Vaccine Misapplication

A reduction in frequency is a poultry industry goal; a system is tested

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Why Do We Vaccinate Birds?

A successful health program relies on proper management, biosecurity, and good vaccination strategies. These practices help prevent and control harmful pathogens, such as viruses, bacteria, fungi, and parasites. Good biosecurity includes thorough cleaning and disinfection, pest control, and limiting movements of people and equipment on and off the poultry farm. Proper ventilation, litter management, and disease monitoring are also key management tools to prevent disease.

Vaccination can support these management and biosecurity practices, but vaccination should never be a substitute for the basic principles listed above. Vaccination helps producers prevent a disease outbreak in their flock and/or reduce clinical signs or adverse effects of specific diseases. It is important to note that vaccinating birds does not prevent infection or shedding of a pathogen.

Types of Vaccines

Vaccines contain live or killed, whole or portions of micro-organisms (viruses and bacteria) and stimulate the production of antibodies. Antibodies are a crucial component of a bird's immune system and function as the memory for the immune system. After vaccination, antibodies "remember" the pathogen so that when the bird is exposed to an infectious agent, the bird's immune system can mount a stronger, faster response that limits how sick the bird gets. There are different types of vaccines that generate antibodies in a bird. These types are used under different circumstances and include live, killed/inactivated/bacterin, and recombinant forms. Vaccines can be purchased from hatcheries and poultry suppliers.

Most poultry vaccines are live-virus vaccines. Live-virus vaccines consist of a weakened version of the disease-causing pathogen and mimic a natural disease exposure. Live-virus vaccines replicate in their host to stimulate an immune response. They are economical but provide immunity for only a short period of time.

Killed or inactivated vaccines stimulate an immune response using antigens (immune-stimulating particles) specific to the virus or bacteria of interest. They generally don't produce as strong or broad of a response as a live vaccine, so they often require boostering or multiple vaccinations. Additionally, killed vaccines are more expensive, require a needle injection, take time to become effective – so there is a delay in protective immunity – and usually require handling of individual birds, which can result in high labor costs for large flocks. However, individually dosing the birds generates a more uniform vaccination because every bird gets the same dose.

Live vaccines, later followed by killed vaccines, are sometimes used in the same flock to produce higher antibodies and a longer-lasting immune response to a specific infectious agent. Killed vaccines typically consist of a liquid phase and an adjuvant phase (ex. mineral oil, vegetable oil, or aluminum hydroxide) that are mixed to form an emulsion that is then injected into the bird. Adjuvants increase the stability of vaccines in the body; this allows longer stimulation of the immune system. However, these adjuvants can also cause unwanted local tissue inflammation and damage.

In addition to live and killed vaccine types, there are recombinant and bacterin types. Recombinant vaccines use a live virus to "carry" the disease virus into the bird. Bacterial vaccines, also termed bacterins, contain inactivated versions of a bacteria.

All vaccines should be shipped and stored according to their label, generally at 35-45ºF, or you risk decreasing efficacy of the product.

Routes of Vaccine Administration

Vaccines can be administered in a multitude of ways. Some common vaccination equipment is shown in **Figures 1-3.** Most commonly, vaccines are injected subcutaneously (SQ; below the skin), intradermally (in the skin), intramuscularly (IM; within the muscle), in the drinking water, or as sprays (ex. gels, fine and coarse sprays). Subcutaneous, intradermal, intramuscular, and drinking water vaccinations rely on exposure of the bird's immune system to vaccine particles in the skin, muscle, or gut. Local inflammation at these sites of vaccination allows the birds to pick up the vaccine particles in their blood, presenting those particles to the bird's immune system. Spray vaccines

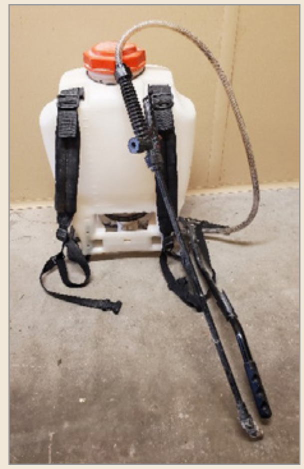

Figure 1. Backpack sprayer or handheld sprayer that can be purchased from several manufacturers. Agricultural sprayers can be modified for the same purpose. A liquid vaccine is sprayed onto all birds in the house. The vaccine contacts the eyes and upper respiratory tract of the bird or is ingested as the bird preens itself and others.

