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Effect of vaccination against sub-clinical Porcine Circovirus type 2 infection in a high-health finishing pig herd: A randomised clinical field trial

Gitte Blach Nielsen[a,b,*], Jens Peter Nielsen[a], John Haugegaard[b], Matthew J. Denwood[a], Hans Houe[a]

[a] Department of Large Animal Sciences, University of Copenhagen, Grønnegårdsvej 2+8, 1870 Frederiksberg C, Denmark
[b] MSD Animal Health Nordic, Havneholmen 25, 1561 Copenhagen V, Denmark

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ABSTRACT

During the last decade, the clinical manifestation of Porcine Circovirus type 2 (PCV2) infections has mostly changed from postweaning multisystemic wasting syndrome and high mortality to sub-clinical infections manifested only through impaired production parameters. However, co-infection with other respiratory pathogens often results in a larger effect on production, sometimes with clinical signs. Little is known about the impact of a moderate level PCV2 infection without co-infections, particularly in terms of feed conversion ratio and antimicrobial consumption. The purpose of the study was to evaluate the effect of vaccination against PCV2 in a sub-clinically infected, high-health finishing herd in terms of viral load in serum, feed conversion ratio and antimicrobial treatments. The study was conducted as a randomised clinical field trial with a parallel group design. Vaccination against PCV2 significantly ($p < 0.001$) reduced the prevalence of PCV2-positive serum pools, from 91% in the control group to 6% in the vaccinated group, as well as the viral load for positive pools from 5.79 to 3.99 log(10) copies per ml serum. Despite this, feed conversion ratio for the two groups were not significantly different with an average of 2.75 and 2.76 feeding units/kg gain for vaccinated and control pigs, respectively ($p = 0.598$). The proportion of pigs treated by injection with an antimicrobial was lower in the vaccinated group (4.4%) compared to the non-vaccinated group (5.6%), but the difference was not significant ($p = 0.125$). In conclusion, in this herd without respiratory co-infections and with moderate viral loads of PCV2, vaccination significantly reduced the prevalence and viral load of PCV2-positive pigs, but had no significant impact on feed conversion ratio or antimicrobial consumption.

1. Introduction

Since the introduction of commercial vaccines against Porcine Circovirus type 2 (PCV2) in 2006 (da Silva et al., 2014), the occurrence of postweaning multisystemic wasting syndrome (PMWS) with wasting, weight loss and mortality up to 20 percent has declined rapidly (Segales, 2012). Now, infection with PCV2 most commonly leads to sub-clinical infections without clear clinical signs, but with an impact on productivity such as reduced average daily gain (Segales, 2012), thereby keeping swine herds from reaching their expected performance (Young et al., 2011). Vaccination reduces the prevalence and viral loads of PCV2-positive pigs. This has been shown for most commercially available PCV2 vaccines including: Ingelvac CircoFLEX (Boehringer Ingelheim Vetmedica), Circovac (Merial), Suvaxyn PCV (Zoetis Animal Health) and Porcilis PCV (MSD Animal Health) (Kixmöller et al., 2008; Opriessnig et al., 2008; Fort et al., 2009; Segales et al., 2009; O'Neill et al., 2011; Fraile et al., 2012a,b).

Average daily gain (ADG) and mortality is often reported in vaccination trials while the economically important parameter feed conversion ratio (FCR) is rarely evaluated. A meta-analysis of vaccine efficacy based on studies from 2006 to 2008, including sub-clinical infections as well as PMWS cases, was performed by Kristensen et al. (2011). Here, a significant increase in ADG of 41.5 g and a reduced mortality of 4.4% were found for finishers. Similar results have been found for ADG in later studies performed in herds co-infected with *Mycoplasma hyopneumoniae* and/or Porcine Reproductive and Respiratory Syndrome virus (PRRS) (Fraile et al., 2012a; Venegas-Vargas et al., 2011), but no dif-

* Corresponding author at: .MSD Animal Health Nordic, Havneholmen 25, 1561 Copenhagen V, Denmark
E-mail addresses: gitte.blach.nielsen@merck.com (G.B. Nielsen), jpni@sund.ku.dk (J.P. Nielsen), john.haugegaard2@merck.com (J. Haugegaard), md@sund.ku.dk (M.J. Denwood), houe@sund.ku.dk (H. Houe).

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ference between vaccinates and control pigs were found regarding mortality (Venegas-Vargas et al., 2011; Fraile et al., 2012a,b), carcass weight and lean meat percentage (Venegas-Vargas et al., 2011). Young et al. (2011), however, reported significant improvements in mortality, ADG, carcass weight and lean meat percentage for vaccinated compared to control pigs in a high-health herd, but found no significant effect on FCR. Nonetheless, in a historical comparison for a PMWS herd, FCR was found to improve 0.3 kg feed/kg weight gain in finishers after implementation of vaccination against PCV2 (Pejsak et al., 2010).

Co-infections with other pathogens exacerbate the impact of a PCV2 infection (Opriessnig et al., 2008; Tomas et al., 2008; Grau-Roma et al., 2011; Segales et al., 2013) and many different bacterial and viral pathogens have been found concurrent with PCV2 on PMWS farms (Madec et al., 2000; Segales et al., 2005). Also, secondary infections with opportunistic pathogens are common (Finsterbusch and Mankertz, 2009). Therefore, a reduction in antimicrobial usage following PCV2 vaccination might be expected, but this has been poorly evaluated in terms of controlled studies with a parallel group design. One such study reported fewer treated pigs in the vaccinated compared to the control group for one farm, but no significant differences for two other farms (Segales et al., 2009). However, in several historical comparisons of the antimicrobial consumption in finishers following PCV2 vaccination, significant reductions have been shown (Pejsak et al., 2010; Aerts and Wertenbroek, 2011; van Dommelen et al., 2011; Soegaard et al., 2014).

