

Update on Needle-Free Vaccination

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Background: There are several reasons why needle-free vaccination of pigs can be a better alternative than using a traditional syringe and needle to deliver vaccine. First, the needle is a “sharps” hazard which requires that workers be trained (perhaps a fairly short, focused training session) in injury avoidance and proper disposal of this biohazard. Most swine veterinarians can assist with developing a proper sharps disposal protocol for their clients. Second, the use of a needle can affect pork product quality. Although the occurrence of broken needles in pork products is quite rare, the consequences for marketing pork can be devastating, so needle use should be minimized. Third, pigs flinch from injections because there is pain and stress that results from the intrusion of the needle into the skin and muscle. Finally, the licensed vaccines have been shown to be effective following conventional injection methods, but immunologists know that there are more effective ways to get protective mucosal immunity.

Effect of injection method on health: We have evaluated the effects of needle-free injection, conventional method of injection, or no injection on piglets. Piglets were provided with



nutritional iron (Dexafer) and immunization (Suvaxyn® MH/HPS) by injection at 1 day of age and control piglets were given Dexafer by mouth. Health, blood iron (hematocrit) and serum antibody responses were measured and growth rate was calculated at weaning. Overall herd health was very good, but more disease occurred in pigs that got a regular injection. Pre-weaning disease or death was 2.2 times more likely to occur in piglets injected with a conventional needle and syringe (Group 1) than in piglets given **Figure 1. Piglet receiving an experimental vaccination.**

no injection (Group 3). Group 3 received no vaccine and iron dextran by mouth. As expected, both the blood iron (hematocrit) as well as the antibody level for group 3 were significantly lower ($p < 0.05$) than in the other groups, which were not different. No significant differences in daily gain or weaning weight were demonstrated. The needle-free injection method (Fig. 1) resulted in equivalent hematocrit, antibody response and growth and did not result in the increased nonspecific sickness that was observed in the group injected with a conventional needle and syringe.

Effect of injection method on meat: After this project was funded and begun, other work has been published which demonstrated that needle free administration of vaccine did not result in a difference in meat quality – both methods were acceptable. (Houser, T. A., et al. 2004. Meat Science 68:329-332.) Because this other work addressed the meat quality issue, we focused our remaining time and resources on improved formulation of mucosal vaccines for pigs

Improved formulation of mucosal vaccines for pigs: We evaluated the efficiency of biphasic vesicles (VTAM1 formula) in mucosal vaccine formulations using a combined mucosal/systemic protocol of immunization in pigs. Pigs received 2 i.n. immunizations at days 0 and 30 and 1 s.c. at day 21. Cholera toxin (a potent adjuvant) was included as a positive control for mucosal immunization. Negative control pigs received saline. Antibody responses were assessed after each immunization and compared with responses induced by a biphasic lipid formulation containing antigen and CpG ODNs after 2 s.c. immunizations. The biphasic vesicles (VTAM1 formula) were characterized, and their main properties are described below. The i.n. formulation contained anionic vesicles with trimodal size distribution characteristics. Average size distributions for the 3 particle populations were 23 ± 1 nm (3% of particle population in this size range), 141 ± 18 (55%), and 784 ± 82 (42%) ($n = 3$). This is consistent with a topical formulation method where the biphasic vesicle components such as the submicron emulsion droplets (mean diameter 141 nm) and phospholipid vesicles trapping submicron emulsion droplets (mean diameter 784 nm) are present. In addition, the small particles with a mean diameter of 23 nm in VTAM1 probably represented surfactant micelles that were not part of the vesicle population. For administration into the nasal cavity, the antigen was mixed with the biphasic vesicles. Binding/association (not entrapment) of the antigen with the vesicles helps increase the residence time of the antigen in the nasal cavity and localizes the antigen in the required regions. The mixture of antigen with the vesicles also improves

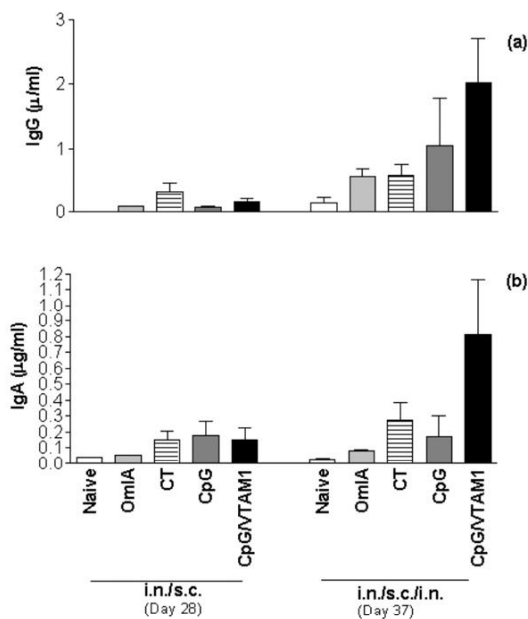


Figure 2. Antibody in nasal secretions after experimental piglet immunization.

stability and versatility. It is envisaged that biphasic vesicles could be used as a “universal” adjuvant for many other antigens as well.

The results (Fig. 2) mean that the novel adjuvant and formulation combination that is described here (Alcón V, et al. 2005.AAPS J. 7(3):E566-71.) is as effective as or better than the best previously known material for mucosal immunization in pigs. The novel combination has the additional advantage of avoiding the toxic effects of materials previously used for mucosal immunization.

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