

# Porcine Circovirus Associated Diseases (PCVAD) in Canada - Prevalence, Co-Factors, and Risk Factors

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## ■ Introduction

Since its discovery and characterization in western Canada in 1995, the significance and dissemination of post-weaning multisystemic wasting syndrome (PMWS) has grown. Shortly after the Canadian report, a similar syndrome was described in most of the pig-producing countries in the world: Europe, Asia, and the United States. The economic impact of the disease is great because of the considerable losses due to mortality and/or production of non-marketable pigs. Consequently, in the last 10 years, the syndrome has become a very serious issue in the global swine industry. In North America there is a major interest due to the explosive outbreaks seen in eastern Canada, particularly in Quebec and Ontario starting in the Fall of 2004. Since then, the syndrome has slowly disseminated to the rest of Canada, United States and Mexico. This syndrome is characterized by respiratory, digestive, hemolymphatic, vascular, and renal lesions associated with Porcine circovirus-2 (PCV-2) infection. Clinical signs and lesions are observed in late nursery (8-10 weeks of age), and finisher pigs, 2-3 wks after placement. Affected pigs present all or some of the following: cough, diarrhea, anemia, icterus, poor body condition, generalized lymphadenopathy and skin lesions.

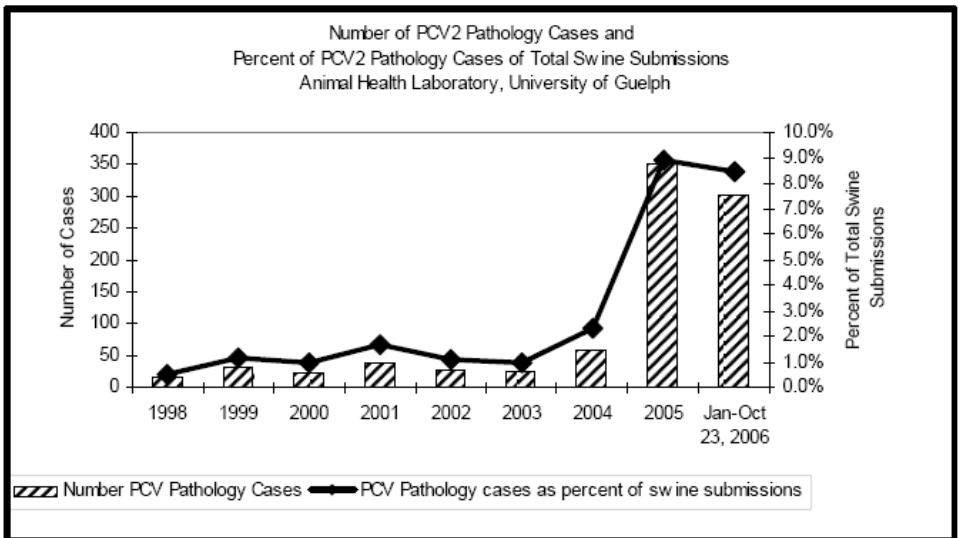
For the purpose of this presentation I will use Porcine Circovirus- Associated Disease (PCVAD) instead of PMWS. This name has been accepted by most swine veterinarians in North America because the previous name of PMWS, does not include the variety of clinical presentations associated with the disease. Comments have also been made that the change has a second objective, to disassociate this disease from Chronic Wasting Disease in elk (like BSE) caused by a prion.

It is important to remember that PCVAD has a case definition and that the following are needed to make a conclusive diagnosis: 1. Typical clinical signs, 2. Characteristic macroscopic and microscopic lesions, and 3. Demonstration of porcine circovirus type 2 (PCV2) in significant quantities in the affected organs.

## ■ Prevalence in Canada

### The Eastern Provinces (Quebec and Ontario)

In 2004, 2005 and part of 2006 PCV-2-associated disease showed a dramatic increase in the Eastern provinces of Canada. **Figure 1** shows this marked increase in Ontario as reported by the Animal Health Laboratory of the University of Guelph.

