Overview of PCVD - The Disease in Eastern Canada & US vs. Europe

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▪ Introduction

Starting at the end of 2004, and particularly since the beginning of 2005, cases of post-weaning multi-systemic wasting syndrome (PMWS) in Quebec increased dramatically. Simultaneously in Ontario and a little later in North Carolina, the same phenomenon of dramatic increase in PMWS cases was observed. In this paper, I will try to shed some light on the possible reasons why this may have occurred and on what can be done to control the losses. I will also briefly look at some of the conditions, other than PMWS, that might be associated with porcine circovirus type 2 (PCV2), and at a few similarities and differences that may exist between the European situation and the one we have to deal with in Eastern Canada and the US.

▪ What causes PMWS/PCVD/PCVAD?

The acronym PMWS is gradually being replaced in Europe by PCVD (porcine circovirus disease) and in North America by PCVAD, (porcine circovirus associated disease). Reasons for this switch include: 1) wasting is not specific to PCV2; 2) PCV2 has been associated with conditions in pigs other than PMWS; 3) the word wasting might have a negative impact on public perceptions of the swine industry, and of the safety of pork.

In fact, looking at the cause of PCVD is a good place to start. Two main positions are currently debated. There are those who believe that (a) PCV2 is the cause of PCVD, although other factors or agents may contribute significantly to the losses associated with it in the field, and (b) that another as-yet-unidentified agent, often called agent X, might be the real culprit. I belong to the first group for three main reasons. The first one is that several

different teams of researchers, from four different countries, have been able to experimentally reproduce clinical signs, characteristic PCVD histological lesions, and mortality, using PCV2 alone (Reynaud et al, 2000; Harms et al, 2001; Bolin et al, 2001; Ladekjaer-Mikkelsen, 2002; Okuda et al, 2003; Pogranichniy et al, 2004; Opriessnig et al, 2004). The second reason is that many different studies have reported a direct correlation between the quantity of PCV2 found in the blood and tissues, and the severity of PCVD (Harms et al, 2001; Bolin et al, 2001; Ladekjaer-Mikkelsen et al, 2002; Okuda et al, 2003; Brunborg et al, 2004; Olvera et al, 2004; Green et al, 2005). Finally, the results obtained so far with commercial or experimental vaccines that contain only PCV2 antigens suggest that there are many situations where these vaccines provide excellent protection. This however does not mean that agents X, Y or Z cannot or are not playing any role in field situations. We already know that PRRS virus, parvovirus and *Mycoplasma hyopneumoniae* can either trigger PCVD problems experimentally and/or make them worse. So it could well be that other organisms, including some that may not have been identified yet, may play a role.

One of the objections from agent X believers is that all herds tested so far in North America are infected with PCV2, and only a fraction of them are suffering PCVD losses. So if PCV2 was the cause of PCVD, why is it that so many infected herds are not showing anything? And while all tested herds in Quebec were positive to that organism before 2004, why did we suddenly begin to have such frequent and severe problems late that year? There are in my view two main possibilities: either we are now dealing with new, more virulent isolates of the virus, or something else, that we did not have before, is triggering PCV2 problems.

Opriessnig et al (2006) have shown experimentally that there can be virulence differences between PCV2 isolates. In that study, one isolate was shown to produce more severe gross and microscopic lesions than the other one tested. Eastern Canada has seen a sharp increase in PCVD cases in the last 2 years and that was chronologically associated with a change in the type of isolates identified in these cases (Carman et al, 2006). Recently, Timmusk et al (2005) reported that in Sweden, a comparison between isolates found in healthy vs. diseased pigs revealed differences both at the nucleotide and amino acid levels, differences which could be responsible for variations in pathogenicity. However other studies failed to find significant differences between isolates that could explain why the disease was found in some herds, and not in others (Larochelle et al, 2003; de Boisséson et al, 2004; Grierson et al, 2004). To what extent the problems that we are now facing in North America could be explained by an increased virulence of the PCV2 isolates involved remains one of the main questions to be answered.

■ How does PCV2 get transmitted?

