Porcine Circovirus Associated Disease:

Where we have been and where we are going.

by Thomas G. Gillespie, DVM Diplomate, ABVP
Rensselaer Swine Service, P.C., Rensselaer, IN

Introduction

The first finding of circovirus was in 1974 in a continuous porcine kidney cell line (PK-15).[1] This first identified porcine circovirus (now known as PCV1) was found to be widespread in the pig population and non-pathogenic for pigs.[1] Since the emergence of a disease causing severe wasting, ill-thrift and elevated mortality in nursery pigs was first described in western Canada in 1997 by Drs. John Harding and Ted Clark, Postweaning Multisystemic Wasting Syndrome (PMWS), as it was initially called, has been identified in most swine-producing countries worldwide. The usage of PMWS has changed to Porcine Circovirus Associated Disease (PCVAD) primarily due to several clinical aspects being observed by swine producers and veterinarians. The disease has resulted in significant health challenges and economic damage in the swine industry. Porcine circovirus type 2 (PCV2) was subsequently identified as an integral component of the disease process.[2] Debate continues regarding the possible role of other co-factors. The disease is not transmissible to humans, and pork from pigs exposed to PCV2 is safe to eat.

History

PCV1 and PCV2 are the smallest known viruses that affect swine and are closely related to psittacine beak and feather disease circovirus. A number of circoviruses have been found that include canary, bovine, goose, columbid, ostrich, raven and a closely related TT virus, a circovirus found in humans that belongs to the *Circoviridae* family, *Anellovirus* genus. Evidence indicating exposure to PCV2 has been found in stored swine serum in Europe as far back as 1969.[1] Veterinarians in the US have discussed finding PCV2 in tissue submissions for over 10 years, but have not understood the significance of finding this virus as a co-infection. Historically in North America, the disease manifested itself as a sporadic occurrence of growth retardation and weight loss in nursery-aged pigs (6 to 12 weeks of age), but usually in co-infections with PRRS virus. Recently, however, a different presentation has been described resulting in severely elevated acute mortality in older pigs usually 6 to 18 weeks of age. In addition, other clinical presentations were also being associated with PCV2 infection, i.e. late nursery presentation and in start up or where sow herds are vaccinated, 16 to 20 weeks of age.

American Association of Swine Veterinarians Action

In an effort to determine the significance of this disease in the North American swine herd, the American Association of Swine Veterinarians (AASV) formed a task force in 2006 to investigate the emergence of a more severe and varied clinical presentation of disease associated with exposure to porcine circovirus type 2. The task force developed a dynamic case definition of the disease in an attempt to provide some guidance to practitioners faced with trying to diagnose and manage the disease. The group also proposed the adoption of a new name, Porcine Circovirus Associated Disease (PCVAD), to cover the list of now somewhat varied clinical presentations. The name is an attempt to better describe the disease process as it occurs today and recognizes that PMWS is not the only clinical expression; although it is one of the more severe and economically damaging.

A heightened awareness of this problem has swept across all major swine producing areas in the United States and Canada. The rapid appearance of severe clinical disease is only one interesting aspect of a very complex problem. The AASV task force was given the charge to gather information and address the concerns of the association's membership. They held a special session during American Association of Swine Veterinarians (AASV) 2006 Annual Meeting where members discussed what was being observed in the field. The task force immediately acted on the charge and began developing a long list of issues that needed to be addressed. In addition, the task force worked closely with the National Pork Board to ensure the concerns of swine producers and processors were also recognized and to aid in the development of educational materials and the dissemination of information.

"Versions" of the Virus

Dr. Raymond Rowland, a virologist with Kansas State University, and Dr. Carl Gagnon, from St. Hyacinthe, has reported that two versions of PCV2 have been identified. The proposal is to use PCV2a and PCV2b for each version. PCV2b is associated with the more severe form of PCVAD. It appears that PCV2b would correspond with an RFLP pattern 3-2-1 and PCV2a would correspond with a RFLP pattern of 4-2-2. A Swedish group has proposed a genotype 3 which appears to be equivalent to PCV2b. Dr. A. Olvera, Barcelona, Spain, indicates that PCV2 could be divided into two groups (1 and 2) and eight clusters (1A to 1C and 2A to 2E). It is my understanding that the isolate that we know as PCV2b would be equivalent to Olvera's 1A.