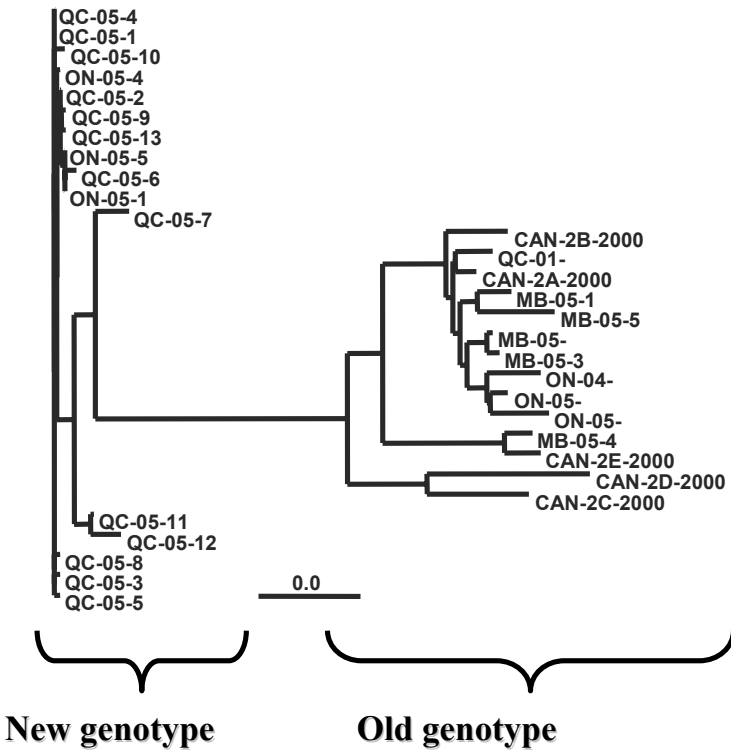


**Figure 1. Number of PCV2 pathology cases and PCV2 pathology cases as percent of total swine submissions at the Animal Health Laboratory (AHL) of the University of Guelph from 1999-2006. (Carman et al. 2006a)**

It should be noted that the PCV-2 isolated from these new cases present significant changes in its genome as shown by polymerase chain reaction-restriction fragment length polymorphism (PCR-RFLP) typing and ORF2 sequencing. The previous RFLP pattern was type 422 changing to type 321 after the Fall of 2004. The RFLP type 321 viruses have greater than 99% sequence homology with each other, and 98% sequence homology with those reported for the UK, France, and China. However, these type 321 viruses

have only 91.6% sequence homology with the previously dominant RFLP type 422, and are only 92% to 93% similar to those previously reported from the USA. ORF2 sequencing also shows that this new PCV2 strain is over 99% homologous to virulent European strains (France and The Netherlands) and only 94-95% to strains isolated previous to 2005 (**Figure 2 and 3**).

Due to the sudden appearance of these genetic changes and the severity of clinical disease and mortality seen in the Eastern provinces swine production, it has been proposed that these outbreaks were caused by the dissemination of a new strain of higher virulence. As of today, this hypothesis has not been proven experimentally or by field studies. However, Dr. Carl Gagnon from the University of Montreal is performing studies in order to prove this hypothesis, if results are available they will be presented at the oral presentation.

