ORIGINAL RESEARCH

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Postweaning multisystemic wasting syndrome: Epidemiology and clinical presentation

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Summary

Objective: To describe the characteristics of postweaning multisystemic wasting syndrome (PMWS).

Methods: A retrospective analysis of the production records of a 600-sow herd with clincial signs consistent with endemic PMWS was conducted. Also, data elicited by a descriptive epidemiologic survey that was completed by 15 producers with herds that had confirmed PMWS was analyzed.

Results: In the case herd, postweaning mortality rate peaked at 7.67% on month 9 of the epidemic, then returned within 16 months to pre-outbreak levels of 2.1%–2.5%. The most common causes of death reported by the farm were unthriftiness (weight loss, emaciation), jaundice (liver disease), and dyspnea (respiratory disease). In the surveyed herds, PMWS was found to be a slow and progressive disease with a high case fatality rate (81.4% ±23.4%). Clinical disease was observed most commonly in pregrower barns (90%), followed by nursery (62%) and grower barns (39%). The syndrome was first noted in pigs 42 ±13.5 days of age. The most frequent clinical signs of PMWS included unthriftiness, dyspnea, pallor, rough hair coat, diarrhea, and jaundice. Postweaning mortality averaged 6.7% ± 5.1% (SD) in affected herds, and was reported as 18.3% in the most severely affected herd. Poor response to various modes of antimicrobial therapy was reported.

Implications: Control of PMWS is difficult and may depend largely on pig flow, improved sanitation, and early recognition and segregation of sick pigs.

Keywords: swine, porcine circovirus, postweaning multisystemic wasting syndrome

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In January 1995, a 600-sow farrow-to-finish swine operation reported high mortality in pigs 3–8 weeks postweaning. Affected pigs demonstrated severe weight loss, tachypnea, dyspnea, pallor, enlarged lymph nodes, and/or jaundice. The disease was described as subtle and progressive, with high mortality in affected pigs. Various antimicrobial agents were tried, but response was poor and most affected pigs died or were euthanized after 3–4 weeks of illness. After an exhaustive diagnostic workup, pathologists failed to identify any etiologic agent, but successfully ruled out all bacterial pathogens common to swine. The disease was named postweaning multisystemic wasting syndrome (PMWS), based on its unique clinical presentation and histopathologic lesions.[1–3]

Porcine circovirus (PCV) has been suspected of an etiologic role in PMWS after investigators identified deeply basophilic staining intracytoplasmic inclusion bodies that contained clusters of PCV.[4] Evidence for a possible association was strengthened by the isolation of PCV from tissues of PMWS-affected pigs[5] and from positive immunohistochemical staining of PCV antigen in affected tissues.[2] At the time of writing, Koch's postulates have not yet been fulfilled, but inoculation studies with cloned virus are underway.

Porcine circovirus (PCV) was first identified as a noncytopathic contaminant of continuous PK-15 cell line.[6] Although other members of the Circoviridae family are pathogenic (psittacine beak and feather disease, chicken anaemia virus), until recently porcine circovirus had not been clearly associated with disease in pigs or other species.[7–9] Because serum antibodies to PK-15 circovirus are widespread in the swine industries of Germany,[9] Canada,[10] England,[11] and the United States,[12] the true involvement of PCV in PMWS is not fully understood, but is hypothesized to involve a variant strain.[5]

Because the unique histopathologic lesions characteristic of PMWS have been previously described,[2,13] the objective of this paper is to present descriptive epidemiologic data from epidemically and endemically affected herds.

Materials and methods

Case herd

A retrospective analysis of production data was undertaken from the 600-sow farrow-to-finish herd that experienced severe mortality in 1995 due to PMWS. Production data from January 1994–December 1996 were analyzed, including data from 10 months of baseline production before the first signs of PMWS were reported, and 10 months production data after PMWS had subsided. Percent postweaning mortality over a rolling 3-month period was available from computerized production records (Easicare Systems Inc., Fyfieldwick, United Kingdom).

