

# **The effect of vaccination and use of commercial immunostimulants on the prevalence of Postweaning Multisystemic Wasting Syndrome in a Pig Herd**



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## Postweaning Multisystemic Wasting Syndrome in a commercial Pig Herd

### EXECUTIVE SUMMARY

- The pigs treated with the Aluminum hydroxide adjuvant had significantly more cases of PMWS than pigs that only received a saline control injection
- Pigs that were lighter on entry to the barn had a higher risk of dying with PMWS than heavier pigs
- Pigs that grew up on the slatted floor had a higher risk of developing PMWS, but pigs on the slatted floor also were lighter, it is not apparent thus if it is a floor effect or a startweight effect.
- Barrows had a trend toward a higher risk of PMWS, but it was not statistically significant.
- The only significant impact on backfat was both the gender and the carcass weight. None of the treatments had any significant impact on the backfat of the animals.
- The only significant impact on loin depth is the weight of the carcass. There was no treatment impact on loin depth or degree of muscling of the pigs
- Both the carcass lean yield and the index are a function of the loin eye depth and the backfat and there was no impact on either due to treatments

### INTRODUCTION.

Post-weaning multisystemic wasting syndrome (PMWS) is an important emerging viral disease affecting nursery and grower pigs, which has recently been associated with porcine circovirus type 2 (PCV2) infections. PMWS has been reported in Europe, South East Asia, and the Americas<sup>[11, 12, 13]</sup>. Although PCV2 has been present in pig populations since at least 1973, only recently have clinical signs been associated with its presence<sup>[4, 5]</sup>.

Clinical manifestations of PMWS include poor body condition with varying degrees of muscle wasting, dyspnea and enlarged lymph nodes; pallor, diarrhea, and jaundice are less frequent. Grossly, lesions of the lungs vary from failure to collapse and increased firmness to diffuse mottling, with areas of consolidation in the cranioventral lobes. Often, the affected pigs will have markedly enlarged lymph nodes with a white and

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homogenous cut surface<sup>5,1</sup>. Histologically, PMWS can produce intracytoplasmic inclusion bodies in vacuolated mononuclear cells, lymphoid depletion/lymphocytolysis of all lymphoid organs and tissues, and patchy to diffuse interstitial pneumonia with lymphocytic-histiocytic infiltrates with variable numbers of multinucleated syncytial cells<sup>5</sup> The primary organ system affected (pulmonary, hepatic or renal) and morbidity/mortality rates vary within and among infected herds<sup>6</sup>.

Although PCV2 can act as a primary disease agent<sup>7</sup> pigs infected solely with PCV2 only develop mild or subclinical illness. Concurrent infections with other pathogens such as Porcine Parvovirus (PPV) or Porcine Reproductive and Respiratory Syndrome Virus (PRRSV) can predispose pigs to a more severe PCV2-related wasting syndrome<sup>11</sup>. In field conditions, tracing the natural history of PMWS is difficult because of inconsistencies in clinical signs and pathologic lesions<sup>6</sup> and the varied nature of concurrent infections.

Recently, were able to demonstrate that adjuvant-draining lymph nodes from a PCV2-infected pig were immunohistochemically more strongly positive for PVC2 antigen than nodes located farther from the injection site. The authors speculated that an introduced immunostimulus combined with a pre-existing infection with PCV2 may result in fulminant PMWS.

The use of vaccines with adjuvants is common practice in swine production. It was the intent of this study to examine the effects of immunostimulation combined with a pre-existing infection with PCV2 under field conditions. The mortality rate in a finishing barn in Prince Edward Island, Canada were recorded and analyzed. The barn had recently suffered from a higher prevalence of PMWS following implementing a vaccination program for *Mycoplasma hyopneumoniae* using RespiSure-ONE™, Pfizer Animal Health, NY, NY USA. To properly evaluate the possible impact of vaccination and non-specific immunostimulation on the development of clinical PMWS in field conditions, several immunostimulants were tested on the next fill.