Figure 2. Wing web applicator. A wing web applicator is a two-pronged applicator that is dipped in the vaccine and then punched through the wing web of every bird in the flock.

Figure 3. Injection gun. An injection or vaccine gun uses an 18 gauge, ¼ inch needle to administer intramuscular and subcutaneous vaccinations. Needles should be replaced after every 500 birds.

Table 1. Common breeder or layer pullet vaccines and routes of administration

Breeder/ Layer Pullet Vaccine	Route of Administration
Marek's	Subcutaneous, in ovo
Newcastle	Drinking water, intraocular, intranasal, spray, intramuscular, subcutaneous
Infectious Bronchitis (IBV)	Subcutaneous, intramuscular, spray
Newcastle/IBV	Drinking water, spray, intraocular, intranasal
Infectious laryngotracheitis	Intraocular, subcutaneous, spray, drinking water
Fowl pox	Wing web, thigh stick (intramuscular, turkeys)
Fowl cholera	Drinking water, wing web
Avian encephalomyelitis	Drinking water, wing web
Infectious bursal disease	Drinking water, spray
Salmonella	Drinking water, spray

are viruses or bacteria suspended in liquid that are administered on top of the birds' feathers using equipment similar to **Figure 1.** The birds consume the vaccine as they preen themselves and other birds in the flock, or they receive direct vaccine contact through their eyes and upper respiratory tract. When ingested, this generates a similar vaccine presentation to the bird's immune system as is seen in drinking water vaccines.

In addition to these routes of administration, vaccines can be administered intraocularly (eye drop) or intranasally (nose drop). Routes of administration of some common vaccines are listed in **Table 1.**

The intradermal vaccination is typically applied within the wing web; SQ vaccines are generally injected in the inguinal fold (flap of skin by the thigh) or in the neck. The breast, thigh, wing, or tail head are common locations for IM vaccination. Administration of IM and SQ vaccines are done by hand, which can be a very labor-intensive process and generates a high risk of injury to the human handler. The equipment shown in **Figures 2 and 3** are commonly used to administer intradermal and IM/SQ vaccines, respectively.

To stimulate the best immune reaction and lasting protection, IM injections require proper placement, not too close to the bone or internal organs and not too deep or superficial within the muscle. In the same way, to get the best protection, SQ and intradermal vaccines need to be placed properly below or within the skin, respectively (**Figure 4**).

A certain amount of skill – and a bit of finesse – are required to administer IM, intradermal, and SQ injections. Without the correct vaccination technique, the immune response in the flock is impaired. Misapplication of vaccines is a major cause of vaccine failure or reduced protection and immunity. Misapplication can occur because of applicator fatigue or injury, missed or incorrectly placed injections, and equipment error, such as a jammed-up gun, empty vaccine bottles, dull needle, or improper calibration/wrong dose. Misapplication can occur with any vaccine and any vaccine equipment.

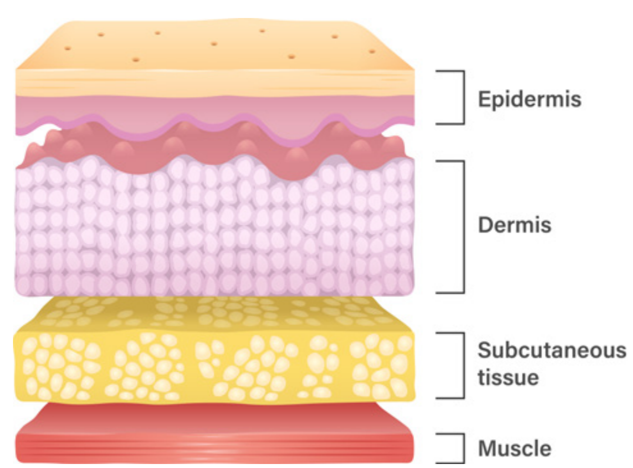

Figure 4. Layers of the skin and muscle. Subcutaneous vaccines are administered in the fatty subcutaneous tissue; this layer is below the skin but above the muscle. Intradermal vaccines are administered in the dermis, the thickest part of the skin. Intramuscular vaccines are administered in the muscle.