JCSH: Harding Swine Veterinary Service, Inc, P.O. Box 2922, Humboldt, Saskatchewan, S0K 2A0, Canada; EGC, JAE: Western College of Veterinary Medicine; JHS: Parkland Veterinary Service; PIW: Veterinary Infectious Disease Organization

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A more detailed description of mortality was available from production records maintained by barn staff on a daily basis. Pertinent information from every pig that died on the unit was recorded, including the date of death, tattoo number, room location, stage of production, and cause of death or description of clinical signs immediately prior to death. For the purpose of this study, the case definition of PMWS included deaths associated with "unthriftiness," "jaundice," "respiratory distress (puffer or dyspnea)," and "unknown reasons." The latter was included because early in the epidemic, it was the category used to record most deaths associated with "unthriftiness."

During the PMWS outbreak, the clinical course was monitored daily by barn staff and herd veterinarians. To rule out porcine reproductive and reproductive syndrome virus (PRRSV), antibody testing was undertaken on two occasions during the outbreak. In January 1995, 80 blood samples were collected from 15 suckling pigs (5 kg, 11 lb), 15 nursery pigs (15 kg, 33 lb), 15 grower pigs (50 kg, 110 lb), 15 finisher pigs (100 kg, 220.5 lb), 10 replacement females (120 kg, 264.5 lb), and 10 mature sows. Serum was harvested and analysed for PRRSV IgG antibody using the indirect-immunofluorescent antibody (IFA) test for the Lelystad and ATCC VR-2332 strains.[14] In May 1995, sera was harvested from thirty 50-kg (110-lb) pigs and was analysed for PRRSV IgG antibody using the IDEXX ELISA.[15]

Epidemiologic survey

By late 1996, numerous Western Canadian swine herds were experiencing clinical disease consistent with PMWS. To gather descriptive epidemiologic data on affected farms, a standardized survey was distributed to affected herds via their attending herd veterinarian. Only herds with a confirmed positive diagnosis of PMWS based on histopathologic examination from multiple pigs and tissues were included in the survey. To maintain consistency, all histopathologic examinations were performed by Dr. Ted Clark, Western College of Veterinary Medicine, Saskatoon, Canada.

The epidemiologic data collected on the survey were subdivided into four sections as follows:

- general farm information and location,
- herd productivity,
- health status of unit, and
- PMWS clinical description.

The health status of each herd was assessed by the attending veterinarian based on their farm visits and veterinary consultations, available diagnostic reports originating from necropsy examinations, serology, slaughter checks examinations, and from health documentation of the source herd(s) provided by the seedstock supplier.

Descriptive statistics were performed using commercial software (Statistix version 4.0, Analytical Software, Tallahassee, Florida).

