Postweaning mortality in Manitoba swine

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Abstract

A case–control study to investigate the contribution of postweaning multisystemic wasting syndrome (PMWS) and *Porcine circovirus type 2* (PCV-2) to deaths among piglets of nursery age (19 to 68 d) in Manitoba indicated a significant positive association between PCV-2 infection and an increased mortality rate in nursery pigs. The clinical syndrome PMWS was seldom recognized in case or control herds; however, PCV-2 infection was widespread at the herd level. Other factors more strongly associated with increased piglet mortality rate than herd level PCV-2 infection were *Mycoplasma hyopneumonia* infection, porcine reproductive and respiratory syndrome (PRRS), and diarrhea caused by *Eschericia coli* K88. Management factors associated with case herd status included close proximity to other herds, larger number of sows supplying pigs to the nursery, larger range in age and weight going into the nursery, the moving of lightweight pigs into another nursery room at the end of the nursery fill, and not using spray-dried plasma in the 1st nursery ration. These results highlight the host–agent–environment triad leading to high nursery-barn mortality rates.

Résumé

Au Manitoba, une étude cas–témoin pour évaluer le rôle du syndrome de dépérissement post-sevrage (PMWS) et de l'infection par le circonspects porcin de type 2 (PCV-2) dans la mortalité chez des porcelets âgés de 19 à 68 j a démontré une association positive significative entre l'infection par le PCV-2 et une augmentation du taux de mortalité chez des porcelets en pouponnières. Le PMWS était peu fréquemment rencontré dans les troupeaux affectés ou dans les troupeaux témoins; toutefois, l'infection par le PCV-2 était largement distribuée dans les troupeaux. D'autres facteurs plus fortement associés que l'infection par PCV-2 avec l'augmentation des taux de mortalité étaient une infection par Mycoplasma hyopneumoniae, *le syndrome respiratoire et reproducteur porcin et la diarrhée causée par* Escherichia coli *K88. Des facteurs de régie associés avec le statut sanitaire du troupeau incluaient la proximité d'autres troupeaux, un plus grand nombre de truies fournissant des porcelets à la pouponnière, de plus grands écarts dans l'âge et le poids des animaux entrant dans la pouponnière, le déplacement des porcs au poids léger dans une autre chambre de la pouponnière à la fin du remplissage de la pouponnière et la non-utilisation de plasma séché dans la première ration en pouponnière. Ces résultats démontrent l'importance de la triade hôte–agent–environnement conduisant à des taux de mortalité élevés en pouponnière.*

(Traduit par Docteur Serge Messier)

Introduction

Nursery pig survivability may be associated with the same management factors that have improved health and growth rates of nursery pigs. Infectious disease may be a significant cause of poor productivity and pig mortality in the nursery stage, 19 to 68 d of age in Manitoba production systems.

The identification of *Porcine circovirus type 2* (PCV-2) and its association with postweaning multisystemic wasting syndrome (PMWS) became a cause of concern to the swine industry in the mid-1990s, when the disease first appeared in healthy swine herds in western Canada (1,2). Since then, PCV-2 has been identified in other pork-producing areas of the world, commonly in herds free of other major contagious diseases (3–11). The mortality rate may reach 40% in weanling pigs in affected herds (2,3), but it varies with the infecting strain of PCV-2. Clinical signs most often first appear 2 to 3 wk after weaning, when pigs are 5 to 6 wk old (2,3,12). Signs are variable but usually include wasting and dyspnea and may include 1 or more of icterus, pallor, and diarrhea, with a poor response to antibiotic therapy (2,3). Consistent signs at necropsy include interstitial pneumonia, lymphadenopathy, hepatitis, and nephritis (1,12). Coinfection with other organisms is usually necessary to produce the clinical disease and gross lesions typical of PMWS in gnotobiotic piglets (13,14).

The objectives of this study were to determine the relevance of PCV-2 to nursery pig losses in Manitoba during a 12-mo period in

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1998 and 1999 and to determine the association between the mortality rate in nursery pigs and noncircovirus infectious disease and management factors on the same farms.

Materials and methods

Selection of study herds

The project was conducted as a case–control study. Herds were selected from swine operations that had a regular veterinarian and kept production records. Herd status was determined by the herd veterinarian.