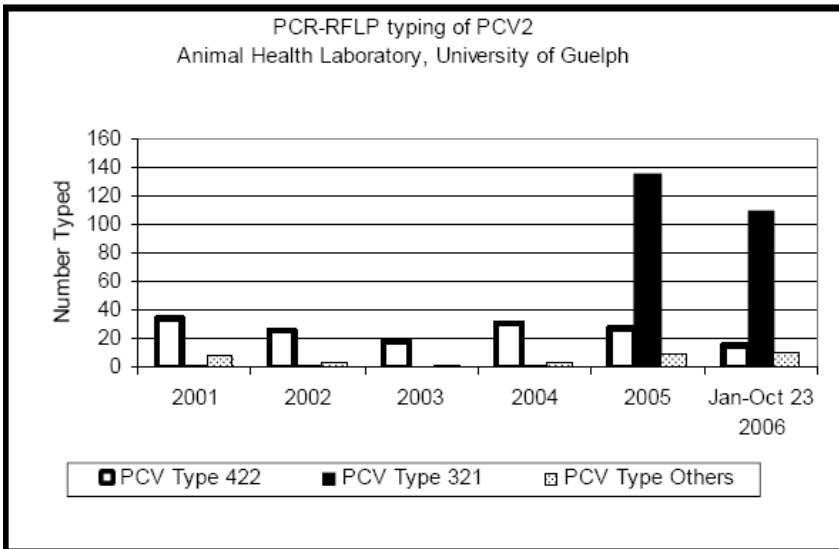


**Figure 2. ORF2 sequence comparison between the old and new PCV2 genotype in Quebec. (Gagnon, 2006)**

**Table 1. Comparison of ORF2 sequences of PCV2 from different countries (Gagnon, 2006)**

	05-QC4	05-QC3	05-QC2	05-QC63	98-QC	03-NL	00-Man	98-Fran
<b>05-QC4</b>	100	0,998	0,997	0,998	0,957	0,994	0,948	0,994
<b>05-QC3</b>		100	0,999	0,998	0,955	0,994	0,946	0,994
<b>05-QC2</b>			100	0,997	0,955	0,993	0,946	0,993
<b>05-QC63</b>				100	0,957	0,996	0,948	0,996
<b>98-QC</b>					100	0,958	0,962	0,958
<b>03-NL</b>						100	0,950	0,997
<b>00 Man</b>							100	0,950
<b>98-Fran</b>								100

QC= Quebec, NL= The Netherlands, Man= Manitoba, Fran= France



**Figure 3. PCR-RFLP typing of PCV-2, 2001-2006 at the Animal Health Laboratory (AHL) of the University of Guelph (Carman et al. 2006a)**

A study performed by Dr. Camille Moore and collaborators in 2005 in 169 farrow-to-finish and 76 finisher farms from Quebec at the request of the AVIA (Association of Industrial Animal Veterinarians, Quebec) and the FPPQ (Federation of Quebec Pork Producers) had the following objectives:

- Verify that there had been an increase in mortality in swine farms in Quebec related to PCVAD outbreaks and, if true, quantify the increase in mortality
- Try to find a relationship between PCVAD and PRRS

The results of this survey are shown in **Tables 2-6** and **Table 8**. General conclusions are that:

- there was an increase of 2.3% in mortality between 2004-2005,
- mortality presented around 2 weeks earlier in farrow-to-finish farms,
- there was a very low increase in cull pigs sales, but an important difference (2.6 times) between farrow-to-finish farms and finishers, and
- finally, there was an significant increase in mortality when PCVAD and PRRS are present in conjunction in the herd.

**Table 2. Mortality in Quebec farms in 2004 and 2005**

	2004		2005	
	Average	SD	Average	SD
<b>Farrow-Finish</b>	5.31	6.07	7.53	6.67
<b>Finishers</b>	4.88	3.15	7.66	4.85
<b>Total</b>	5.18	5.34	7.57	6.15

**Table 3. Age of mortality in weeks in Quebec farms in 2004 and 2005**

	2004		2005	
	Average	SD	Average	SD
<b>Farrow-Finish</b>	12.9	2.82	12.86	2.57
<b>Finishers</b>	14.9	2.7	14.8	2.3
<b>Total</b>	13.5	2.8	13.4	2.63

**Table 4. Percent of cull pigs sold (less than 70 kg.) in Quebec farms in 2004 and 2005**

	2004		2005	
	Average	SD	Average	SD
<b>Farrow-Finish</b>	2.0	1.7	1.76	2.65
<b>Finishers</b>	4.3	10.5	4.7	6.9
<b>Total</b>	2.5	6.5	2.7	4.7