Results

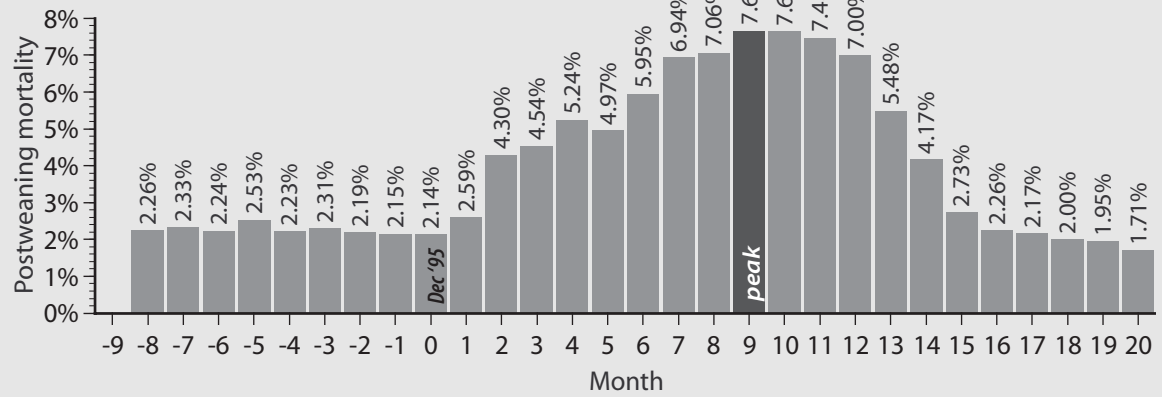
Case herd

The clinical outbreak lasted from December 1994–March 1996. Clinically diseased pigs were most frequently noted in the nursery and grower stages, and were rarely noted before weaning. Postweaning multisystemic wasting syndrome was first observed in pigs at 6–8 weeks of age (3–5 weeks postweaning). Initial clinical signs were a subtle weight loss and increased weight variation among pen groups. Although the course of the disease was protracted, the onset of clinical signs in affected pigs was very often unnoticeable in the early stages. Postweaning mortality increased for 16 months, beginning in December 1995, and peaked in month 9 at 7.67% compared to the pre-outbreak postweaning mortality rate of 2.1%–2.5% (Figure 1). The most frequent clinical signs prior to death were unthriftiness, dyspnea, and jaundice (Figure 2), compared to the other clinical signs including lameness, heart failure, arthritis, diarrhea, intestinal torsion, pallor, sudden death, and stress/fighting. Postweaning multisystemic wasting syndrome accounted for 76% of the mortality in the nursery stage and 43% of the mortality in the grower-finisher stage. All serologic samples were negative by IFA and ELISA for the PRRSV antibody for VR-2332 and the Lelystad strains.

Epidemiologic survey

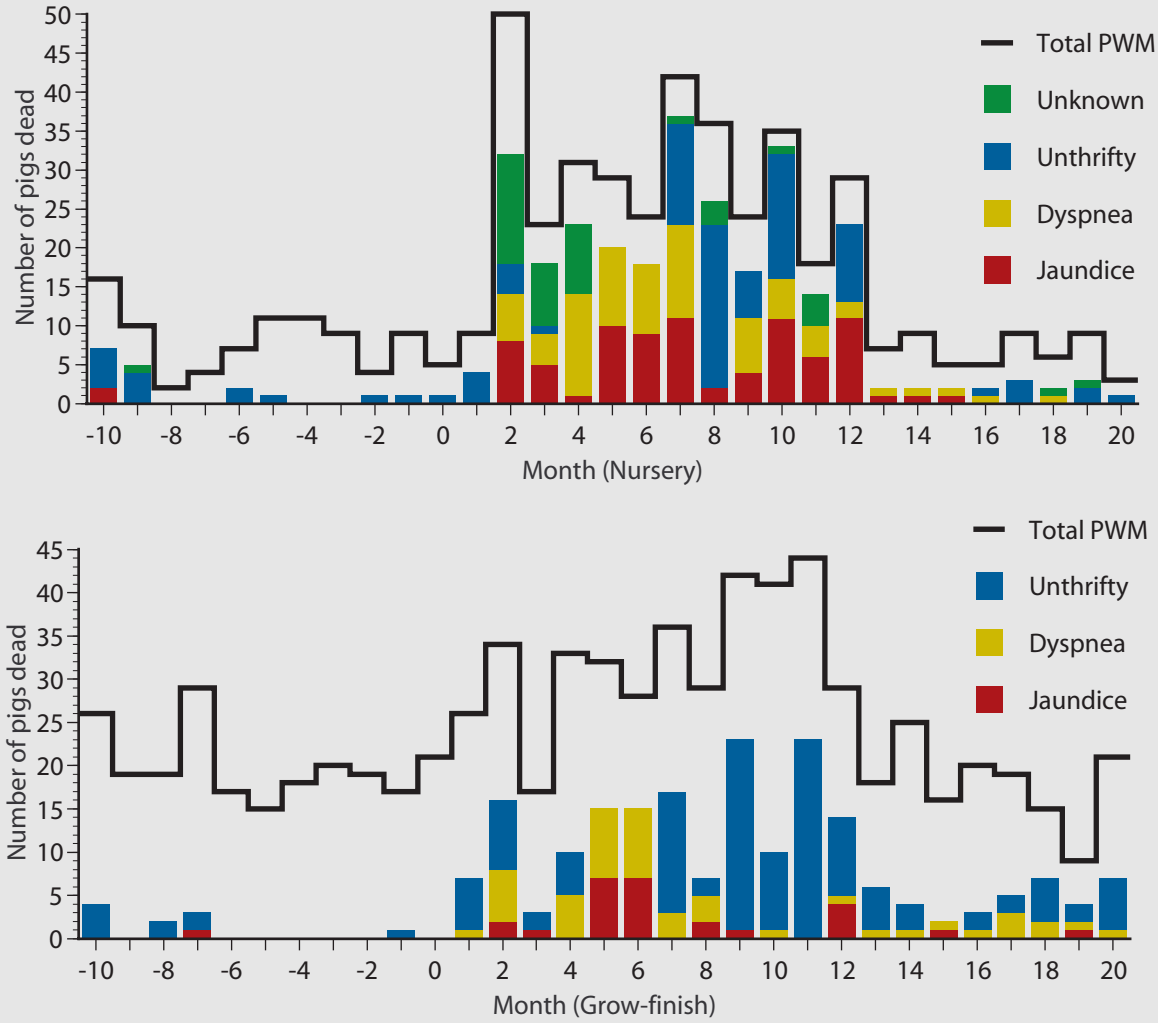
Surveys were completed by 60% of the farms contacted (15 farms). All herds from which a response was received were in Saskatchewan and Alberta. All herds surveyed were farrow-to-finish herds with 80–500