Clinical Expressions and Case Definition

A number of variable clinical presentations are being described and associated with PCV2 infection. However,

due to its ubiquitous nature, exposure to PCV2 is a common finding in pigs submitted for diagnostic work-up. Thus, it was recognized that a set of criteria was needed to determine when a disease manifestation was likely associated with PCV2 infection. PMWS is recognized as a major clinical manifestation of PCVAD, but not the only one. Although research has yet to confirm Porcine Dermatitis Nephropathy Syndrome (PDNS) as one aspect of PCVAD, it is included as one of the possible or potential clinical expressions until further knowledge becomes known.

While individual animals may exhibit clinical signs, the herd does not always experience PCVAD which may lead to misdiagnosing the problem. To derive the following case definition, the committee adopted the approach utilized by the Centers for Disease Control and Prevention (CDC) to define "cases" in human medicine where a definitive etiology remains unknown. The following criteria were selected as the basis of a case definition so all researchers and veterinarians will know what constitutes PCVAD. This case definition is considered to be a dynamic document which will be altered as additional information becomes available.

PCVAD can be subclinical (at least PCV2 can be subclinical) or include one or more of the following clinical manifestations concurrently:

1. Multisystemic disease with weight loss (formerly known as PMWS)
2. High mortality: Doubling of historical mortality rate without introduction of a new known pathogen
3. Respiratory signs including pneumonia
4. Porcine Dermatitis and Nephropathy Syndrome (PDNS)
5. Enteric signs including diarrhea and weight loss
6. Reproductive disorders including abortions, stillbirths and fetal mummification (diagnosis requires the presence of fetal myocarditis associated with PCV2 antigen in lesions. Experimentally infecting gestating animals with PCV2 has caused abortions and premature farrowing without fetuses showing myocarditis lesions, Park et al.)

PCVAD is a broad categorization of multisystemic diseases that are confirmed by documentation of the following histopathological findings in affected pigs:

1. Depletion of lymphoid cells
2. Disseminated granulomatous inflammation in one or more tissues (e.g. spleen, thymus, ileum, lymph nodes [sternal, bronchial, inguinal and mesenteric], lung, kidney, liver, tonsil, etc.)
3. Detection of PCV2 within the lesions
4. PCV2 associated reproductive disease diagnosis requires the presence of PCV2 antigen in fetal myocarditis lesions

Economic Concerns

In addition to the obvious health and welfare concerns, numerous commodity newsletters and corporate news reports by their corresponding CEOs have mentioned PCVAD as a leading cause for economic concern within the pork industry. Mortality, underweight market pigs and increased culls all represent lost opportunity and increase costs. The disease also results in the need for additional animal health, labor and housing expenditures. By some reports, losses associated with increased mortality, and decreased average daily gain and feed efficiency cost the industry $6.60 per pig.[3]

Case Presentation

A 1200-sow, farrow-to-finish operation located in the eastern corn belt of the United States was diagnosed with PCVD in December 2004. Pigs are placed in conventional 1000-head finishing units. The system is PRRS virus negative. A diagnosis was made in 12-16 week old growing pigs. Histopathological and immuno-histochemical testing revealed the presence of PCV 2 antigen within lesions of multifocal granulomatous lymphadenopathy, meeting the criteria established for PCV 2 associated disease.

Production records were collected from the farm and seasonally adjusted into six-month periods, (December though May) for two years prior to the clinical break and the beginning of the current, ongoing outbreak. Parameters were evaluated in a batch or group for all performance data. Parameters included average daily gain (ADG), feed efficiency (FE), number of pigs placed (Placed) and mortality rate (Mortality).

Economic analysis was made with the following valuation assumptions: average feed cost - $0.0599/lb, mortality opportunity cost - $125 per animal, and ADG - $/lb. All values are listed in US dollars. Student's t-test was used for analysis. The reported P values for Mortality, ADG and FE were one tailed. The P value for Placed was two sided. All were significant at or below P=0.05.