**Table 5. PRRS status of the surveyed farms (%) (Moore et al. 2006)**

	Yes	No	Unknown
<b>Farrow-Finish</b>	48	28	24
<b>Finishers</b>	75	12	13
<b>Total</b>	56	23	21

**Table 6. PCVAD status of the surveyed farms (%) (Moore et al. 2006)**

	Yes	No	Unknown
<b>Farrow-Finish</b>	49	37	14
<b>Finishers</b>	50	31	19
<b>Total</b>	49	35	16

### **The Western Provinces (Manitoba, Saskatchewan and Alberta)**

Up until the summer of 2006 in the Western Provinces, PCVAD was a sporadic finding. However the picture has changed from the sporadic form to the epizootic form on several farms. A common finding is the combination of PCVAD and PRRS virus with mortality in 8- to 13-week-old pigs sometimes exceeding 20%. In herds where PRRS is not present, wasting appears to be

the predominant clinical sign, with mortalities ranging between 7 to 8%. Veterinarians in the West report 3 different manifestations of PCVAD:

**Type I:** Sporadic occurrence, minimal effect on long term mortality, mainly wasting presentation fitting with the PMWS case definition.

**Type II:** Persistent PCVAD signs. Mortality is elevated, maybe doubled in the affected age group and there is an increase in the number of cull pigs sold.

**Type III:** Epizootic, severity varies with presence of concurrent disease, especially PRRS. Mortality ranges around 8 to 25% in 8- to 13-week-old pigs.

**Table 7. Current PCVAD situation in Western Canada classified by manifestations** (Western Hog Journal, Spring 2006)

PCVAD manifestations	Number of sows	Relative proportion (%)
Never diagnosed	35,400	32.3
Type I	47,000	42.7
Type II	14,900	13.5
Type III	12,700	11.5

Some conclusions of the informal survey made by the Western Swine Health Associates are:

- There are some regional differences on the severity of the clinical presentation
- Larger herds tend to present more Type III manifestations
- There seems to be no difference in the presentation between multiple sites and single site systems.

## ■ Co-Factors and Risk Factors

It is generally accepted that PCV2 is a necessary component for the presentation of the syndrome; however it seems that other co-factors are required for inducing PCVAD. Among these co-factors other diseases such as PRRS (**Table 8**), *Mycoplasma hyopneumoniae*, and swine influenza have been mentioned.

**Table 8. Percent mortality depending on pathology** (Moore et al. 2006)

	-/-	PRRS+	PCVAD+	+/+	Unknown
<b>Farrow-Finish</b>	3.8	5.06	5.4	10.5	6.58
<b>Finishers</b>	2.8	7.05	5.9	9.5	6.2
<b>Total</b>	3.7	5.4	5.7	10.07	6.5
<b>SD</b>	2.5	3.8	2.8	6.41	4.25
<b>% of herds</b>	17.6	4.5	12.7	43.4	21.7

Management, immune stimulation or vaccination also seem to play an important role in the presentation of this syndrome. Harding (2006) posed a very interesting hypothesis where “the key to controlling and preventing PMWS in any herd regardless of PMWS status, location, strain or co-factors involved is to reduce and maintain PCV2 viral load below this biologically critical “threshold”. This hypothesis is based on previous findings where the viral load of PCV2 in tissues and serum of PCVAD is correlated with the severity of clinical signs and associated histological lesions in both experimentally and naturally infected pigs.

As mentioned before PMWS was first described in 1995, however, retrospective studies have shown that both PCV2 infection and clinical cases of PMWS were present as early as 1985 indicating that PCV2 is not a new virus. These findings, together with the fact that PCV2 infection is present in almost 98 % of the swine farms around the world clearly suggest that PCVAD is a multifactorial disease. Therefore the identification of risk factors related to PCVAD expression is very important. Epidemiologically we can perform studies such as case/control or cross-sectional comparing affected versus non-affected herds in order to find these risk factors. In the literature there are several risk factors studies published; here are some interesting conclusions of the different risk factors in swine farms in France and Spain.