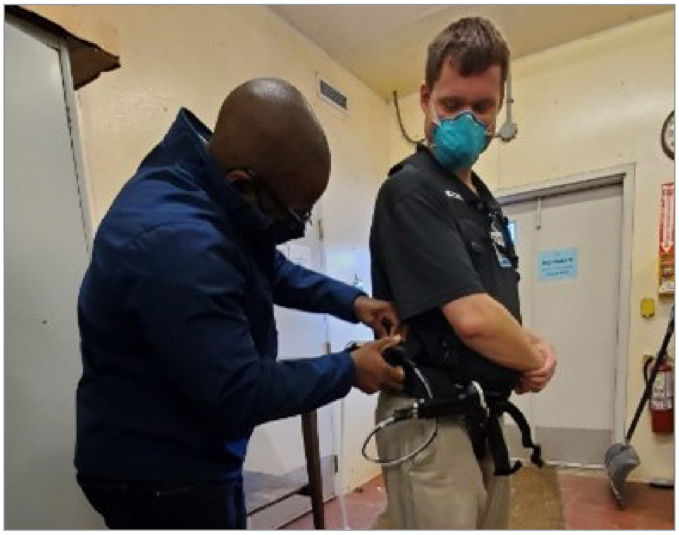

Figure 5. A pHi-Tech PVX-100 vaccination system is placed around the waist of a participant in training.

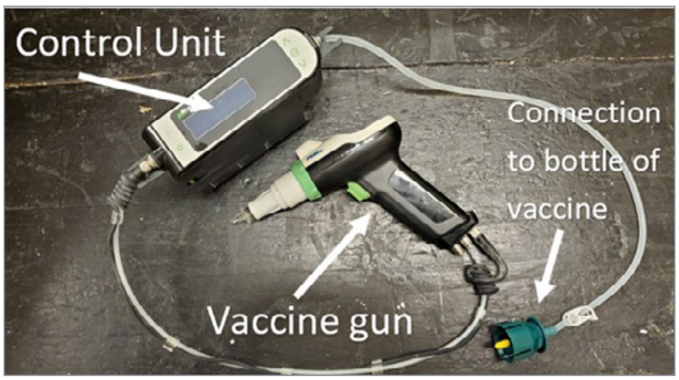

Figure 6. pHi-Tech PVX-100 vaccination system.

A Tool: The pHi-Tech PVX-100 Vaccination System

One product created in 2019 in an attempt to reduce the frequency of vaccine misapplication on the farm is from Phibro Animal Health Corp. The trademarked pHi-Tech PVX-100 vaccination system, for IM, SQ, and intradermal vaccines, features a handheld vaccination gun, a control unit, a vest to hold the gun and control unit, and a computer and mobile application to analyze efficacy of vaccination.

The system starts with setting up the application. Within this application, multiple users can define:

- The location and flock being vaccinated
- The vaccine gun being used
- The operator currently vaccinating
- The vaccine being used
- Specific instructions for a vaccine
    - Temperature
    - Dose
    - Starting volume in the bottle

From this information, the control system can track when vaccine bottles need to be changed and when temperature of the vaccine is outside the acceptable range. This makes following label instructions easier and ensures the greatest stability and efficacy of the vaccine. The electronic dosing system's application tracks vaccination rate and any notifications or errors that occur during vaccination. The mobile app and the control unit communicate through Bluetooth. Once the system has an internet connection, all data is backed up on a cloud system that can be viewed by multiple users.