Here are some points that may help to understand the various ways by which the organism could get transmitted:

- The virus has been reported to be excreted through nasal and ocular secretions, urine, feces and colostrum.
- It is also present in semen and some boars have been found to shed it for at least 24 weeks (McIntosh et al, 2005); however the exact role of artificial insemination in the epidemiology of the infection is not clear at this time
- It is very persistant in the environment
- Experimentally it has been possible to infect pigs by intra-nasal, oral, intra-muscular and intra-uterine inoculation
- After experimental infection, some animals were found to be carriers for at least 125 days (Bolin et al, 2001)
- Pigs from herds with no clinical signs can contract the disease if placed in contact with sick pigs, or if placed in close proximity (Kristensen et al, 2004)
- Pigs can become infected *in utero*, and the virus can cause acute reproductive problems, particularly in start up herds; this however is not frequent; there are some data suggesting that PCV2 could be a cause of chronic reproductive failure, but since other data suggest the opposite, this is also an area that would need more investigation
- Isolates with different genotypes can be found between herds, and within the same herd (Allan G, personal communication, 2005)
- Early work conducted on other species like cattle, horses and even humans suggested that they could become infected with this organism. More recent studies on the subject were unable to detect the presence of infection in people, horses, cattle, sheep, dogs, cats, mice, and poultry (Rodriguez-Arrioja et al, 2003). However, certain laboratory mice can be infected with PCV2 experimentally, become viremic and have lesions.
- There has been speculation about the fact that feed ingredients, like spray dried plasma, could be a potential source of infection for pigs. In a recent experiment where six samples of spray dried plasma were tested by PCR, five were found positive (Gauthier R, personal communication, 2005). However the organism could not be cultured from any of the samples. This could suggest that either the organism was present in the samples but dead, the technique used was not sensitive enough to detect it or the type of sample itself (plasma) may act as some kind of inhibitor for isolation of the organism.

■ How can we control PCVD?

Since PCVD was first described, in 1997, there have been lots and lots of suggestions on what could be done to reduce the severe losses that can be associated with it. As always, some appear better than others. At this time, although this could change, the following points are among those that seem to offer the best chances of success or improvement when PCVD is a problem: genetic changes, vaccination, management changes, serotherapy, the control of other diseases, like PRRS, that can trigger the condition or increase its severity and finally, depopulation/repopulation.

Genetic Changes

Desrosiers (2006) has reviewed the impact that genetics may have on this disease. What comes out is that different breeds, genetic lines or genetic combinations (a specific boar line with a specific sow line) may have a vastly different resistance to PCVD. At this time preliminary information suggests that the Landrace breed, or some Landrace lines could have an increased susceptibility, and that the Pietrain and Hampshire breeds, or some specific lines of these breeds could have an increased resistance to PCVD. But since the data on the relative resistance of certain genetics are not all going in the same direction, and since other criteria have to be considered in the choice of breeders, care should be taken before making changes. In my opinion however genetics remain one of the control options that offer the most interest.

Vaccines

A PCV2 vaccine for use in sows and gilts has been available in France and Germany for about two years. In one study from the first country, the average weaning to slaughter mortality rate dropped from 11.0% to 7.7% in 15 herds where the vaccine was used (Auvigne et al, 2006). In the second country the birth to slaughter mortality rate in 38 herds where the vaccine was used dropped from 28.7% to 17.9% (Joisel et al, 2006). In each of these studies the results were compared before and after the use of the vaccine, so it could be that in some herds the performance might have improved even in the absence of vaccination. Nevertheless, the information I received from several French practitioners suggests that the vaccine is frequently useful to prevent losses associated with PCVD. This vaccine has also been available in Canada since last spring. While the results are generally positive, there are situations where losses following its use are still high. This seems to be particularly true when the problems are occurring relatively late, so at 12-14 weeks of age or older. This question of whether or not the vaccine would protect pigs that get infected late was indeed one of the big ones we had. One can easily understand that the maternal immunity provided to piglets with colostrum

consumption could protect them while they are in the nursery, but what about pigs that begin to show clinical signs when, theoretically, they are no longer protected by that immunity? This question was particularly relevant for us in Quebec since the majority of our cases so far have occurred in finishing units. It does seem that we have cases where problems were starting at that stage and where the results are still considered as good. But not good enough in others. These results though are preliminary and we need more time to properly assess the value of the vaccine.