Case herds were those experiencing high nursery-pig mortality rates during the previous 18 mo. A high rate was defined as more than 3% mortality on a continuous basis or a single episode of nursery mortality exceeding the herd normal. Control herds were those with nursery mortality rates equivalent to the industry expected rate, which for most herds was less than 3%. For a herd to be included in the study, the producer had to be willing to keep records of the numbers of pigs moved into the nursery and the numbers of pigs that died during the nursery phase.

A convenience sample of farms was selected on the basis of recommendations by the herd health veterinarians, and 61 farms were visited by 1 investigator (T.J.) between May 1 and June 30, 1999. Each producer completed a detailed survey describing herd management and disease status; the form was collected by the same investigator in a face-to-face interview.

Disease status of study herds

Disease status was determined at the farm level on the basis of producer recollection, historical laboratory data, vaccination protocol, current clinical problems, and necropsy findings in 1 to 3 nursery pigs submitted during the study to the laboratory of Manitoba Agriculture and Food, Veterinary Services Branch (MAF-VSB), for complete postmortem evaluation.

Necropsy on the submitted nursery pigs included gross examination and a panel of polymerase chain reaction (PCR) tests for *Porcine respiratory and reproductive syndrome virus* (PRRSV), PCV-2, *Mycoplasma hyopneumoniae,* and *Swine influenza virus.* At the pathologist's discretion, other tests (including microbiologic, histologic, and serologic tests, along with virus isolation) were used to assist with diagnosis. The clinical problems identified in the pigs submitted for necropsy were recorded.

Whenever possible, 5-wk-old nursery pigs were physically inspected, and the number of pigs with obvious clinical problems was recorded. Producers were questioned about both etiologic agents and syndromes observed in the previous 18 mo, and information in the MAF-VSB laboratory data bank was reviewed and added to that recalled by the producer. Chronically ill pigs may be euthanized on some farms, which will appear to increase the mortality rate, whereas on other farms they will be kept alive. To collect information on these pigs, the term "light" referred to a pig that was smaller than expected for its age, and "poor-doer" to a pig that had a chronic nonspecific illness. If the producer believed that the herd was free of a specific disease agent but the agent was identified on that farm by the MAF-VSB laboratory, then the herd was considered positive for that agent.

Table I. Summary of data collected from 28 case herds and 33 control herds on 61 Manitoba swine farms participating in a 1998–1999 case–control study of postweaning mortality

	Number of herds	
Variable	Case herds	Control herds
Survey completed	28	33
Nutrition information	25	28
Clinical signs observed on farm visit	14	9
Necropsy		
3 pigs per farm	26	27
2 pigs per farm	2	1
1 pig per farm	0	2
0 pigs per farm	0	3[a]
Data collection frequency		
Weekly	3	1
Monthly	9	6
Yearly	3	5
Per complete nursery fill	4	3
Production data estimated by producer	6	9
Production data not available	3	9

[a] Researchers were not allowed on 3 farms for biosecurity reasons and therefore were unable to obtain pigs for necropsy

Production records

Data collected on the movement of pigs into the nursery and on deaths in the nursery barn varied by farm (Table I). Production data were submitted from 25 case herds and 24 control herds. These data were collected by week on 4 farms, by month on 15 farms, by year on 8 farms, and by complete nursery-barn fill on 7 farms. On 15 farms, the data were estimated by the producer from the previous year's nursery statistics. Twelve farms did not submit production data.

Calculation of adjusted 7-wk mortality rate in nursery pigs

An adjusted 7-wk mortality rate was necessary to compare nursery mortality across farms. This was calculated for each farm by dividing the observed number of deaths in the nursery phase by the number of weeks that the pigs were in the nursery and multiplying the result by 7. This conversion assumed a consistent morality rate over the entire nursery period.