Results

The PCVD outbreak significantly impacted mortality, ADG and FE (Table 1).

Table 1 Means and SE for Performance Parameters Pre- and Post-PCVD Outbreak.

Parameter	2003/2004	2005	P value
N	24	12	
Pigs Placed	1175.9 ±21.8	1106.82 ±37.8	0.09 (moderately significant)
Mortality	1.61 ±0.14	4.85 ±0.56	<0.001 (highly significant)
ADG, lb/d	1.87 ±0.01	1.82 ±0.02	0.05 (significant)
FE	2.68 ±0.06	2.83± 0.04	0.05 (significant)

The economic analysis revealed a combined loss of $6.60 per animal in the outbreak phase (Table 2). The bulk of the cost impact was through mortality, excluding culls, which were not analyzed in this study. Mortality was analysed as animals per 1000 head placed into finishing units.

Table 2 Economic Impact of PCVD in PRRS Negative Finishing Pigs

Parameter	Production Change	Value, USD	Total
Mortality,%	+ 3.24	$ 2.78	
ADG, lb	- 0.05	$ 2.09	
FE	+ 0.15	$ 1.73	
			$ 6.60

Vaccine Response

The response that veterinarians and producers have observed in North America has been extremely good when considering mortality alone. A common comment has been that "mortality rates have not been this low in years"! Production data from group close outs are beginning to show very nice responses. Mortality has been reduced from the high rates of 8% to 20%+ back to more normal levels. In addition, an improvement in average daily gain (ADG) of 0.1 to 0.2 lb during the finisher phase (100-110 days) will result in 10-20 lb heavier market weight.

Management Practices

While the vaccine has provided a very nice response, swine producers need to examine their routine management practices with their veterinarian to support the vaccine and to attain the maximum benefits. France began to recognize a problem in 1994/1995 and what resulted is now known as the Madec 20-point plan (Table 3). It is recommended that at least 16 points be incorporated for the best response, although most of the points are "common sense" suggestions, deviation from good management practices will occur over time in most units.

It has been shown that several commonly available disinfectants are useful against PCV2.[4] Proper sanitation programs with adequate drying before animals are placed are useful practices in reducing not only PCV2 but most pathogens that are associated with causing economic concerns.

Educational Web Sites

Many web sites contain educational information on PCVAD. Following are sites frequently used by the author.

www.pmwsinpigs.org
www.pcv2.org
www.thepigsite.com
www.pcvd.org
www.pighealth.com
www.vetmed.iastate.edu/departments/vdpam/swine/diseases/pcv2/default.asp

Summary

As veterinarians are conducting farm trials to find answers for their clients, researchers are testing theories about how this virus can be associated with the variable clinical expressions and mortality observed across a wide range of production situations. Pharmaceutical and biological companies are striving to provide quality vaccines and products. Research, effective vaccines, improved diagnostics and enhanced management are all tools to help prevent and minimize the clinical signs associated with exposure to PCV2 and lessen the devastating losses.

References

1. Nauwynek, H., Lefebvre, D., Misinzo, G., Meerts, P., Mateusen, B., Sanchez, R., and Delputte, P., Pathogenesis of porcine circovirus 2 infections. *Proceedings of American Association of Swine Veterinarians*, 2007, pg 489-495.
2. Allan, G., and Ellis, J. 2000 Porcine circovirus: a review. *Journal of Veterinary Diagnostic Investigation* 12: 3-14.
3. Gillespie, T., Okones, J., Edler, R., Anderson, G., Kolb, J., and Holck, T., Seasonally adjusted economic impact of PCV 2 Associated Disease (PCVD) in a US grow/finish swine unit. *Proceeding of 19th IPVS Congress, Denmark*, 2006, pg 280.
4. Royer R, et al., Susceptibility of porcine circovirus type 2 to commercial and laboratory disinfectants. *J Swine Health Prod* 2001; 9 (6):281-284.

Original date of article August 2007