

## PORK SAFETY

**Title:** Incidence and severity of *Arcanobacterium pyogenes* injection site abscesses with needle or needle-free injection methods - **NPB # 08-239**

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### Industry Summary:

The pork industry loses a substantial amount of money each year due to the trimming of pork carcasses in processing plants. A large portion of carcass trimming is due to the presence of abscesses on pork carcasses. These abscesses form in many locations, however abscesses are frequently seen at sites where injections of vaccines and antibiotics are commonly given. The most common form of administering injection is by the use of a needle-and-syringe system. An emerging technology available to swine producers that can be used to replace these needle-and-syringe systems is needle-free jet injection. Needle-free jet injection delivers vaccines by using a pressurized gas to force the vaccine through the skin of the animal rather than a traditional hypodermic needle. Therefore, the purpose of this experiment was to determine if there was a difference in the rate of abscess formation when comparing needle-free injection and conventional needle-and-syringe injection methods.

We utilized 198 nursery age pigs for this trial. The trial began after the pigs were allowed to adjust to the environment of the Kansas State University Segregated Early Weaning (SEW) unit for 21 days. On the first day of the trial each pig received 4 injections of aluminum hydroxide adjuvant. On one side of the pig, injections were given in the neck and ham using a needle-and-syringe system. On the opposite side, a needle-free jet injection system was used to administer one injection in the neck and another in the ham. Immediately prior to injection, the surface of the skin where the injections were given was contaminated with an inoculum of *Arcanobacterium pyogenes*, a bacterium that is commonly associated with abscesses found in livestock carcasses. Pigs were then fed for 27 and 28 days. On days 27 and 28, the pigs were humanely euthanized and then sent to the Kansas State Veterinary Diagnostics Laboratory where necropsies were performed on each animal and each injection site underwent histopathological evaluation to determine where abscesses had formed.

In this project there were a total of 792 injections given. Of the 792 injection sites that were evaluated, histological evaluation uncovered only 13 abscesses at those locations. Of the 13 abscesses found, 12 were found at injections sites that utilized the needle-free jet injection system and 1 was found for the needle-and-syringe injection system. When comparing neck and ham injection sites, 5 abscesses were found at neck injection sites and 8 were found at ham injection sites. 10 of the abscesses observed were on the left side of the animal while 3 were found on the right side. Additionally, granulations formed as a result of immune reaction to the adjuvant were not different between the two injection methods.

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The results of this study indicate that abscess formation due to injections is very hard to reproduce in a controlled experiment. Additionally, there does not seem to be a difference between the rates of abscess formation between the neck and ham regions. However, this experiment suggests that the utilization of these needle-free systems has the potential to increase the occurrence of abscesses when *A. pyogenes* is present.

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**Key Words:** abscess, *Arcanobacterium pyogenes*, carcass trimming, needle-free injection, needle fragments

### Scientific Abstract

198 nursery age pigs were used to evaluate the difference in the occurrence of injection site abscesses between needle-free jet injection and conventional needle-and-syringe injection systems. Pigs were fed for 21 d prior to treatment administration to acclimate the pigs to the environment of the Kansas State University Segregated Early Weaning (SEW) unit. On d 21 each pig was injected with aluminum hydroxide adjuvant in the neck and ham with needle-free jet injection (Pulse Needle-Free Systems, Lenexa, KS) and conventional needle-and-syringe injection. Needle-free and conventional needle-and-syringe injections were randomly assigned to pig side yielding a total of 396 injections per treatment with a total of 792 injection sites. Immediately prior to injection, the external surface of the injection sites were contaminated with an inoculum of *Arcanobacterium pyogenes*, a bacterium commonly associated with livestock abscesses. The pigs were then fed for a period of 27 and 28 d. On d 27 and d 28 the pigs were humanely euthanized and sent to the Kansas State Veterinary Diagnostics Laboratory where necropsies were performed and the injection sites underwent histopathological evaluation. The needle-free jet injection system was associated with more injection site abscesses than the conventional needle-and-syringe injection method for both neck ( $P=0.0625$ ) and ham ( $P=0.0313$ ) injection sites. Twelve abscesses were found at injection sites administered via needle-free jet injection method while only 1 abscess was found where a conventional needle-and-syringe injection method was used. At the neck injection sites, 5 abscesses were found while at the ham injection sites, 8 abscesses were observed. Of the 13 abscesses that were found, 10 developed on the left side of the animal and only 3 were seen on the right side. There were no differences between granulation formation for the neck ( $P=0.51$ ) or ham ( $P=0.29$ ) regions when comparing the needle-free and needle-and-syringe injection methods. In summary, the implementation of needle-free jet injection systems in market hog production will be beneficial to eliminate needles and needle fragments in meat products but, when in the presence of *Arcanobacterium pyogenes*, it may increase the occurrence of injection site abscesses in pork carcasses that will need to be trimmed in pork processing plants. Although more abscesses were associated with needle-free jet injection, their occurrence was still observed at a very low rate given that injection sites were intentionally contaminated prior to injection.

