

Needle-free and intradermal vaccination of pigs – a perfect match

In the swine industry, vaccination is a preferred method in the prevention and control of many pathogens. Traditionally, vaccines are administered intramuscularly with a needle and syringe. However, the known drawbacks of this method both in human and animal health have stimulated research in alternate vaccine delivery methods.

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In addition to overcoming the negative aspects, the success of these alternate methods is also driven by efficacy that is as good as or better than following vaccination with a needle and syringe. The focus of this article is on an alternate vaccination method that combines the benefits of needle-free injection and intradermal vaccine delivery.

The problem with needles

Although vaccination with a needle and syringe is inexpensive and easily adaptable, there are many disadvantages for both the pig and their users. From the pigs' perspective, needle injections introduce stress, pain and increase the risk to transmit diseases. Although it is generally recommended that needles are changed between litters to counteract some of this, the reality on it being done may be different.

The microscopic images of a needle would suggest that even more frequent changes may be needed considering the fast deterioration that occurs as a result of injections. Needles also have a negative impact on carcase quality because of the deep tissue damage and increased chance for abscesses. In addition, needle fragments following breakage may or may not be picked up by the needle detectors following slaughter resulting in accidental findings by the consumer and poor image for the pork industry. From the users' perspective, the primary issues are the occurrence of needle sticks and difficulty with proper disposal of used needles. According to the Upper Midwest Agricultural Safety and Health center, over 80% of farm workers and 73% of swine veterinarians have accidentally stuck themselves and vaccines are reported as the most frequent product involved in needle stick injuries.

Benefits of needle-free

First, the basic principle of needle free injectors, such as IDAL, is that a high pressure stream of fluid is forced through the skin via mechanical pressure in a fraction of a second. The advantage is that this results in the elimination of broken needles and associated carcass trim, improves employee safety by avoidance of the accidental needle stick, and reduces the biological waste. They also reduce the risk of spreading viraemic diseases like PRRSV, which occurs when re-using the same needle-syringe on multi-

Pigs	Users
Reduces stress and pain	No needle sticks
Improved welfare	No needle disposal
No tissue or carcass damage	Improved vaccination consistency
Reduced transmission of disease	More accurate dosing
No broken needles	

Table 1. Needle-free vaccination has many benefits for pigs and users.

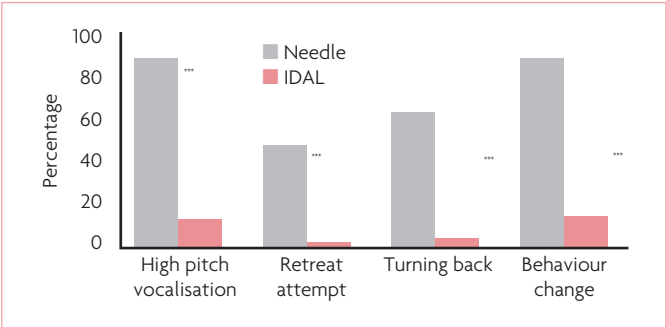


Fig. 2. IDAL injection reduces fear and pain reactions in sows compared to needle injections (42 sows in each treatment group; *** P<0.005).

ple animals, and cause less stress and pain for the animal. Needle-free injection tends to be more precise and reliable, with the dose and location of deposit being virtually identical every time, compared to needle-syringe vaccination, which relies more on equipment (for example needle length and gauge) and technique.

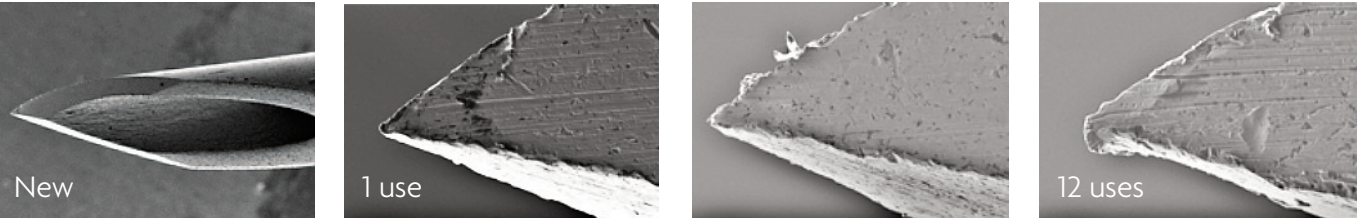
Improved welfare

Recently, results from two independent studies with the IDAL confirmed the positive impact of

needle free vaccination on the welfare of sows and piglets. In a first study, a Spanish research group from the University of Barcelona Nutrition and Animal Welfare Department compared several behavioural and physiological parameters in pregnant sows either vaccinated with the needle-free IDAL injector or a standard needle and syringe. Although there were no significant differences observed in the social, exploration, drinking or resting patterns, sows vaccinated with a needle were less active than IDAL sows (P=0.0309).