Statistical assessment

The simple associations between case and control herd status and management and disease factors were determined by chi-squared tests for qualitative variables and Student's t tests for quantitative variables. Variables significant at $P < 0.15$ were examined in a series of multivariate models with the use of logistic regression. Models examined the association between herd status and a variety of management and disease variables, including biosecurity, management of pigs at weaning and in the nursery barn, nutrition, previous and current clinical disease, and diseases identified by postmortem examination. Models were built by backward elimination: after

Table II. Production data for the nurseries

Variable	Case herds (n = 28) Mean (standard deviation)	4th quartile	1st quartile	Control herds (n = 33) Mean (standard deviation)	4th quartile	1st quartile
Sow herd size	720 (482)[a]	760	442	543 (258)[b]	670	350
Sows in system filling the nursery	4806 (4564)[a]	5600	1625	3535 (1884)[b]	6000	1600
Time in nursery barn (wk)	6.8 (1.5)	7.1	6.0	7.3 (2.4)	9.0	5.5
Pigs "light" at weaning (%)	10.1 (9.1)	10.0	4.0	7.9 (8.0)	11.3	2.0
"Poor-doers" at weaning (%)	3.7 (5.0)[a]	4.0	1.5	1.7 (1.7)[b]	2.0	0.5
7-wk mortality rate (%)[c]	4.6[d]	6.3	1.8	2.1[e]	2.3	0.8

[a,b] Values differ significantly at $P < 0.01$

[c] Calculated reliably for only 24 case and 24 control herds

[d,e] Values differ significantly at P = 0.00003

removing the variable with the highest P-value, the model was recalculated, and this procedure was repeated until all factors left in the model were statistically significant at $P < 0.10$.

Results

Production data and 7-wk mortality rate

Case herd size was larger than control herd size ($P < 0.01$), as measured by the number of sows providing pigs to the nursery barn (Table II). The time nursery pigs spent in the barn did not differ by herd status. The adjusted 7-wk mortality was much higher in case herds (4.6%) than in control herds (2.1%) (P = 0.00003). Case herds also had more poor-doers (3.7%) than control herds (1.7%) at the end of the nursery fill ($P < 0.01$). Pigs that were poor-doers on the day of weaning were euthanized by one-third of the producers and moved to the nursery by approximately two-thirds regardless of herd status.

Biosecurity

Compared with the control farms, the case farms used more sows to fill the nurseries (P = 0.02), had more swine farms within a 3.2-km radius (P = 0.01), and were less likely to have a shower-in facility (P = 0.05) (Table III). The mean number (and standard deviation) of swine farms within a 3.2-km radius of the study herds was 4.1 ± 4.4 and 1.1 ± 1.7 for the case and control herds, respectively. Shower facilities were provided by 68% of the case farms and 82% of the control farms. Protective boots and coveralls were provided on 96% and 89% of the case farms and on 94% and 90% of the control farms, respectively. In most of the case and control farms (79% and 70%, respectively) dead stock was picked up by a rendering truck at the end of the lane. Artificial insemination was used by all but 2 case and 2 control herds.

Managing pigs in the farrowing barn

Most farrowing-room practices were similar in the case and control herds, including the average number of farrowing rooms per farm, the average ages at which iron and antibiotics were administered to piglets, and the average age at which piglets were castrated. All herds cross-fostered pigs, and almost all of the farrowing rooms were cleaned and disinfected after weaning.

There was no difference in the age of weaning for case herds (19.5 ± 2.0 d) and control herds (19.2 ± 2.5 d). On average, 50% of both case and control herds weaned pigs between 18 and 21 d of age and did not wean pigs younger than 16 d old. Compared with control farms, case farms tolerated a lower minimum weaning weight target (4.1 ± 1.0 versus 4.6 ± 1.1 kg; P = 0.005) and a higher maximum weaning age (25.3 ± 2.5 versus 22.11 ± 2.6 d; P = 0.01) (Table III). Case herds were more likely than control herds to put pigs from multiple farrowing rooms into 1 nursery pen (86% versus 46%; P = 0.004), less likely to sort pigs by sex (43% versus 64%; P = 0.05), and more likely to use a sick pen in the nursery barn (86% versus 58%; P = 0.002).

Nursery facility design and space allowance

The case and control farms were very similar in nursery facility design. Most facilities had either metal or plastic slats, and none had bedding. Single- or double-nipple waterers were most popular, and only about 26% of all herds used bowl drinkers. There was no difference in the proportion of case and control herds that used floor feeding, wet–dry feeders, or chlorinated water. Control herds tended to allow more space per pig (0.28 ± 0.08 m^2) than case herds (0.25 ± 0.09 m^2) ($P < 0.10$). Both case and control herds allowed approximately 5 feeder spaces per pen, 5 pigs per feeder space, 1.5 waterers per pen, and 17 pigs per waterer. There was no difference between case and control herds in the size of pens, the average number of pigs per pen (approximately 22), or the maximum number of pigs per pen.