Similarly, results obtained in Canada and the US with inactivated PCV2 vaccines designed for use in young pigs suggest that these vaccines are efficacious. The field information gathered to date indicates that losses have been reduced in some cases, while in others a total elimination of PMWS losses has been observed. In fact in Quebec there are even situations where the performance after vaccination appears to be better than it was before the PMWS outbreak. One of the reasons that could possibly explain this is that in the past, some losses may have been associated with PCV2 without being recognized as such. A question I often get is which type of vaccine appears to give the best results, the sow vaccine, or the pig vaccines. If we just look at efficacy per se, up to now it looks as if pig vaccines would have an edge. The protection seems to be more complete, more frequently. I have recently seen one case where pigs born from vaccinated sows were still sick, but clinical signs and losses abated when the pigs themselves were vaccinated. I'm being told however that the effectiveness of the sow vaccine is not optimal in the first pigs that are born from vaccinated sows, but improves gradually over time. If this is true, a valid comparison between the two types of products will only be possible in Canada in the months and years to come.

Management

As for most other diseases the quality of management can help to prevent or reduce the negative impact of PCVD. A French scientist, Dr. François Madec, has proposed a list of 20 rules which, when followed, have reduced the severity of losses in a number of herds (Madec et al, 1999):

Farrowing room

- Emptying of pit, cleaning, disinfection; wash sows and treat for parasites; adoptions: limit cross fostering to what is strictly necessary and only within 24 hours of farrowing; observe parity rank; conformity of vaccination plans

Nursery

- Small nursery pens, solid partitions; empty pit, clean, wash and disinfect; lower stocking density (3 pigs/m^2); increased feeder space (7 cm/pig);

perfect ventilation; perfect temperature; no mixing of batches (1 batch per room)

Finishing

- Small pens with solid partitions in finishing; empty pit, wash and disinfect; 0.75 m^2/pig; temperature, ventilation: OK; no mixing of pens; no mixing of batches

Other measures

- Respect flow of air and animals within buildings; strict hygiene (tail and teeth clipping, castration, injections…); early removal of sick pigs to hospital pens

As can be seen, many of the measures proposed are basically applying good husbandry practices, and as for some of the others they would be difficult to implement in many of our North American systems (e.g. multi-site systems). Nevertheless, it is believed in France that the more of these rules that are applied the greater are the chances that losses associated with PCVD will be reduced.

Lots of other strategies have been suggested by different authors to help control PCVD. These include: reduce the number of weaned or feeder pig sources; reevaluate the vaccines and vaccination programs used; use disinfectants (e.g. Virkon S) that have good activity against PCV2; batch farrowing every 2, 3, 4 or even 5 weeks; partial depopulation of the nursery; bioflavonoids, vitamin E and Se, antioxidants, mash feed, feeds with larger particle size, restricted feeding, no feed changes after moving pigs, richer diets; no hospital pens, either euthanize sick pigs or move them elsewhere; increase weaning age; acetaminophen, acetylsalicylic acid, florfenicol, tilmicosin; closing the herd; use measures to improve colostrum intake; all piglets to suckle their natural mothers for the first 24 hours. The list seems almost endless and one must admit that the results obtained have been very variable, and quite frequently disappointing. There are, however, situations showing that management strategies and infection pressure may have a significant impact on the outcome. For example, Boivent et al (2005) reported that the same sow herd was sending piglets to two different weaning-to-finish operations, and for about a year, one had major problems with PCVD while the other had none.

Serotherapy

Ferreira et al (2001) were the first to propose serotherapy as an alternative to prevent losses associated with PCVD. Piglets that were about 33 days of age were injected subcutaneously with 20 mL of serum from pigs ready for market

that had gone through the problem and had recovered. The results obtained in three trials were excellent (15.2% vs. 4.9%; 18.5% vs. 2.7%; 17.9% vs. 2.8% mortality). Different variations of this strategy, in most cases using lower volumes of serum, have been used successfully in other countries like Spain, UK, the Czech Republic and Canada. But the procedure is not easily applied, there are risks associated with it and except for a few particular situations, the results obtained overall in Quebec have not met expectations.

Control of Other Diseases

Other diseases, PRRS in particular, can either trigger PCVD problems or make them worse. In Quebec, losses in PCVD affected herds are on average much higher in PRRS-positive than in PRRS-negative herds. The mortality rate in PRRS-negative herds does not often exceed 10 or 15%, while we have seen cases where mortality was 50% or more in PRRS-positive herds. Furthermore, in some experimental infections the losses were much higher when both PCV2 and PRRS virus were inoculated, compared to either virus given alone (Harms et al, 2001; Pogranichniy et al, 2004). Thus it is important to try controlling all infections that could potentially make things worse, and this includes, among others, enzootic pneumonia and swine influenza. The same could possibly be said about parvovirus if it was found circulating concurrently with PCV2.