Figure 1



Changes in total postweaning mortality (%) in the case herd during the acute or epidemic presentation of PMWS

Figure 2



Proportion of postweaning mortality associated with PMWS compared to total mortality in the nursery (upper graph) and grow-finish (lower graph) stages during the epidemic presentation in a single herd

Distance between total line and top of bars indicates non-PMWS-related mortality.

sows. All herds had continuous-flow grower and finisher barns, 53% had continuous-flow nurseries, and 60% had continuous-flow farrowing rooms. The age of the herds ranged from 1–25 years in operation since inception or depopulation, but 60% were less than 5 years old. All herds were situated at least 0.8 km (0.5 miles) from the neighboring hog operation, and 50% were > 2.4 km (1.5 miles). Performance (mean ± standard deviation) on farms was good to excellent:

- litters per sow per year: 2.3 ± 0.2;
- liveborn littersize: 10.7 ± 0.6;
- preweaning mortality:11.4% ± 4.4; and
- weaned per litter: 9.3 ± 0.6.

All of the herds were clinically free of *Actinobacillus pleuropneumoniae*, swine dysentery, and transmissible gastroenteritis, and most were also clinically free of *Mycoplasma hyopneumoniae* pneumonia (Figure 3). The diseases or pathogenic agents that were endemic to most herds included PRRSV, ileitis associated with *Lawsonia intracellularis*, and *Haemophilus parasuis* (Figure 3).

The effects of PMWS were longstanding in some of the herds, averaging 18 months among the surveyed herds. Pigs with PMWS developed initial clinical signs at 42 ± 13.5 days of age. Clinical disease was noted most commonly in the nursery and the pregrower stages of production (Figure 4). The most frequent clinical signs reported were unthriftiness, dyspnea, pallor, rough hair coat, jaundice, and diarrhea (Figure 5). The postweaning mortality rate was 6.7% ± 5.1% and the subjective case fatality rate of PMWS affected pigs was 81.4% ±23.4%. Poor response to various modes of antimicrobial therapy was reported on all farms.

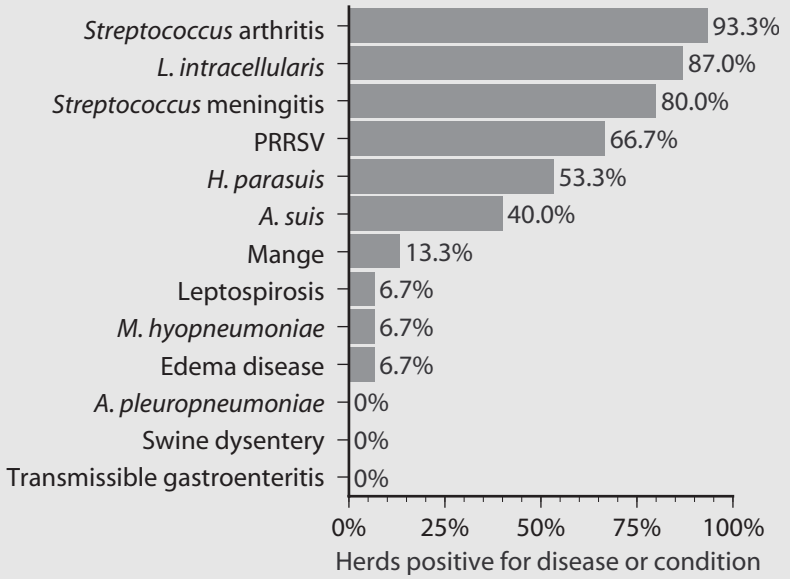
Discussion

Postweaning multisystemic wasting syndrome is a new and unique disease affecting swine. It results in significant nursery and grow-finish mortality, and is characterized by unthriftiness, dyspnea, rough hair