Management of the nursery

Most of the case and control herds used all-in, all-out management in nursery rooms. Nursery rooms were filled ("all in") in 20 of the 28 case herds (71%) and in 23 of the 33 control herds (70%). The average age at which pigs left the nursery did not differ between the case and control herds (67.4 ± 10.8 d and 69.3 ± 18.1 d, respectively), but the average weight of pigs leaving the nursery tended to be greater for control herds (13.4 ± 4.9 kg) than for case herds (11.7 ± 3.9 kg) ($P < 0.10$). Feeding boards and electrolytes were routinely used in about one-third of both case and control herds. Most case and control herds did not routinely receive gruel feeding. Approximately half of both case and control herds received medication in water or by injection when required. Case herds had a higher nursery-barn mortality rate (4.6% versus 2.1%) and more poor-doers at the end of the

Table III. Biosecurity factors associated with low, uniform nursery-barn mortality (control herds) compared with high or variable nursery-barn mortality (case herds)

Factor for control herds	*P*-value	Odds ratio
Biosecurity		
Fewer sows filling nursery	0.02	0.99
Fewer swine herds within 3.2-km radius	0.01	0.65
Shower-in facilities more likely	0.05	4.90
Farrowing-room management		
Higher minimum weight at weaning	0.005	3.10
Lower maximum weaning age	0.01	0.67
Pigs from multiple farrowing rooms in 1 nursery pen less likely	0.004	0.11
Sorting by sex in nursery pens more likely	0.05	2.70
Sick pen in nursery barn less likely	0.002	0.14
Nursery-barn management		
Fewer poor-doers at end of nursery phase	0.01	0.59
Light pigs less likely to be placed in another nursery room with younger pigs	0.04	0.24
Nursery nutrition		
Spray-dried plasma in 1st nursery ration more likely	0.02	13.40
Spray-dried plasma in 2nd nursery ration more likely	0.07	4.58
Older when switched from 2nd to 3rd ration	0.03	1.19
Disease status: less likely to be positive for		
Porcine circovirus type 2 (PCV-2)	0.07	0.30
Mycoplasma hyopneumonia	0.008	0.19
Escherichia coli K88	0.04	0.24
Among 3 poor-doers undergoing necropsy during the study: less likely for 1 or more pigs to have		
Positive PCR results for PRRSV	0.03	0.27
Positive PCR results for PCV-2	0.03	0.24
Coughing	0.009	0.13
Pallor	0.05	0.001
Diarrhea	0.05	0.001

PCR — polymerase chain reaction; PRRSV — *Porcine reproductive and respiratory syndrome virus*

nursery fill (3.7 ± 5.0%) than control herds (1.7% ± 1.7%) (Table II). Although the proportion of light pigs at the end of the nursery fill did not differ, case herds (32%) were more likely than control herds ($P = 0.04$) to put light pigs into other nursery rooms with younger pigs when a nursery room was being emptied (13%) (Table III).

Nutrition of nursery pigs

For the 1st, 2nd, and 3rd nursery rations, there was no difference in the proportions of case and control herds that received a complete feed, a ration mixed on the farm, or a pelleted ration or in the proportion that received specific in-feed antibiotics, nor were there dietary differences in the proportions of protein, lysine, or energy content between the case and control herds (data not shown). The 1st nursery ration was less likely to contain spray-dried plasma in the case herds than in the control herds (61% versus 97%; $P = 0.02$), as was the 2nd ration (13% versus 34%; $P = 0.07$) (Table III). Pigs in the case herds were younger than pigs in the control herds (29.0 ± 4.9 d versus 38.8 ± 12.7 d; $P = 0.03$) when switched from the 2nd to the 3rd nursery ration.