### Introduction

The presence of abscesses on pork carcasses has been a constant problem for the pork industry. Results from the 1994 Pork Chain Quality Audit involving 48,665,000 hogs indicated that, at the time of slaughter, some form of carcass trimming occurred on 13.4% of carcasses. A total of 7.59% of carcasses were trimmed for abscesses at slaughter, and another 0.52% were trimmed for injection site blemishes at that time. The percent of the total slaughter trim involving abscesses and injection-site blemishes was 56.63% and 3.85%, respectively. Furthermore, at the time of carcass fabrication 11.1% of the carcasses underwent some form of additional carcass trimming. Abscesses accounted for 33.3% of the fab trim while injection site blemishes

accounted for 13.5%. In the 2003 Benchmarking Value in the Pork Supply Chain Final Report (Stetzer and McKeith 2003), the #5 cause of lost dollar value was reported to be abscesses/injection site blemishes. Whole or partial condemnations due to abscessation were reported in 9.3% of hogs slaughtered, while 1.9% was due to injection site blemishes. While the location of an abscess would sometimes preclude an injection being causative, many abscesses occurred in anatomical areas where injection was a possible or likely cause. *Arcanobacterium (Actinomyces) pyogenes* is a frequent bacterial cause of abscessation in hogs.

## Objectives

1. Determine if the incidence of injection site abscesses in market pigs varies with the use of conventional needle injection when compared to needle-free injection.
2. Compare and contrast the rate of development and physical nature of injection site abscesses resulting from conventional needle injection when compared to needle-free injection.

## Materials and Methods

The Kansas State University (KSU) Institutional Animal Care and Use Committee approved protocols used in this experiment. Pigs were housed at the KSU Segregated Early Weaning unit.

A total of 198 nursery age pigs were used in this 49 day study. The pigs were allowed a 21 day conditioning period to become acclimated with their environment before treatments were administered. On day 0 of the trial each pig received a total of 4 intramuscular injections of a 2 mL dose of aluminum hydroxide vaccine adjuvant. On one side of the animal a conventional needle-and-syringe injection method utilizing a disposable 18 gauge  $\times$   $\frac{3}{4}$  inch needle was used to administer an injection in the neck and ham and needles were changed after every 25 animals. On the opposite side of the animal a Pulse 250 needle-free jet injector (Pulse Needle-Free Systems Lenexa, KS) set at 45 psi was used to administer injections in the neck and ham. A random number generator was used to randomize which side of the animal received each type of injection. Immediately prior to injection, the skin over the injection site was contaminated with an inoculum of *A. pyogenes*, a bacterium commonly associated with abscesses in swine, which was prepared by the Kansas State Veterinary Diagnostics Laboratory (KSVDL). The injection devices were not decontaminated or disinfected between injections.

After injections were administered the pigs were housed in their originally assigned pens for 27 and 28 days and monitored daily with feed additions weighed and recorded. On day 27 and day 28 the pigs were humanely euthanized via jugular injection of 6 mL of Fatal Plus, 390 mg/mL pentobarbital. The euthanized pigs were then sent to the KSVDL where externally palpable lesions were measured through the skin with calipers. Necropsies were then performed on all animals with abscessed areas harvested, measured and weighed. Representative portions of the reactive tissue surrounding the injection sites were placed in 10% neutral buffered formalin for histopathological evaluation. A score of "0" was given to tissue from injection sites that were normal when viewed under a microscope. A score of "1" was given to tissue that contained groups of swollen macrophages with some granulation surrounding them that were due to a reaction to the adjuvant. A score of "2" was given to tissue that had abscesses and granulation visible microscopically.

The FREQ procedure of SAS was used with injection site serving as the experimental unit. The paired binary data was then analyzed using McNemar's test.

