Correct and effective vaccination of poultry


Millions of Euros are now invested annually in the vaccination of poultry. A vaccine’s efficacy, however, is dependant on effective administration. What tools are available to effectively monitor and audit vaccination techniques?

This article will look at the requirements for effective vaccination, focusing on the differences between live and inactivated vaccine preparations.

Proposals for the practical auditing of the vaccination procedure will be considered with the goal of improving vaccine administration and ultimately bird immunity.

The goal

Dr Edward Jenner introduced the world to the concept of vaccination in 1796. With his somewhat crude experiment, performed on his gardener’s eight year old son, Jenner proved that a cowpox vaccination induced immunity to the more severe disease smallpox. Science may have progressed since those early days, but Jenner’s observations are still valid.

- To induce immunity an antigen (cowpox) must be presented in a sufficiently high enough dose to initiate an immune response in the target species.
- There is a time delay from point of vaccination to the development of protective immunity (Jenner waited eight weeks before challenging with smallpox).

Modern poultry farming has resulted in the development of high density poultry areas, which bring with them an increased risk of disease spread. The poultry sector manages this risk by routine vaccination against known poultry pathogens of specific economic importance. The efficacy of a vaccination schedule however requires proper vaccine administration, a challenging feat when thousands of birds need to be vaccinated at one time.

Vaccines used in the poultry industry are either live attenuated viral/bacterial strains or inactivated viruses/bacteria formulated with a suitable adjuvant.

Reputable vaccine manufacturers subject all batches of vaccines to stringent quality control tests, ensuring the end user is supplied with a product containing sufficient antigen to initiate an immune response in the target bird. Thus assuming bird health, vaccine administered to the target bird in the prescribed dosage will induce immunity to the specific disease.

Furthermore, a well planned vaccination schedule will result in maximum immunity at the time when poultry are most susceptible to infection or when disease would have the highest negative impact on economic performance.

Live vaccines

Live poultry vaccines are generally attenuated bacterial or viral strains, which replicate in the vaccinated bird inducing a cellular and humoral immune response. Due to the ability to self propagate most live vaccines are suitable candidates for mass application by spray or via the drinking water. Mass application is, however, not without potential risks. Poor administration techniques result in only part of the population being exposed to the vaccine strain with resultant poor flock immunity.

Success of live vaccination is also dependant on the vaccine strain being presented to the correct target cells. This is clearly demonstrated when comparing the efficacy of a live Newcastle disease (ND) vaccine administered by different routes. Gough and Alexander demonstrated immunity to a ND virus challenge within 3-4 days of a ND vaccination administered by the aerosol route, an administration technique that delivers the vaccine virus directly to the respiratory mucosa.

In comparison administering the same vaccine by the drinking water route resulted in a delay in the development of immunity (Fig. 1).

Further to this Gough and Alexander demonstrated that the aerosol route of administration induced the highest serological response (Fig. 2).

Inactivated vaccines

Inactivated vaccines are formulated with a high antigenic mass of bacterial or viral origin formulated in a suitable adjuvant.

Vaccination results in a humeral response, the magnitude of which is directly related to the concentration of antigen administered per dose (Fig. 3). Inactivated vaccines must be administered by injection; success of vaccination is thus dependant on the skills of the vaccine administrator in administering a full dosage of vaccine to each bird.

This too holds true for certain live vaccines that are administered by injection.

Auditing procedures

Auditing of vaccination procedures should be implemented on two levels.

Firstly, on farm auditing of the accuracy and efficacy of the actual vaccine application procedures, and secondly a retrospective evaluation based on the interpretation of serology results.

For the purpose of this article we will look at methods to audit each administration route separately, followed by the interpretation of serological results.

Drinking water administration

The goal of a drinking water vaccination is for each chicken to drink a minimum of one dose of vaccine solution.

On the surface this may appear to be the simplest method of live poultry vaccine mass administration; however a drinking water application done correctly is time consuming.

Water availability

- Vaccine should be reconstituted in a sufficient volume of water to cater for a two hour period.
- Sufficient drinker space is required to allow free access to the vaccine solution.
- Water consumption during the first three weeks of a chick’s life is erratic, thus walking through the house during the vaccination chasing up inactive chicks, especially along the sides of the house, is recommended.
- To further stimulate drinking birds should be deprived of water prior to the vaccination. Usually 1-2 hours of water deprivation is sufficient to stimulate thirst.
Vaccine solution must be con-
To prevent neutralisation of the
Birds in open barn style hous-
Coarse spray is intended to
Equipment must be free of dis-
The cold chain must be main-
To evaluate the uniformity of
As smaller volumes of water
Cleanliness of equipment is
The cold chain must be main-
Uniform vaccination requires a
Birds in cages are sprayed cage
Fine spray or mist is intended
Spray distribution and droplet
The correct equipment must be
Continued from page 17
ever this is dependant on envi-
The water system must be
drained prior to administering the
vaccine solution, this is to avoid the
first chickens quenching their
thirst on standard water.

Vaccine viability
The cold chain must be main-
tained during the transportation of
to the site and on site
Avoid exposure of vaccine
vials and vaccine solution to
direct sunlight.
The addition of skinned milk
and tongues of birds that have
consumed vaccine solution will
be temporarily stained blue. The
procedure results in at least 90%
of chickens colouring blue.