Disease status of the herd

Producers reported an increase in the culling rate for nursery pigs during the 12 mo before the study in 18% of all herds. Five case herds (18%) and 2 control herds (6%) also had an increase in mortality rate in the 90 d before the farm visit. On the basis of clinical signs, laboratory data, and investment in routine vaccination protocols, case herds had more problems than control herds with *M. hyopneumoniae* ($P = 0.008$) and *E. coli* K88 ($P = 0.04$) and tended to have more problems with PCV-2 ($P = 0.07$) (Table III). Clinical signs of *M. hyopneumonia* infection were seen in nursery pigs in 61% of the case herds but only 25% of the control herds. Vaccination against *M. hyopneumoniae* was used in 4% of the case herds but none of the control herds. Postweaning diarrhea due to *E. coli* K88 was seen in 50% of the case herds and 22% of the control herds. Of the 28 case herds, 19 (68%) were PRRSV-positive, compared with 14 (42%) of the 33 control herds. Vaccination of weaned pigs against PRRSV was currently being used in 36% of the case herds but only 15% of the control herds. Two of the case herd producers believed, on the basis of observed clinical signs, that PMWS had occurred in their herds before the study, but this diagnosis had not been confirmed by a veterinarian or a diagnostic laboratory. None of the control herd producers believed that their herds had had clinical signs of PMWS.

Review of the records of laboratory submissions from the participating farms for the 12 mo before the farm visit revealed that PCV-2 had been identified in a pig in 71% of the case herds and 46% of the control herds. The necropsy results for the 3 poor-doers that underwent necropsy during the study may be a better measure of the clinical problems in the study farms. On the basis of those results, case herds were more likely than control herds to have at least 1 pig test positive for PRRSV by PCR (18% versus 10%; $P = 0.03$), were more likely to have 1 pig test positive for PCV-2 by PCR (41% versus 7%; $P = 0.03$), and were more likely to have at least 1 pig with clinical signs of coughing (33% versus 10%; $P = 0.009$).

Veterinary and diagnostic laboratory service

In the 12 mo before the study, case herds had fewer veterinary herd visits (3.6 ± 1 visits) than control herds (6.1 ± 2 visits) ($P < 0.01$) and tended to have more veterinary diagnostic laboratory submissions (7.1 ± 2) than control herds (6.1 ± 2) ($P < 0.1$). In addition, a higher proportion of the case herds than of the control herds had more than 6 laboratory submissions (18% versus 3%; $P < 0.05$).

Discussion

This study illustrates the host–agent–environment triad that leads to production losses in swine units (15,16). Problems on pig farms are typically due to multiple factors. Disease, mixing and moving of pigs, nutrition, housing, and personnel all affect the success of a swine unit. Each of these factors interacts to affect the productivity of the farm. Often factors that are important are clustered by farm.

In our study, we found that case farms used more sows to fill the nurseries, had more farms within a 3.2-km radius, and were less likely to have a shower-in facility. Although there are few diseases that travel through the air, proximity to other swine facilities increases the chance of disease spread by rodents, birds, and fomites (17). However, showering will remove viruses and bacteria from the face, hair, and hands of individuals and ensures that people change boots and coveralls (18,19). It also produces a "mind-set" whereby visitors to a farm are more aware of biosecurity issues.

Weaning is a critical time in the lives of pigs. They no longer have the benefit of milk antibodies, their circulating level of colostral antibodies is declining, they are mixed and moved, and they have to learn how to eat solid food (20,21). When compared with control herds, the case herds in our study had a lower minimum weight at weaning and a higher maximum weaning age, had pigs from multiple farrowing rooms in 1 nursery pen, were less likely to have been sorted by sex, and were more likely to have a sick pen.

Lightweight piglets of a given age have a difficult time eating solid feed at weaning (20,22) and are more likely to die from starvation or because they succumb to disease in the nursery unit. A uniform age at weaning is preferable to a wide range of ages: it is easier to target the correct feed and environmental temperature, and the levels of colostral antibodies are more closely matched, resulting in fewer outbreaks of disease. Mixing pigs from multiple farrowing rooms likely leads to more disease spread. The probability of a successful nursery fill increases as the number of sources decreases.

It is not clear from this study why sorting pigs into pens by sex affects nursery performance. However, split-sex feeding is thought to be a more advanced management technique and therefore may be a surrogate measure of other good management practices. Similarly, the fact that the case herds were more likely to have pigs in a sick pen may not be an indication of causation but, rather, a consequence of having more sick pigs.