Continued on page 17

Fig. 1. The life span of a needle is short. They become blunt and loose sharpness following less than 12 uses (images courtesy of University of Veterinary Medicine Giessen, Germany in Cooperation with MSD Animal Health, Germany).



Continued from page 15

In addition, 33% of the needle sows compared to 3% of IDAL sows had a panic response to the observer 24 hours after vaccination while they were completely calm prior to vaccination ($P=0.006$). Other behavioural indicators were also reduced in IDAL sows (Fig. 2).

In addition, chromogranin A levels, a measure of increased sympathetic activity, and C-reactive protein, a measure of muscle damage, were both lower following IDAL vaccination. All of these results support that needle-free vaccination should be considered as a tool to improve welfare of the pregnant sow.

In a second study, German scientists videotaped the behaviour of approximately three week old piglets following vaccination with either a needle or IDAL.

The study included over 300 pigs in each treatment group and was done in a 240 sow farm. The analysis of the video clips confirmed that IDAL piglets were more active, were suckling more and had more social contacts than the needle piglets in the post-vaccination observation period ($P<0.01$). Again indicative that needle-free vaccination improves welfare of the pigs.

Intradermal vaccination

Compared to traditional intramuscular vaccines, intradermal vaccines typically have two requirements:

- They tend to have a smaller volume which means that a reformulation or adaptation of existing vaccines is usually needed.
- They need an application device as needle and syringe are not practical for mass administration of intradermal vaccines.

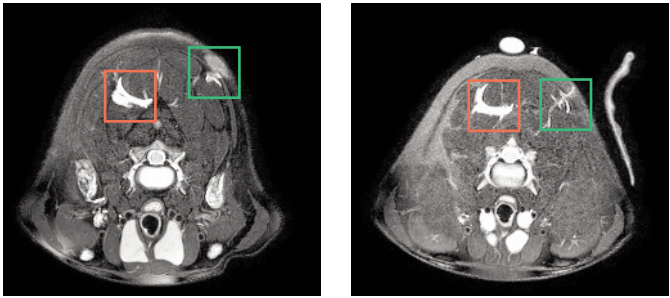


Fig. 3. Image for pig 1 and 2 at the level of the injection site (0mm). The vaccine on the IM side (red) appeared as a strong signal deep in the muscle, while the vaccine on the IDAL side is a faint line or area in and below the skin (images courtesy of H. Kauffold & H. Sigmarsson, Large, Faculty of Veterinary Medicine, University of Leipzig, Germany).

	Depth*	Lateral spread*	Comment
IDAL	Extends to 12mm below skin	18-22mm	Cloud and line like appearance indicating a fine and lateral dispersion of vaccine
Needle/ syringe	Starts at 12 and extends to 34mm	38-48mm	Bolus/depot of vaccine in deeper regions of neck surrounding the vertebrae

*Depth and spread are approximations and are based on the results of two pigs.

Table 2. Vaccine deposit characteristics following IDAL vs needle and syringe vaccination.

Before discussing the immunological benefit of intradermal vaccination, it is important to understand the difference in depth and tissue distribution of vaccine administered either with a needle-free injector like the IDAL or with a standard needle and syringe.

Briefly, three week old pigs were vaccinated in opposite sides of the neck with a 0.2mL vaccine dose via IDAL and a 2.0mL vaccine dose via needle (17g x 12mm) and syringe.

Approximately 15 minutes following vaccination, a series of magnetic resonance images (MRI) were made

in 2mm increments from caudal to cranial with 0mm being the point of injection. The MRI images support that intramuscular injections of a standard vaccine dose with a needle and syringe result in the formation of a bolus deep in the muscle adjacent to and lateral of the needle.

In contrast, the IDAL disperses the vaccine in the skin and the adjacent tissue. This type of wide dispersion of vaccine is believed to increase exposure of antigen to dendritic cells, the resident immune cell in the dermis, explaining the effectiveness of this vaccination method.

The immune response

The skin, which consists of the epidermis, dermis and sub cutis (fatty layer), is the first physical and immunological barrier against injury and infection and is more immunogenic than the muscle.

As already mentioned, the dermis has a high concentration of dendritic cells (DC), which induce and orchestrate the first (innate) immune response through capturing and presenting the antigens, as well as many lymph and blood vessels.

Following intradermal vaccination, DC are activated following uptake of antigen and these activated cells migrate to the lymph nodes, which in turn leads to activation of B-lymphocytes.

The local inflammatory response induced by vaccination also attracts inflammatory cells that differentiate into dendritic cells and macrophages, which participate in the immune response.

Overall, this process tends to be more efficient following intradermal than intramuscular vaccination and results in an immune response that is faster and as good or better than intramuscular vaccination.

Conclusion

The many benefits of needle free vaccination for pigs and users combined with the immunological benefit of intradermal vaccination make these two a perfect match and a vaccination method that should be considered for the modern swine producer. ■

References are available from the author on request