## PROJECT OBJECTIVES

The objective of this study were to investigate the hypothesis that stimulation of the immune system, either specifically with a vaccine against *Mycoplasma hyopneumoniae* or non-specifically with two immuno-modulating compounds (Emulsigen®, and Alhydroge™) or an immunoglobulin supplement (Solutein™) can influence the clinical and pathological expression of post-weaning multisystemic wasting syndrome in growing pigs naturally infected with PCV-2 and

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### PROJECT DESIGN

The project was conducted at the PPIG facility on Union Road, PEI and involve the use of 950 pigs in 3834 pens; 2020 in the slatted area and 184 in the deep bedding area. Each pen will house 24 or 25 animals depending on the floor type and segregated on the basis of gender. There was six treatments; intramuscular (im)vaccination with a commercial vaccine, im injection with one of two non-specific immuno-modulating compounds: Emulsigen® or Alhydrogel™, oral administration post-weaning, of the immunoglobulin supplement, Solutein™, im injection of physiological saline (injection control) no treatment (system control).

The treatment allocations are outlined below:

		South/West Exposure																			
Pens →	02 SCE	04 T3 G	06 T5 G	08 T1 G	10 T2 G	12 T3 B	14 T4 B	16 T5 B	18 T1 B	20 T2 B	22 T4 B	24 T5 B	26 T2 B	28 T3 G	30 T4 B	32 T5 G	34 T1 G	36 T2 G	38 SCE	40 S	
	office	SLATTED FLOOR END										BEDDED END									
		01 T1 B	03 T2 B	05 T3 B	07 T4 B	09 T5 B	11 T1 G	13 T2 G	15 T3 G	17 T5 G	19 SCE	21 T5 B	23 T4 B	25 T1 B	27 T3 B	29 T5 B	31 T3 G	33 T1 G	35 T2 G	37 SCE	39 S

**Figure 1 Treatment allocations in the barn**

### North/East Exposure

#### Treatment Key:

Code	
SCE	System Control
B	Barrow
G	Gilt
S	Sick Pen
T1	Vaccine
T2	Emulsigen®
T3	Alhydrogel™
T4	Solutein™
T5	Injection Control

Specific parameters measured include:

#### Animal Health Parameters

- Disease Incidence and Treatment rate
- Mortality and Post Mortem diagnosis

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### **Animal Production Parameters**

Daily Feed Consumption  
Feed Conversion  
Daily Growth Rate

### **Pork Quality**

Carcass Lean Yield  
Backfat, Loin Eye Depth  
Carcass Demerits  
Meat Colour, Firmness

### **Time Line**

The study was performed over one fill of pigs, between April, 2002 and July, 2002 with the

#### **Task 1: Animal Production Parameters**

**Objective:** Animals were placed into pens upon arrival into the barn. Animals were separated by gender and during the first two weeks animals were weighed and identified by means of a uniquely numbered ear tag. Animals were randomly assigned to one of six treatment pens; vaccinated with a commercial vaccine, injected im with either Emulsigen® or Alhydrogel™, oral administration post-weaning of Solutein™, or no treatment (injection and system controls). Once animals have been weighed and identified, feed intake was measured on a daily basis. Daily feed consumption was recorded for each pen. Disease incidence and treatment was recorded in addition to recording of mortalities and reported post-mortem diagnosis.

**Time Schedule:** April, 2002 to June, 2002

**Personnel:** 2 full time technicians plus part-time research scientist.

#### **Task 2: Pork Quality**

**Objective:** Assessment and comparison of carcass lean yield, backfat, loin eye depth, carcass demerits, meat colour, firmness and pH between animals in the different treatment groups.

**Personnel:** 1 research scientist and 1 technician

**Time Schedule:** June, 2002 to July, 2002

#### **Task 3: Data Analysis and Compilation of Final Report**

**Objective:** Compilation of data and subsequent analysis. Preparation of final report.

**Personnel:** 1 research scientist and 1 technician

**Time Schedule:** July, 2002 - September, 2002

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### RESULTS

#### Diagnosis of Post-Weaning Multisystemic Wasting Syndrome

The definitive diagnosis of the PCV2-related wasting disease is based on the detection of viral antigen and/or nucleic acid, characteristic histo-pathological lesions, and compatible clinical signs<sup>[10]</sup>). In the present study, a pig was determined to have PMWS when it fulfilled all three of the following parameters:

1. Positive identification of the virus by FAT and/or PCR;
2. Gross signs of wasting (at least moderate loss of muscle mass, body fat stores);
3. Histological lesions, either intracytoplasmic inclusion bodies or both lymphoid depletion/lymphocytolysis (mesenteric lymph node, and/or spleen, and/or Peyer's patch) and interstitial pneumonia with syncytial cells.