coat, pallor, jaundice, and diarrhea, and (less frequently) coughing and central nervous system disturbances. The most frequent necropsy lesions are systemic lymphadenopathy, interstitial pneumonia, hepatocellular apoptosis, lymphohistiocytic infiltration of gastric, cecal and colonic mucosa, splenic B-cell follicles loss, infiltration of T cell areas by histiocytic cells, and deeply basophilic stained clusters of intracytoplasmic inclusion bodies in B-cell-dependent areas of lymphatic tissue.[2,13]

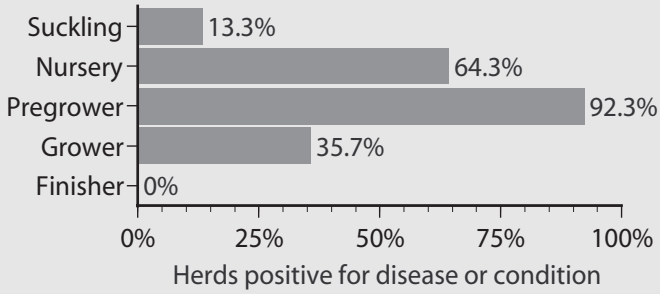
Since the outbreak subsided in the case herd, pre-outbreak levels of performance (1.95% postweaning mortality) have been achieved and maintained for 18 months, although sporadic cases of PMWS have been noted. Although there is no definitive reason why mortality returned to pre-outbreak levels, we hypothesize that implementing strict all-in–all-out pig flow, improving washing and disinfection techniques, and segregating and euthanizing pigs in a more timely fashion reduced infection pressure and viral transmission to susceptible pigs. Natural immunity to the causative agent is presumed to have developed during the course of the outbreak, thus reducing the risk of transplacental infection, viremia, exposure to high concentrations of the causative agent, and failure to transfer passive antibodies.

Figure 3



Health status of herds included in the epidemiologic survey

Figure 4



Proportion of the surveyed herds that noted PMWS in suckling, nursery, pregrower, grower, and finisher pigs

Although a limited number of herds were included in the survey, the epidemiologic data reported is the first available on the effects of endemic PMWS. Many of those herds that did not respond to the survey had experienced PMWS for less than 3 months and therefore had only a partial understanding of the effect of PMWS on their herd productivity. Affected pigs in this survey consistently developed clinical disease around 42 days of age; however, more recent field experience suggests that the age of first onset may be associated with pig flow, the degree of facility compartmentalization, and the ability of the management to segregate and remove affected pigs.[16] High concentrations of maternal antibody may also provide a protective effect, hence delaying the onset of clinical signs.