Rose et al. 2006 study concluded that the odds of PMWS were increased when fattening pigs tested positive for parvovirus (PPV) and porcine reproductive and respiratory syndrome (PRRS) virus, when separate vaccines for parvovirus and erysipelas for the gilts versus associated vaccines were used, and when on-farm semen collection was used versus all the semen purchased from an insemination centre. Large pens in weaning facilities increased the odds of PMWS as did a short empty period of the farrowing and nursery facilities. In a second comparison, in addition, a common pit in the

finisher rooms and a high level of cross-fostering increased the odds of PCVAD.

Lopez-Soria et al. 2005 concluded that vaccination of gilts against PRRSV increased the odds of PCVAD expression and vaccination of sows against atrophic rhinitis decreased the odds of the disease; however, there is a possibility (due to the small sample size) that those two factors could be false effects or confounding variables. On the other hand, a higher prevalence of antibodies to PCV2 at 12 weeks of age was observed in pigs from “case” farms than in pigs from “control” farms suggesting that an earlier infection with PCV2 might be a risk factor for PCVAD expression.

References mentioning that there are genetic differences in susceptibility to PCVAD can also be found. Opreissnig et al. 2005 studied a limited number of pigs from 3 different lines, concluding that there were differences in host susceptibility to PCV2-induced disease and that Landrace pigs are predisposed to PCV2-associated lymphoid depletion since the incidence of PMWS based on gross and microscopic lesions was 0% in Duroc, 15.8% in Landrace, and 0% in Large White. Finally, Lopez-Soria et al. 2004 concluded that under the conditions of their study there was a genetic effect on the expression of PCVAD in the progeny of the different genetic crosses.

**Table 9. Differences in mortality (%) between 3 different genetic combinations**

<b>Genetic line</b>	<b>Mortality Farm A</b>	<b>Mortality Farm B</b>
<b>100% Pietrain</b>	1,5%	2,1%
<b>50% Pietrain</b>	4,7%	5,9%
<b>0% Pietrain</b>	9,8%	26,0%

Caution on genetic influence should be exercised not to over conclude, since these differences might be related to certain individual and or certain lines, and may not be consistently found in a specific breed.

Finally, Dr. Sylvie D’Allaire and collaborators are presently conducting a risk factor assessment for PCVAD in Quebec; available results will be presented at the meeting.

## ■ Conclusions

On the basis of the current knowledge on PCV2 infection, it is evident that the clinical and pathological scope of this infection has been expanded since its

initial association with PMWS. Little doubt over the association and causality of PCV2 on PCVAD exists today, the literature shows many co-factors and risk factors related to the presentation of PCVAD. Therefore it is important that in order to control its detrimental effects it is important to first confirm a PCVAD diagnosis by necropsy and histopathology and immunohistochemistry or *in situ* hybridization. And then focus, among others, on eliminating or minimizing the effects of co-infection, particularly PRRSV through breeding herd stabilization, pig flow changes, and/or vaccination. Remember that if herd evidence suggests an association between vaccination practices and PCV2-associated disease, re-evaluation of use and timing of certain vaccines is important. Good management practices should be exercised, i.e. strict and true all-in-all-out, early removal of runt pigs and of those that don't respond to treatment, and reduction of mixing and moving of pigs; reduction of viral load by using disinfectants both in buildings and transport vehicles have been demonstrated to be efficacious against PCV2, and if it is an option, consider changing pig genetics if there is enough evidence that there is a predisposition at the farm.

Finally, as commercial vaccines have become available in North America, reports generally seem to agree that they are an effective tool in the control of PCVAD; therefore a combination of the above measures and vaccine might provide the control strategy for this interesting, complex but devastating syndrome that we have been experiences for the last 2 years, let's wait and see what the future brings...

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