Depopulation/Repopulation

Hassing et al (2004) reported that of six Danish herds that were depopulated, cleaned, disinfected and left emptied for 3-4 weeks, then repopulated with animals from herds without PCVD, five got rid of the problem. In the sixth herd it reappeared about three months after the repopulation program, but in that case the supplier of pigs was the same as before the depopulation/repopulation. Gresham et al (2003) also reported that PCVD had not recurred in three farms after complete depopulation and re-stocking with pigs from unaffected farms. Thus successes in the control of PCVD have been obtained in the past with depopulation/repopulation, and it could constitute an alternative. It should be kept in mind that since we still don't fully understand the epidemiology of that condition, and the ways by which it can become a problem, caution should be exercised when deciding to make a costly decision such as depopulation and repopulation. We had very few herds in Quebec with significant PCVD problems before late 2004; we have had many since then and we're still not sure why.

■ Are there other conditions that could be associated in one way or another with PCV2?

Desrosiers (2005, 2006) has reviewed some conditions for which a potential association with PCV2 has been made. These conditions include porcine dermatitis and nephropathy syndrome (PDNS), sow reproductive problems, boar infertility, porcine respiratory disease complex (PRDC), enteritis, necrotizing lymphadenitis, multifocal interstitial nephritis, necrotizing tracheitis, proliferative and necrotizing pneumonia, hepatopathy, myocarditis and vascular lesions, necrosis of skeletal muscles, gastric ulcers and congenital tremors.

The number of conditions with which PCV2 has been associated has increased significantly during the last few years. In fact, there may be other conditions, different from those described in this list that could also be associated with PCV2 in one way or another. For example, some French veterinarians believe that there could be an association between PCV2 and cases of ear necrosis. Similarly some reports are suggesting that PCV2 could potentially be associated with porcine epidemic diarrhea and exudative epidermitis.

Of course the role that the organism may play in many of these conditions requires further clarification, but it is clear that what we were formerly calling PMWS is not the only condition that PCV2 impacts.

■ Similarities and differences between Europe, Eastern Canada and the US

Some of the features described for PCVD are common to all countries where it has been diagnosed. In fact, by definition, some specific criteria must be met to confirm the diagnosis:

- Animals that are wasting
- Histological lesions of lymphoid depletion, granulomatous inflammation; inclusion bodies may or may not be present
- Identification of PCV2 in the lesions

The clinical picture appears to always include wasting and a lack of response to conventional treatments. Other clinical signs like diarrhea, paleness and thumping vary in severity from one case to another. The post-mortem gross lesions that seem to be observed most frequently include lungs that do not collapse normally, an enlargement of lymph nodes and kidneys that are either larger than normal and/or have white spots on them. The last two are

particularly suggestive. Many other lesions can be seen, but they seem to vary in frequency from one case to another. No single lesion is present in all cases, so it is often necessary to perform several necropsies of sick, representative pigs to have a better chance of identifying some of the more suggestive lesions. Final confirmation of the diagnosis requires tests for PCV2 (usually histopathology and immunohistochemistry or immunofluorescence) conducted at the laboratory.

Some differences have been noted in the expression of the disease in various countries. When PCVD was initially reported in Western Canada, it was mainly in farrow-to-finish herds and pigs developed clinical signs at about 6-8 weeks of age (Harding, 1997; Harding et al, 1998). Icterus (jaundice) was frequent, and skin lesions suggestive of PDNS (porcine dermatitis and nephropathy syndrome) did not seem to be frequent since they were not even mentioned in the early reports (Harding, 1997; Clark, 1997; Harding et al, 1998). When it hit Europe, it affected mainly pigs that were about 8 to 12 weeks of age (Madec et al, 1999). This was the case, among others, for France and Spain. In a study conducted in Denmark in 2003-2004 on 74 herds with, and 74 herds without PCVD, the clinical signs were observed in most herds within 4 weeks of weaning, which occurred at 30 days on average (Nielsen et al, 2006). The difference in mortality between affected and unaffected herds was higher in the nursery (11.2 vs 3.1%) than in finishing units (5.2 vs 3.2%). In European cases, jaundice was present but not frequent and PDNS lesions were frequently reported in herds with PCVD. In the UK more cases of PDNS were diagnosed at the start of the outbreak than cases of PCVD. Today the disease (PCVD) has a tendency to occur at a later age in some European countries, like UK and Spain for example.