**Figure 2 Pigs affected with PMWS clearly failed to grow with their pen mates**

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## Incidence of PMWS

Group	Treatment	PMWS cases	Total pigs in groups	Prevalence Rate
1	Mycoplasma Vaccine	3	172	1.7 %
2	Oil adjuvant	0*	172	0.0 %
3	Aluminum hydroxide adjuvant	5*	173	2.9 %
4	Saline injection	0*	197	0.0 %
5	Solutein	2	145	1.4%
6	Control	1	95	1.1 %

### Figure 3 summary of PMWS mortality by treatment

The pigs treated with the Aluminum hydroxide adjuvant had significantly more cases of PMWS than pigs that only received a saline control injection.

### The mean startweight of pigs with or without PMWS

	PMWS	Non PMWS	P
Start weight	19.4 kg	22.3 kg	P=0.040

### Figure 4 summary of PMWS by pig Startweight

Pigs that were lighter on entry to the barn had a higher risk of dying with PMWS than heavier pigs

Table 3: Floor type and the prevalence of PMWS

	PMWS	Non PMWS	P
Bedded Floor	1	425	
Slatted Floor	8	382	P=0.028

### Figure 5 Summary of PMWS by floor type

Pigs that grew up on the slatted floor had a higher risk of developing PMWS, but pigs on the slatted floor also were lighter, it is not apparent thus if it is a floor effect or a startweight effect.

Table 4: Gender and the prevalence of PMWS

	PMWS	Non PMWS	P
Gilts	3	480	
Barrows	6	316	P=0.101

### Figure 6 Summary of PMWS by gender

Barrows had a trend toward a higher risk of PMWS, but it was not statistically significant.

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### Growth Rate

```

Random effects u_i ~ Gaussian                               Obs per group: min =      8
                                                           avg =     22.7
                                                           max =     25

Log likelihood = 887.38928                                LR chi2(9) = 207.79
                                                           Prob > chi2 = 0.0000
    
```

adg	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
_Itreatmen~2	.0207729	.0134794	1.54	0.123	-.0056463	.047192
_Itreatmen~3	.0050808	.0135039	0.38	0.707	-.0213864	.0315479
_Itreatmen~4	.0203121	.0170249	1.19	0.233	-.0130561	.0536804
_Itreatmen~5	.0103789	.0129389	0.80	0.422	-.0149809	.0357386
_Itreatmen~6	.0446526	.0166982	2.67	0.007	.0119248	.0773805
solutein	-.0085716	.0067582	-1.27	0.205	-.0218174	.0046742
<b>startweight</b>	<b>.0044819</b>	<b>.0003539</b>	<b>12.67</b>	<b>0.000</b>	<b>.0037883</b>	<b>.0051754</b>
<b>gender</b>	<b>-.0684283</b>	<b>.0089217</b>	<b>-7.67</b>	<b>0.000</b>	<b>-.0859144</b>	<b>-.0509421</b>
bedding	-.0062046	.0089831	-0.69	0.490	-.0238111	.0114019
_cons	.6813143	.0201634	33.79	0.000	.6417948	.7208339
/sigma_u	.0181597	.0045887	3.96	0.000	.0091661	.0271533
/sigma_e	.0898561	.0021627	41.55	0.000	.0856174	.0940949
rho	.0392407	.0193782			.0136489	.094777

Likelihood ratio test of sigma\_u=0: chibar2(01)= 8.37 Prob>=chibar2 = 0.002

The only parameters that affected the growth rate of the pigs was the startweight and the gender of the pigs. These are expected findings. The treatment appeared to have no effect on growth rate of the pigs.