## VIII. Results

1. Determine if the incidence of injection site abscesses in market pigs varies with the use of conventional needle injection when compared to needle-free injection.

With a total of 792 injection sites only 13 abscesses were found by gross and histological evaluation. There were 11 individual pigs that had injection site abscesses with one individual having 3 abscesses. There was a greater amount of abscesses from the use of the needle-free jet injection systems compared to the

conventional needle-and-syringe injection system for both the neck ( $P = 0.0625$ ) and the ham ( $P = 0.0313$ ) injection locations (Table 1). Of the 13 observed abscesses, 12 occurred at injection sites from needle-free injection and only 1 developed at an injection site from conventional needle-and-syringe injection. Additionally, no statistical difference ( $P > 0.05$ ) was observed in comparing abscess occurrence and injection site as neck injection sites produced 5 abscesses while 8 abscesses were observed at ham injection sites. There was not a significant difference in occurrence of abscesses between right and left sides. Of the 13 abscesses that were found, 10 developed on the left side of the animal and 3 were found on the right side.

**Table 1. Pigs with histological injection site abscesses after vaccination<sup>1</sup>**

Item	Needle-and-Syringe	Needle-Free <sup>2</sup>	<i>P</i> -value
Neck			
Total	198	198	----
Positive	0	5	0.06
Negative	198	193	----
Ham			
Total	198	198	----
Positive	1	7	0.0313
Negative	197	191	----

<sup>1</sup> 198 pigs were injected twice by needle-free injection on one side and twice by needle-and-syringe injection on the opposite side before being euthanized after 27 and 28 days and having injections sites evaluated for abscess formation.

<sup>2</sup> Pulse Needle-Free Systems, Lenexa, KS

2. Compare and contrast the rate of development and physical nature of injection site abscesses resulting from conventional needle injection when compared to needle-free injection.

As mentioned in the previous section there was a significantly higher number of abscesses as a result of needle-free injection compared with traditional needle and syringe injection systems. However, we were unable to do much classification of the abscesses due to the extremely low number of abscesses that were formed for either injection method. Granulations formed that were attributed to tissue reaction to the adjuvant are listed in Table 2. There were no significant differences in the number of samples with granulations attributed to tissue reaction for either injection method for either injection location. This would indicate that a similar immune response to the aluminum hydroxide adjuvant was occurring for both injection types.

**Table 2. Pigs with histological injection site granulation after vaccination<sup>1</sup>**

Item	Needle-and-Syringe	Needle-Free <sup>2</sup>	<i>P</i> -value
Neck			
Total	198	198	----
Positive	20	24	0.51
Negative	178	174	----
Ham			
Total	198	198	----
Positive	24	32	0.29
Negative	173	166	----

<sup>1</sup> 198 pigs were injected twice by needle-free injection on one side and twice by needle-and-syringe injection on the opposite side before being euthanized after 27 and 28 days and having injections sites evaluated for abscess formation.

<sup>2</sup> Pulse Needle-Free Systems, Lenexa, KS

## Discussion

Our findings contradict results by Houser et al., (2004) who found no difference in abscess formation between needle-free injection compared with conventional needle injection. This difference might be caused by the inoculums used in this study since no inoculum was used in their study. This theory would agree with results found by Sutterfield et al., (2009) who reported a greater amount of bacterial translocation using a needle-free injection system compared with a needle injection system for enhancing beef strip loins.

Previous audit data has reported that abscesses occur at a relatively low rate in the commercial slaughter hog population (NPPC, 1994). This would be in agreement with our data since only 5.6% of the pigs used in this trial were positive for abscess formation. This is somewhat surprising since we purposely contaminated the exterior of the skin with a pathogen known to be found in abscesses from pork carcasses.

Our results suggest that a similar number of granulations were formed for both of the injection treatments indicating a similar immune response to the adjuvant. This would be in agreement with Houser et al., (2004) who reported similar immune response for vaccines administered with needle-free and conventional needle injection methods.

There is no question that the use of needle-free jet injection systems will benefit the pork industry by eliminating the potential of needles and needle fragments residing in meat products. However, these results suggest that implementing the use of needle-free jet injection systems into commercial swine production may increase the amount of injection site abscesses as a result of *A. pyogenes* contamination. To further understand the relationship between the occurrences of abscesses with different injection types, further research is needed.

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