The handheld gun, control unit, and vest are lightweight and ergonomic, designed to minimize fatigue. There are single- and double-needle systems, so up to two vaccines can be administered. A needle guard reduces the risk of needle stick injuries. The electronic dosing system uses priming and calibration features that ensure the correct dose is administered at every injection. Error alerts – e.g., pulling the needle too early, improper placement (ex. hitting keel bone), empty vaccine bottles, incorrect vaccine temperature – show up as a light on the vaccine gun and a message on the control unit.

Figure 7. Graduate student using the electronic dosing system to vaccinate a chicken via breast injection.

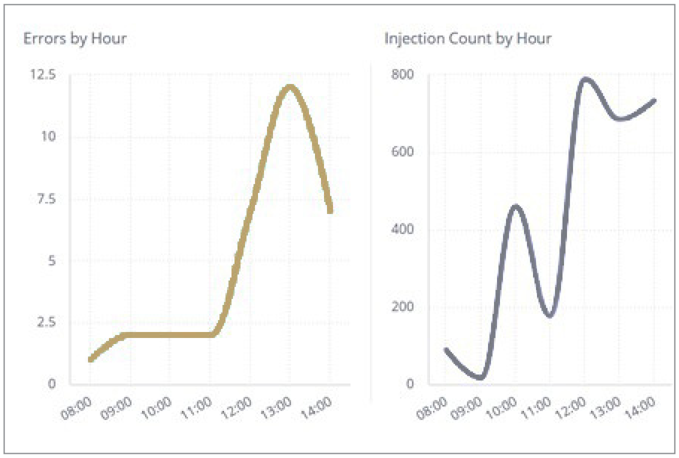

Figure 8. Charts representing injection errors and injection counts by hour for the entire group during the electronic dosing system trial.

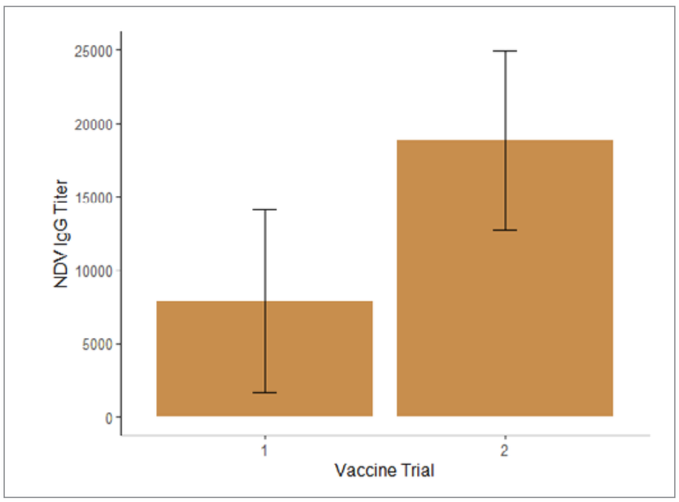

Figure 9. Vaccine titers from Trial 1 (traditional vaccine equipment) and Trial 2 (electronic dosing system).

Putting the PVX-100 to the test

A group of Purdue University students, faculty, and farm management personnel tested the pHi-Tech PVX-100 vaccination system at the Animal Sciences Research and Education Center's Poultry Research Farm.

An hour of training focused on learning proper use of the system and how the system is set up and connected to the phone and computer applications. Later, breast injection vaccinations were administered to about 3,000 12-week-old layer pullets. The vaccine was a killed vaccine containing Newcastle disease virus, infectious bronchitis virus, and *Salmonella* enteritidis. From loading and priming through cleaning and disinfecting the vaccine system, the entire process lasted about six hours. Of the 2,922 injections performed by three vaccinators and five handlers, using one electronic dosing system, 30 errors or misapplications occurred. Because the operator was immediately notified of misapplication, all affected birds were revaccinated correctly.

Figure 8 is an image from the application. The image shows that there was a higher error rate as the vaccinators and handlers picked up speed, and the vaccination rate increased as the group got more experience. The injection rate was likely slower than would be seen on commercial farms because 60 individual pens were vaccinated. If there had been multiple users or machines, efficacy and efficiency of each machine and operator could be monitored, and that information could be followed over time and across flocks. This information could then be compared to vaccine antibody titers to evaluate a farm's vaccination program.