### Feed Conversion:

TREATMENT	Summary of FCR	
	Mean	
A10h3	2.90	
Control	2.85	
Oil	2.86	
Saline	2.89	
Vaccine	2.90	
solutein	2.93	
Total	2.8925	

Source	Analysis of Variance				
	SS	df	MS	F	Prob > F
Between groups	.016369443	5	.003273889	0.34	0.8857
Within groups	.25243064	26	.009708871		

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There was no treatment effect on feed conversions or feed efficiency.

## Carcass

## Loin Depth

```

Random-effects ML regression          Number of obs   =       790
Group variable (i) : tattoo          Number of groups =        40

Random effects u_i ~ Gaussian        Obs per group:  min =         8
                                       avg =       19.8
                                       max =        24

Log likelihood = -2670.0044          LR chi2(8)      =       23.84
                                       Prob > chi2     =       0.0024

```

loin	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]
_Itreatmen~2	-.6128271	.8974387	-0.68	0.495	-2.371775 1.14612
_Itreatmen~3	.3676634	.9118341	0.40	0.687	-1.419499 2.154825
_Itreatmen~4	-.9427252	1.04671	-0.90	0.368	-2.99424 1.108789
_Itreatmen~5	-1.303947	.9033686	-1.44	0.149	-3.074517 .466623
_Itreatmen~6	-.4496312	1.110798	-0.40	0.686	-2.626756 1.727493
gender	1.146752	.6324447	1.81	0.070	-.0928167 2.386321
bedding	-1.034443	.5578411	-1.85	0.064	-2.127791 .0589054
<b>weight</b>	<b>.2677634</b>	<b>.0861436</b>	<b>3.11</b>	<b>0.002</b>	<b>.0989251 .4366018</b>
_cons	37.63647	7.637726	4.93	0.000	22.6668 52.60614
/sigma_u	.6188035	.5399663	1.15	0.252	-.4395109 1.677118
/sigma_e	7.07992	.1828007	38.73	0.000	6.721637 7.438203
rho	.0075813	.0132125			.0001227 .1170551

Likelihood ratio test of sigma\_u=0: chibar2(01)= 0.39 Prob>=chibar2 = 0.266

The only significant impact on loin depth is the weight of the carcass. There was no treatment impact on loin depth or degree of muscling of the pigs. In this study, only an increasing carcass weight had a significant positive effect on Loin eye depth, with both gender and bedding trending to significance.

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### Backfat

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Random-effects ML regression          Number of obs   =       790
Group variable (i) : tattoo          Number of groups =        40

Random effects u_i ~ Gaussian        Obs per group:  min =         8
                                       avg =       19.8
                                       max =        24

Log likelihood = -2299.1468          LR chi2(8)      =       56.89
                                       Prob > chi2     =       0.0000
    