The problems began to significantly hit Eastern Canada, late in 2004 and early 2005. The disease is sometimes present in the nursery, but occurs much more frequently at about 3-4 weeks post placement in finishing units, at approximately 12-13 weeks of age. In some cases, the first clinical signs are observed even later, when pigs are as old as 17-19 weeks of age. Jaundice is rare, and we regularly see cases of PDNS in herds where PCVD is diagnosed, but not always. Among other peculiarities of some of our cases is the apparent increased frequency of severe interlobular edema, and occasionally the presence of infarcts on the spleen, a lesion which was thought to be almost pathognomonic of hog cholera, a reportable disease that we certainly don't want in our country.

Reports from the US are generally the same as in Eastern Canada as far as timing and clinical presentations are concerned. However, recently Henry & Tokach (2006) reported on cases in Kansas where approximately 30% of dead pigs had PDNS or 'bulls- eye' skin lesions, and an increased incidence of ear tip necrosis. As mentioned above, some French practitioners also

believe that when PCVD is present on a farm, more pigs with ear necrosis can be observed. This did not seem to be something significant in Canada, so far.

A recent study in finishing herds of Quebec was conducted by Dr. Camille Moore to try to evaluate the prevalence of the condition, and its severity, for the period extending from January to May 2005. Data from 2004 were also used for comparison purposes, and revealed that the average mortality for 2004 was 5.2%. The study involved a representative sample of both finishing and farrow-to-finish operations, for a total of 245 farms. The following observations were made for the studied period of 2005:

- 56% of farms had PCVD
- The average mortality was 7.6%, or 2.4% more than in 2004
- Herds with only PCVD had 5.7% mortality; those with both PCVD and PRRS, 10.1%
- The average age of dead grower pigs was 12.9 wks for farrow-to-finish operations, 14.8 for finishers

The study did not look at what was going on in the nurseries. Of interest is the fact that mortality occurred later in finishing units than on farrow-to-finish farms. However it should be said that the same difference of two weeks was observed in 2004, prior to the time when PCVD really became a major problem.

Segalés (2006) reported on the present situation in different European countries in regards to PCVD. Generally speaking, the situation in most countries is not as bad today as previously. However the extent of losses associated with PCVD in various countries is sometimes difficult to assess accurately. For example, conversations and exchanges with several practitioners and academicians in France suggest that the clinical problems are way less important today than a few years ago. But according to official figures, the losses in nursery and finishing units are still quite a bit higher than before the start of PCVD problems.

Epidemiological studies conducted in different countries have yielded variable results concerning potential risk factors. For example in the UK, data from Cook et al (2001), and Green et al (2005) suggested that proximity to affected herds was a risk factor to develop PCVD problems. In contrast, distance to affected herds was not found to be a significant risk factor in a recent Danish study conducted by Enøe et al (2006). The impact of other diseases like PRRS does not seem to be consistent either. In the studies of Cook et al (2001), Green et al (2005), Larochelle et al (2003) and Meerts at al (2004), this condition did not seem to play a significant role in the development of PCVD, while in others, it did (Rose et al, 2003; de Jong et al, 2005). As mentioned above, losses in Quebec are often greater in PRRS-positive than in

PRRS-negative herds. In one particular small system that had always been PRRS-positive, losses in the finishing units went from about 3.5% when the system was only positive to PRRS, to more than 30% for a five-month period when the combined problems of PRRS/PCVD occurred.

Conclusion

PMWS/PCVD/PCVAD has produced severe losses for pig producers in many areas of the world. While North America has to a certain extent avoided these severe losses until recently, we now have areas where losses are unacceptably high and solutions have to be found.

Different control alternatives have been briefly discussed in this paper. In my opinion the two approaches most likely to make our lives easier with this condition are genetics and vaccines. Some genetic lines or combinations are clearly more resistant to PCVD than others, and the preliminary results obtained with vaccines are very encouraging. An effective and practical control of the problems associated with PCV2 now appears possible.

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