Spray administration
The spray application technique
is especially suitable for the
administration of respiratory type
vaccines such as Newcastle dis-
ease and Infectious Bronchitis, as
the vaccine strain is deposited
directly onto the target cells; re-
spiratory mucosa. We distinguish
between two forms of spray with
different goals and applications.
Coarse spray is intended to
deliver large droplets of vaccine
to the upper respiratory tract and
eye. In addition, the feathers of
the bird are moistened stimulat-
ing preening which further in-
creases the chance of vaccine
uptake. Coarse spray is the pre-
ferred method of vaccine admin-
istration for young unprimed
chicks.

Assessing water intake
To evaluate the uniformity of
water intake a blue dye is added
to the vaccine solution. The crops
and tongues of birds that have
consumed vaccine solution will
be temporarily stained blue. The
intensity of the colouring is an
indication of the volume of water
consumed. A correct vaccination
procedure results in at least 90% of
chickens colouring blue.

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Distribution in the house
Uniform vaccination requires a
differentiation of the vaccine
spray in the poultry house at
different levels.
Vaccine must be reconstituted in
a sufficient volume of water
to distribute the required number
of dosages over the entire popu-
ation.
Birds in open barn style hous-
ing must be crowded for an effec-
tive vaccination. Crowding is
achieved using barriers or by
herding birds to the sides of the
house forming a bird free passage
down the centre.
Birds in cages are sprayed cage
by cage.
During vaccination ventilation
must be turned off and open
sided houses must have curtains
raised to keep out cross winds.
This is especially important when
fine spray or mist is the method of
application.
In excessively hot climates mini-
 mum ventilation may be required,
in which case application should
be limited to a coarse spray.
Spray distribution and droplet
size can be monitored using
water sensitive paper, a special
paper which changes colour
when exposed to moisture. Place
strips of water sensitive paper in
the back of cages or against the
wall to test that vaccine spray is
being distributed to all corners of
the house/cage.

Administration by injection
All inactivated as well as a few
live poultry vaccines are adminis-
tered by a subcutaneous or intra-
muscular injection. This method
of application requires accurate
deposition of the full dosage of
vaccine to each individual bird.
Technically this is the most
demanding vaccination tech-
nique as operators are required to
work at pace while vaccinating
thousands of birds. The immune
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PROPER SERUM SAMPLE HANDLING AND STORAGE

The following are guidelines for the proper handling and storage of serum samples:

- Collect 2-3ml blood, this will yield 0.5-0.75ml serum.
- Use disposable syringes and uncoated glass or plastic collection tubes.
- Separate serum from blood by centrifugation or natural coagulation (1-2 hours at room temperature).
- Clearly label samples, identifying company, flock, type of bird and age.
- Short term storage (<48 hours): 4-8°C.
- Long term storage: -20°C in plastic storage vials with airtight cap.

The correct size needle must be regularly calibrated prior to use.

The key to vaccine administration is required to achieve a consistent immune response following vaccination.

Overdosing is costly, underdosing results in poor immunity.

Serology is a helpful tool in evaluating the efficacy of an individual vaccine or vaccine administration. Checking the serological response to a specific antigen administered by the operator will indicate the accuracy of vaccination. A poor % CV in combination with a low mean titre could indicate a large percentage of birds are being missed or are not receiving the full vaccine dose.

The key to vaccine administration by injection is "Quality is more important than speed!"

Serology

Serology provides a useful profile on previous stimulation of the bird’s immune system, but serology by no means provides the full picture. Serology only measures circulating antibody levels (IgG and IgM), a function of humoral immunity, and fails to give us insight into cellular and local immunity. Despite this shortcoming, used in the correct context serology can provide valuable clues on the success or failure of a vaccination.

The key to reliable serology results start on the farm with sample collection. For sampling to be statistically valid there are two basic conditions that have to be met:

- Random selection.
- The number of birds being sampled is large enough to give a false result if vaccine distribution was not uniform.

A protocol should be agreed upon whereby samples are collected throughout the house.

Proper sample size:

- The number of blood samples taken from a flock has a direct impact on the reliability of the results. The fewer the number of samples collected the higher the risk of calculating an inaccurate mean flock titre.
- A minimum of 23 samples is the recommended number to be collected for a meaningful appraisal of flock immunity.

In addition to the above factors sample handling and storage is important to ensure a good quality serum sample is delivered to the laboratory.

Samples with excessive haemolysis, bacterial or fungal contaminants or samples that have started to decompose will not deliver reliable serology results.

Interpretation of serology

Following vaccination it generally takes 4-6 weeks for the development of significant antibody levels. Earlier serological results are not yet available.

The mean titre of the tested birds in a flock tells you how strong the antibody response is. A low mean titre could indicate samples were collected too soon after vaccination, or a poor vaccine application, or in the case of inactivated vaccines poor priming prior to vaccination.

The coefficient of variation percentage (%CV) provides an indication on how variable the titre response of a flock is. For most diseases the %CV following a correctly applied vaccination should be less than 40%.

If the %CV is above 60% there is definite room for improvement of the vaccine application techniques.

Summary

- The success of a vaccination is dependent on correct vaccine administration.
- Vaccine administration is best audited on site at point of application.
- Checking on correct procedures.
- Using tools such as blue dye or water sensitive paper to evaluate uniformity of administration.
- Retrospectively the success of a vaccine administration can be evaluated by interpreting serology results.
- Attention to the details of administration is required to achieve a consistent immune response following vaccination.

References


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