drinking water |

Explanations: * vaccinations are performed in breeding areas at high risk of infections with MD and/or IBD as well as ND and IB viruses;
** if not vaccinated in ovo in the 18th day of incubation (MD, IBD) or with a coarse spray in the 1st day of life (ND and IB) and in an injection (IBD);
*** single or double vaccination, depending on the epizootic situation

**Tab. 5. The immunoprophylactic program for turkeys of parental flocks**

| Vaccination term | Disease under the prophylactic program | Type of vaccine | Administration |
|---|---|---|---|
| 1 day of life | Turkey Rhinotracheitis (TRT) | Live | Coarse spray |
| 10 day of life | Newcastle Disease (ND) | Live | Coarse spray or in drinking water |
| 21 day of life | Turkey Rhinotracheitis (TRT) | Live | Fine spray or in drinking water |
| 6 week of life | Newcastle Disease (ND) | Live | Fine spray or in drinking water |
| 7-8 week of life | Ornithobacterium rhinotracheale Infection (ORT) | Inactivated | Subcutaneous or intramuscular injection |
| 9-10 week of life | Turkey Rhinotracheitis (TRT) | Live | Fine spray or in drinking water |
| 11 week of life | Newcastle Disease (ND) | Live | Fine spray or in drinking water |
| 13 week of life | Ornithobacterium rhinotracheale Infection (ORT) | Inactivated | Subcutaneous or intramuscular injection |
| 15-16 week of life | Avian Encephalomyelitis (AE) | Live | In drinking water |
| 19 week of life | Fowl Cholera | Inactivated | Subcutaneous or intramuscular injection |
| | Ornithobacterium rhinotracheale Infection (ORT) | | |
| 21 week of life | Erysipelas | Live | Subcutaneous or intramuscular injection |
| 23 week of life | Fowl Cholera | Inactivated | Subcutaneous or intramuscular injection |
| | ND, TRT, PMV-3 | | |
| 25 week of life | Erysipelas | Live | Subcutaneous or intramuscular injection |
| 27-28 week of life | ND, TRT, PMV-3 | Inactivated | Subcutaneous or intramuscular injection |

**Tab. 6. The prophylactic program for slaughter turkeys**

| Vaccination term* | Disease under the prophylactic program | Type of vaccine | Administration |
|---|---|---|---|
| 1 day of life | Turkey Rhinotracheitis (TRT) | Live | Macromolecular spray |
| 10 day of life | Newcastle Disease (ND) | Live | Macromolecular spray or in drinking water |
| 21 day of life | Turkey Rhinotracheitis (TRT) | Live | Coarse spray or in drinking water |
| 28-30 day of life | Hemorrhagic Enteritis (HE) | Live | In drinking water |
| 35-40 day of life | Ornithobacterium rhinotracheale Infection (ORT) | Inactivated | Subcutaneous or intramuscular injection |
| 8-9 week of life | Turkey Rhinotracheitis (TRT) | Live | In drinking water or fine spray |
| 10 week of life | Newcastle Disease (ND) | Live | In drinking water or fine spray |

Explanation: * in cases of endemic occurrence of Fowl Cholera, slaughter turkeys should be immunized in the 5-6 week of life with inactivated vaccine administrated in either subcutaneous or intramuscular injection

Paramyxovirus 3 (PMV-3) and pneumoviruses of Turkey Rhinotracheitis (TRT) (the second injection). Two vaccines may be administered simultaneously in a different manner, e.g. that against Infectious Bronchitis virus in the form of a spray, and that against Infectious Bursal Disease (IBD) virus in drinking water. In addition, it has been demonstrated that concurrent immunization of chicks against Infectious Bursal Disease and Marek's Disease results in a less rapid decrease in titres of antibodies against the IBD virus (12).

In recent years, great advances in biotechnology as well as recognition of techniques for sequencing and recombination of viral and bacterial genomes have afforded new possibilities in the production of avian vaccines. Recombinant vaccines have been elaborated against serotype $H_5N_2$ of avian influenza virus (2), Newcastle Disease virus (4), Infectious Bursal Disease virus (1), and *Salmonella* Typhimurium serovars (5). In addition, DNA recombination techniques have been applied to work out a vaccine against the Newcastle Disease virus (DNA vaccine), (13), however the recombinant vaccines have not been applied so far in the immunization of commercially reared birds. In order to improve the immunogenicity of vaccines, sometimes a specified clone of the wild-type strain is isolated, e.g. clone 30 of LaSota strain of the Newcastle Disease virus or clone K of A strain of the Turkey Rhinotracheitis pneumovirus.

A special type of vaccines has been elaborated against the Infectious Bursal Disease virus, i.e. the so-called „complex vaccines" containing a live attenuated strain of Infectious Bursal Disease virus coated with specific antibodies against the Gumboro Disease virus. Hyperimmunized serum protects the vaccinal strain against neutralization by maternal antibodies and the Bursa of Fabricius – against premature colonization and replication of the virus. The vaccine is to be applied for the immunization of 18-day-old hen embryos *in ovo* (10) or day-old chicks through a subcutaneous injection.

In order to increase the efficiency of vaccinations, a certain rule should be followed in poultry rearing practice, namely: the period between two consecutive vaccinations should not be shorter than 10-14 days. Not complying with technical guidelines of the immunization process may lead to postvaccinal complications. At intramuscular or subcutaneous injections, abscesses or granulomas or likely to occur at the injection site (7). Spray vaccination may result in the manifestation of a subclinical infection with mycoplasmas. So as to achieve the desired effect of immunization, it is necessary to determine a vaccination program optimal for a given flock, farm or rearing area of birds. Consideration should also be given to the current epizootic situation (diagnostic tests, serological monitoring) as well as technical and economic conditions of rearing of the birds. The elaboration and implementation of appropriate vaccination programs should result from the current epizootic situation at a given rearing area of reproductive flocks and at the rearing area of their progeny. Exemplary immunoprophylactic programs applied in domestic poultry flocks are presented in tables 2-8.

All programs of specific prophylaxis will be effective on condition that the avian rearing is carried out in compliance with the designed technology, age-adjusted feeding and recommendations for biosecurity measures.

**Tab. 7. The immunoprophylactic program against Derzsy's Disease in flocks of geese and Muscovy ducks**

| Vaccination term | Type of vaccine | Administration |
|---|---|---|
| 1 day of life* | Specific serum | Intramuscular or subcutaneous injection |
| 14-21 day of life | Live vaccine | Intramuscular or subcutaneous injection |
| 6-7 week before laying | Live vaccine | Subcutaneous or intramuscular injection |
| 4 week before laying | Live vaccine | Subcutaneous or intramuscular injection |

Explanation: * exclusively in chicks from non-vaccinated flocks or those with a low level of antibodies (chicks hatched from eggs from the final laying period)

**Tab. 8. The immunoprophylactic program against Derzsy's Disease in flocks of slaughter geese and Muscovy ducks**

| Vaccination term | Type of vaccine | Administration |
|---|---|---|
| 1 day of life* | Specific serum | Intramuscular or subcutaneous injection |
| 14-21 day of life | Live vaccine | Intramuscular or subcutaneous injection |

Explanation: * as in tab. 7

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**Author's address: prof. dr hab. Andrzej Koncicki, ul. Baczyńskiego 1, 10-371 Olsztyn-Kieźliny; e-mail: koncicki@uwm.edu.pl**