```

backfat	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
_Itreatmen~2	-.6989071	.6838036	-1.02	0.307	-2.039138	.6413235
_Itreatmen~3	-.520564	.6923308	-0.75	0.452	-1.877507	.8363794
_Itreatmen~4	.1635089	.7944586	0.21	0.837	-1.393601	1.720619
_Itreatmen~5	-.3814373	.6856595	-0.56	0.578	-1.725305	.9624305
_Itreatmen~6	-2.034941	.8334983	-2.44	0.015	-3.668568	-.4013144
<b>gender</b>	<b>-2.211219</b>	<b>.481266</b>	<b>-4.59</b>	<b>0.000</b>	<b>-3.154483</b>	<b>-1.267955</b>
bedding	.243151	.4231376	0.57	0.566	-.5861835	1.072486
<b>weight</b>	<b>.3021001</b>	<b>.0537728</b>	<b>5.62</b>	<b>0.000</b>	<b>.1967074</b>	<b>.4074929</b>
_cons	-4.536638	4.782276	-0.95	0.343	-13.90973	4.83645
/sigma_u	.8364147	.217016	3.85	0.000	.4110712	1.261758
/sigma_e	4.38296	.1129098	38.82	0.000	4.16166	4.604259
rho	.0351377	.0178859			.0118379	.0872457

Likelihood ratio test of sigma\_u=0: chibar2(01)= 7.46 Prob>=chibar2 = 0.003

The only significant impact on backfat was both the gender and the carcass weight. None of the treatments had any significant impact on the backfat of the animals.

Both the carcass lean yield and the index are a function of the loin eye depth and the backfat and there was no impact on either due to treatments. (data not shown)

### Pork Quality:

	Pork colour		Marbling		Fat firmness		Muscle	
Vaccine	3.3		2		3.3		3	
Oil Adjuvant	2.5		2		3		3.5	
ALOH4	3.6		2.25		2.5		2.5	
Solutein	3.0		2		2.8		3.3	
Saline	2.7		1.8		3		2.6	
Anova F (p)	2.14	(0.1260)	0.18	(0.9469)	1.08	(0.3997)	1.81	(0.1789)

There was no significant impact on pork quality with any of the treatments.

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## DISCUSSION

A higher number of pigs treated with aluminum hydroxide developed PMWS than pigs treated with either saline or oil based adjuvant, suggesting that perhaps this immunostimulant may have facilitated the development of clinical disease. However, when considering the fact that only 9 pigs developed PMWS, and they were distributed among 3 treatment groups, our findings should be confirmed in future studies. Higher numbers of deaths due to PMWS would have allowed us to more confidently interpret associations between groups. It is therefore more accurate to simply state that PMWS was present in pigs submitted to various treatments as well as in control pigs, and that there is probably a slightly higher risk associated with injecting aluminum hydroxide compared to saline or oil; more trials are needed to confirm this hypothesis.

In earlier studies<sup>7,11</sup> inoculation of PCV2 alone was reported to cause only mild disease while mortalities associated with PMWS were thought to require a concurrent viral infection<sup>[11]</sup>. In this field study, pigs had a PCV2 infection and 9 out of 725 (1.24%) pigs developed severe lesions associated with PMWS. This finding is consistent with the more recent literature that acknowledges PCV2 as a disease agent capable of causing severe illness in field conditions<sup>[12]</sup>. Interestingly, one of the pigs that developed the severe form of the disease was in the control group, which was not iatrogenically immunostimulated.

Overall, our results are more consistent with a recent Danish field study<sup>12</sup> in which both immunostimulated and non-immunostimulated PCV2-infected pigs developed clinical PMWS. Our study also appears to be consistent with previous suggestions that injecting immunostimulants could be responsible for the progression of a PCV2 infected pig to develop clinical PMWS<sup>6</sup>. There are probably other unknown factors involved in the development of PMWS in commercial operations and, clearly, further studies are needed to identify possibly influential factors.

Fully slatted flooring (compared to deep bedding) and lower starting weights seemed to predispose pigs to PMWS in our study. Although PMWS was more frequently found in the straw-bedded side, the affected pens were randomly located within that side in accordance to what has been reported in the literature<sup>4</sup>. Before concluding that floor type had an association with PMWS, it should be noted that pigs on the fully slatted had a smaller starting weight than those on the bedding. There may be confounding between floor type, starting weight and the risk of PMWS. In the previous fill there appeared to be no difference between PMWS risk between the two floor types. There was a trend

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towards barrows having a higher risk of PMWS ( $p=0.10$ ). To our knowledge, no other reports of the association between occurrence of PMWS and factors such as gender, floor type, and starting weights have been published.

The conditions in which the pigs were living are very similar to finishing barns throughout North America. It is possible that chemical immunostimulation does cause PMWS as Krakowka et al. (2001) speculated. However, it is difficult to extrapolate laboratory findings to a typical farm situation where pigs are naturally and chemically immunostimulated by environment and vaccination schedules. From the findings of this study, it appears that chemical immunostimulation, caused by vaccination and or adjuvants may have contributed to clinical PMWS in a situation where PCV2 was already associated with disease. More studies should be carried out to confirm this observation.

There appeared to be no adverse or beneficial impacts of the treatments either the vaccines, adjuvants or the immune stimulant on the growth rate, feed efficiency, carcass quality or the pork quality. It appears that either the pigs developed PMWS and died or they grew normally with the same efficiency and resulted in the same meat quality.

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