Vaccine titer results

To evaluate effectiveness of the vaccination, Newcastle disease virus antibody titers were measured using a commercial enzyme-linked immunosorbent assay (ELISA) kit. These values were compared to a previous breast injection completed with a vaccine crew using traditional vaccine guns on a different flock. A larger vaccine titer suggests a better antibody response to the vaccine and potentially better disease protection.

Although the two trials had different study treatments applied, which limits interpretation, on average, the trial with the pHi-Tech PVX-100 electronic dosing system (EDS) produced significantly higher antibody titers compared to the traditional vaccine equipment. The average titer in the trial with the traditional vaccination equipment was 7,888; the trial with the EDS was 18,830 (**Figure 9**). This equates to a 42% higher response with the EDS equipment.

Also evaluated was the coefficient of variation (CV), a measure of variation in titers, where a lower CV indicates a more uniform vaccination and vaccine response. CV values below 60% are a good target level. The EDS system produced antibody titers with a lower coefficient of variation (0.32) than the traditional vaccine equipment (0.79); this indicated the EDS had a much more uniform vaccine response compared to the traditional equipment.

Conclusions

Vaccination is a vital tool for achieving good flock health/production when used in addition to good management and biosecurity. Live, killed/inactivated, recombinant, or bacterin vaccines are used to stimulate antibody production to protect flocks from clinical disease. Vaccines can be administered into the muscle (IM) or skin (SQ and intradermal), as well as in drinking water, as a spray, and as a drop in the eye (intraocular) or nose (intranasal).

Administration of IM and SQ vaccines requires proper technique to get the best immune response. Misapplications are a common cause of vaccine failure. Vaccine misapplication can occur because of worker fatigue, missed or incorrectly placed injections, and machinery errors. Phibro Animal Health Corp, says its vaccine system, the pHi-Tech PVX-100, seeks to limit common causes of vaccine misapplication and reduce worker fatigue. In this trial, the PVX-100 system improved vaccine titers and uniformity in vaccine response, indicating better disease protection, which allowed monitoring of vaccination efficacy and efficiency, reducing misapplication.

Key takeaways

- Vaccination is not a substitute for good management and biosecurity.
- Hatcheries and poultry suppliers are a good source to purchase vaccines.
- Follow vaccine labels for shipping, storage, and administration or your efforts may be wasted.
- To avoid misapplication, proper skills and techniques for vaccination procedures must be used.
- Electronic dosing systems are an effective way to administer IM and SQ vaccines.

Resources

https://www.clemson.edu/extension/4h/programs/ag-animals/livestock/files/youthacademy/poultry/module4/poultry-health-management.pdf

https://static1.squarespace.com/static/5591528ae4b05e44b9c136da/t/55b14aeae4b0790f690b2ddd/1437682410755/Vaccination+of+Small+Poultry+Flocks.pdf

https://www.phitech.pahc.com/?campaignid=15505530426&adgroupid=131779033878&network=g&keyword=phi%20tech&matchtype=b&creative=568628447725&adposition=&device=c&utm_source=google&utm_medium=cpc&utm_term=phi%20tech&utm_content=b&utm_campaign=GoogleAds-Brand&gclid=Cj0KCQjwma6TBhDIARIsAOKuANwwui4sPWasD0kYZ6nWfAkw5D51oH1AsoKz-8PCw5-0EdJZjOSoLQ8aAooaEALw_wcB

https://www.hhs.gov/immunization/basics/types/index.html

https://www.thepoultrysite.com/articles/bacterin-usage-in-flock-amanagement

https://www.cobb-vantress.com/assets/Cobb-Files/management-guides/278bf28faa/cobb-vaccination-procedure-guide-englishFCC0CCBF492C3BF8E205233B.pdf

https://5mpublishing.sirv.com/poultry/legacy/files/Socorex%20Swiss%20Animal%20Health%20Syringes%20poultry.jpg

https://www.agri-pro.com/products/pox-vaccinator

https://edis.ifas.ufl.edu/publication/VM062