Knowledge concerning the effect of PCV2 vaccination in high-health, sub-clinically infected herds is currently lacking, especially regarding FCR and antimicrobial consumption. The purpose of the study was to evaluate effect of PCV2 vaccination at weaning in high-health finishing pigs (30–110 kg) experiencing a sub-clinical PCV2 infection, characterized by a moderate level of viremia (10^5–10^7 PCV2 copies per ml serum), in the absence of *Mycoplasma hyopneumoniae*, *Actinobacillus pleuropneumoniae* serotypes 2 + 6 + 12 and PRRS. Including viral load in serum as the most direct measure of vaccine efficacy, the specific objective of the study was to compare viral load in serum, FCR and antimicrobial treatments between PCV2-vaccinated and non-vaccinated finishing pigs under the mentioned disease conditions.

2. Materials and methods

The study was a randomized clinical field trial carried out from July 2014 to July 2015. Permission was received from the Danish Health and Medicines Authority (License no. 2014022507) and written consent was obtained from participating herd owners. A full description of the trial protocol is available from the corresponding author on request.

2.1. Herd selection information

Three large swine practices close to Copenhagen, Denmark, were contacted in order to recruit full line farming enterprises. The inclusion criteria consisted of: feed consumption recorded at pen level during the finishing period, suspicion of sub-clinical PCV2 infection in finishers but not during the weaning period, low impact of other diseases and motivated owners. Six candidate enterprises without PCV2 vaccination were initially found, of which five enterprises were subsequently excluded due to lack of PCV2 virus in blood samples (one enterprise), PCV2 infection in weaners (two enterprises) and seroconversion to either PRRS or *Actinobacillus pleuropneumoniae* during the finishing period (two enterprises). Finally, one farming enterprise without PCV2 findings in the weaning period and moderate PCV2 levels (10^5–10^7 PCV2 copies per ml) in pooled serum samples from finishers was selected for the trial. This enterprise consisted of two herds (Herd A and B), located 3 km apart on Sealand, and had no previous history of PMWS and no clinical signs of a PCV2 infection.

Herd A was a 675-sow herd producing pigs weighing approximately 30 kg at departure. Production parameters for the weaning period prior to initiation of the trial were 418 g (ADG), 2.4% mortality and 1.8 feeding units (FU)/kg gain (FCR, one FU = 7.38 MJ potential physiological energy (Tybirk et al., 2006) corresponding to 12.2 MJ metabolic energy per FU). Throughout, feed consumption is measured in FU, since this unit allows for standardization of feed energy content regardless of diet type. Each weekly weaning batch consisted of around 350 LYD-crossbred piglets, which were placed in cleaned and disinfected sections of the farm. Section management was primarily all-in, all-out at weaning batch level. Pigs were transferred from Herd A to Herd B according to a 14-weeks rotational scheme consisting of deliveries every other week, six times in a row, followed by a four-week delivery pause. Herd B only received pigs from Herd A; each batch consisting of approximately 380 pigs (one finishing batch).

Herd B produced 8000 finishing pigs per year with production parameters for the finishing period prior to starting the trial of 927 g (ADG), 3.3% mortality and 2.7 FU/kg gain (FCR). Section management was strictly all-in, all-out at finishing batch level followed by wash and disinfection. The liquid feed produced on-site consisted primarily of wheat, barley and an additional protein supplement, which was changed during the trial from purely soybeans to a mixture of soy + fava beans. Feed was offered 4 times daily according to a predetermined feed curve reaching a maximum of 2.85 FU per pig per day, 35 days after arrival to Herd B.

Both herds had a high health status in the Danish SPF (specific pathogen free) system and repeated blood sampling and testing confirmed the absence of *Mycoplasma hyopneumoniae*, *Actinobacillus pleuropneumoniae* type 2 + 6 + 12 and PRRS. However, *Lawsonia intracellularis* was detected in both herds during the trial as a cause of diarrhea.

During the trial, normal farm procedures concerning flow of pigs were maintained as described here (see also Fig. 1): At the age of three to four weeks and an average body weight of 6.5 kg, piglets were weaned and sorted by size. During the following seven to eight weeks, the majority of pigs reached a live weight between 25 and 32 kg and were transferred to a finishing facility (Herd B or another recipient). Selection of pigs for transfer was done entirely by farm personnel based on body weight and a general good health condition.

Herd B comprised a total of 12 farm sections. Each finishing batch of 384 pigs occupied two sections with females and castrates (castrated males) placed at each side of the corridor. Each section contained 12 single pens with a shared feed chute per 2 pens resulting in six double pens per section. For simplicity, a double pen is hereafter referred to as pen. Selection of pigs for slaughter was done by farm personnel between eight and thirteen weeks after arrival. Pigs that did not reach an estimated minimum live weight of 92 kg within this period (lightweight pigs) were moved to a separate section for continual growth.

In both herds, oral antimicrobial treatments were administered section-wise, resulting in an even distribution to both trial groups. Consequently, only antimicrobial treatments by injection could be used for comparison between trial groups.

2.2. Study design

The study was a randomized field trial with a parallel group design consisting of one group being vaccinated at an age of minimum three weeks with 2 ml of the PCV2 vaccine PORCILIS® PCV (MSD Animal Health) as an intramuscular injection in the neck and one group serving as non-vaccinated control. The allocation ratio