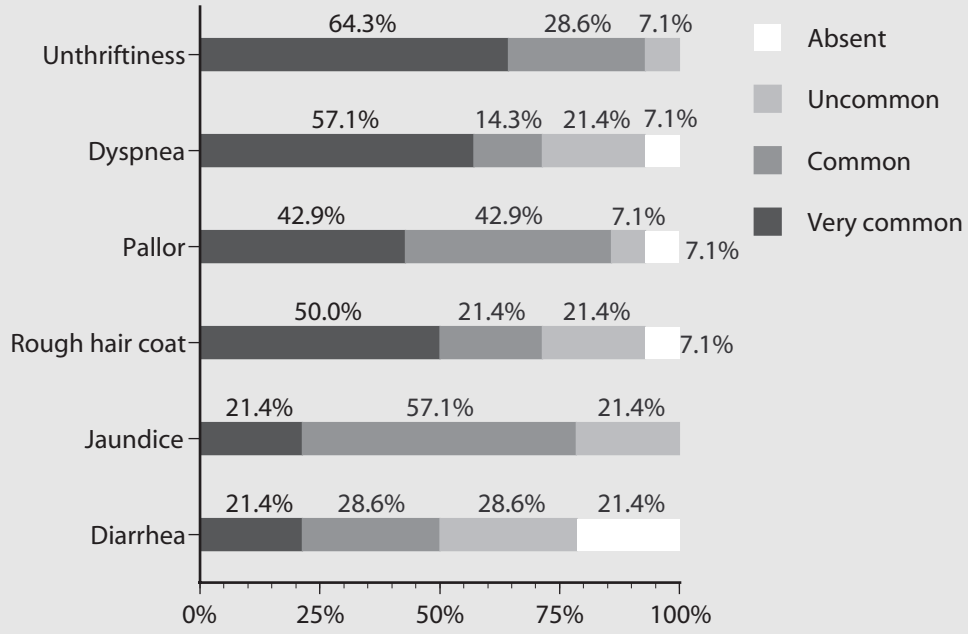
There is evidence to suggest that PMWS is associated with infection with porcine circovirus, although a causal relationship has not yet been confirmed. The putative association is supported by the positive immunohistochemical staining of virtually all affected tissues, EM identification of inclusion bodies characteristic of porcine circovirus, and the isolation of PCV from affected pigs.[5] The predilection of porcine circovirus for macrophages, monocytes, histiocytes, and antigen-presenting macrophages in lung, thymus, and spleen suggests that PCV pathogenesis may be the result of immune dysfunction. Immunosuppressive effects are common to other members of the Circoviridae family.[17]

Interactions with other viruses in the pathogenesis of PMWS have not been ruled out. However, PMWS is an entity entirely distinct from PRRSV and can be clinically devastating in herds that are clinically and serologically free of United States and European PRRSV strains based on repeated PRRSV IgG testing. The two diseases can be differentiated both clinically and pathologically:

- the presence of icterus and gross and histologic liver lesions in affected pigs are characteristic of PMWS but not PRRS;
- histologic lesions in lymph tissue are characterized by depletion in cases of PMWS, whereas proliferation is the characteristic lesion in cases of PRRS;
- gross and histologic kidney and liver lesions are noted frequently with PMWS but are not noted in PRRS.

Recently, a novel virus similar to the human hepatitis E virus was

Figure 5



Relative frequency of the 6 most common clinical sign of PMWS in surveyed herds

identified as a cause of multifocal lymphoplasmacytic and necrotizing hepatitis with random hepatocellular swelling and vacuolation.[18] Although similar in nature, the association between swine hepatitis E and PMWS is not fully understood.

Studies on the etiology of PMWS are ongoing at the time of this writing. There is strong immunohistochemical evidence of PCV antigen in lesional tissue, but experimental transmission studies using purified virus must be completed. Although antibodies to porcine circovirus are widespread in the pig industry,[9–12] these studies only confirm the presence of PK-15 strain PCV antibody. The strain of PCV putatively associated with PMWS is unique[5] and no industry-wide serologic testing has been performed with the strain of PCV associated with disease. Thus, the mutation of a nonpathogenic PK-15 strain PCV to a more virulent strain remains a possibility.

It is unfortunate that more is not known about the epidemiology of the syndrome at present. However, further epidemiologic studies including a serologic case-control investigation will be undertaken as soon as the etiologic agent has been identified and a sensitive, specific antibody test is available. In addition, studies are planned that will more clearly elucidate the pattern of transmission on affected farms, identify any potential risk factors for susceptible pigs, and determine the relative frequency of clinical signs and performance in affected and non-affected pigs within the same cohort.

Implications

- Practicing veterinarians should be aware that PMWS involves postweaning wasting or unthriftiness and should be considered particularly where jaundice is noted, or in PRRS-free herds where dyspnea is noted.
- Postweaning multisystemic wasting disease most commonly affects nursery pigs around 42 days of age (±2 weeks).
- The severity and duration of the syndrome varies from herd to herd; clearly, more research is needed to identify potential risk factors associated the clinical presentation and epidemiology of the syndrome.

Acknowledgements

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