Case herds had a higher proportion of poor-doers at the end of the nursery fill. This is important information because it removes the speculation that the mortality rate in case herds is simply due to greater culling of poor-doers and validates the original classification of the farms by the veterinarian. Although the term "poor-doer" may be somewhat subjective, we can be confident in our classification of case and control herds considering that there were more poor-doers in the case herds. Case-herd producers were more likely to put lightweight pigs into another nursery room with younger pigs when a room was being emptied. Lightweight pigs in this study appeared to be a significant source of infection for the pigs in another nursery room. In particular, pigs infected with PRRSV can shed the virus for 60 to 90 d after infection (23). Alternative management of these individuals, to avoid intercohort pathogen transfer, includes euthanasia, movement to the grower barn in spite of weight, or housing in an opportunity barn (a separate facility, geographically removed from all other pigs).

Case herds were less likely than control herds to have spray-dried plasma in the 1st nursery ration and tended to be less likely to have it in the 2nd ration. Spray-dried plasma is a highly digestible form of protein for newly weaned pigs (24–26). It also has the potential to provide some immunoglobulins at the level of the intestinal mucosa. Pigs fed spray-dried plasma are expected to grow better in the first few weeks of the nursery phase, have a smaller postweaning slump, and be able to resist diarrhea more easily than pigs not fed spray-dried plasma. The early nursery rations are very expensive, so producers may try to reduce the amount required for the pigs. However, pigs in the case herds were switched from 2nd to the 3rd ration at an earlier average age than pigs in the control herds. This may have resulted in nutritional stress. Our results suggest that restricting spray-dried plasma in nursery rations may not save on the cost of production, as the practice is associated with an increased mortality rate for the nursery pigs.

Compared with the control herds, the case herds were more likely to be positive for *M. hyopneumoniae* infection, to have current or historical clinical problems with the disease, and to be vaccinated against the disease (27). With the introduction of viral diseases, such as those caused by PCV-2 and PRRSV, *Mycoplasma hyopneumoniae* infection appears to be an important disease in all major swine-producing countries.

A cause of diarrhea and sudden death in nursery pigs, *E. coli* K88 tends to be resistant to most antimicrobials (28,29). Case herds were experiencing more disease associated with *E. coli* K88 in both nursing and nursery pigs than were control herds.

Identification of PCV-2 by PCR was more frequent among the laboratory submissions from case herds than of those from control herds (71% versus 46%). This virus also tended to be associated with more current clinical problems in the nursery pigs of case farms compared with control farms. Circovirus can cause clinical signs of disease on its own. However, when pigs are infected with this virus and other disease agents, the clinical signs of PCV-2 infection and of the other diseases are magnified (2,3). This study indicates that PCV-2, together with other disease agents, is contributing to problems in the case herds. The considerably higher rate of identification of PCV-2 infection in the laboratory submissions from the case herds may be due a higher prevalence in the case herds or the fact that more samples were submitted to the diagnostic laboratory from the case herds than from the control herds. Indeed, in the previous 12 mo, 5 case herds but only 1 control herd had more than 6 laboratory submissions. Only 2 of the 28 case herds and none of the 33 control herds had experienced PMWS. The diagnoses for the 2 case herds were made by the producers on the basis of observed clinical signs. However, during the study, 1 case herd experiencing clinical problems in the nursery was identified as PMWS-positive and had a positive circovirus PCR result.

Case herds had more laboratory diagnoses of PRRSV infection (by PCR analysis) than control herds, both among the pigs undergoing necropsy and the laboratory submissions: 68% of the case herds and 42% of the control herds were PRRSV-positive, but none used PRRS vaccine in nursing or nursery pigs. Hence, PRRS may be causing about the same amount of difficulty in case and control herds.

Case herds had more pigs with coughing, pallor, and diarrhea than control herds. Considering that case herds had more laboratory identifications of *M. hyopneumoniae*, PRRSV, PCV-2, and *E. coli* K88 than control herds, these clinical differences would be expected.

In many pig-producing countries in the world, PCV-2 and associated clinical syndromes have been reported (4–11). In the field, PMWS has been associated with PCV-2 infection in conjunction with other diseases (6,8) or poor management conditions, or both (30). This study provides little evidence that circovirus is a major primary pathogen in nursery pigs in Manitoba. It appears to be widespread and can be found in herds that are not experiencing clinical signs of PMWS. This has been observed in other parts of Canada and in other countries (3,7,31). The conclusion of this observational study is that multiple disease agents, in concert with poor management decisions, are responsible for mortality rates in nursery pigs that are higher than acceptable.

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