Acute *Mycoplasma hyopneumoniae* infection in a naive breed-to-wean herd

Tom Gillespie, DVM, DABVP; Oliver Gomez Duran, DVM, PhD, DECPHM, MRCVS

Summary

Mycoplasma hyopneumoniae (MHP) infection occurs globally and contributes to economic losses. Acute infections occur in immunologically naive populations affecting pigs of all ages and causing clinical signs including fever, coughing, acute respiratory distress, and death. An acute MHP infection was investigated in a naive 4200-sow breed-to-wean herd. An increase in sow mortality (4.16%, 8.33%, and 3.89%) and preweaning mortality (10.45%, 12.38%, and 12.06%) occurred when comparing the naive, acute infection, and post-infection periods, respectively. Further production differences included 166.3, 158.3, and 164.2 kg weaned/sow/year and 29.43, 28.35, and 28.28 pigs weaned/mated female/year in naive, acute infection, and post-infection periods, respectively.

Keywords: swine, naive sows, production loss, *Mycoplasma hyopneumoniae*

Received: July 19, 2021
Accepted: February 2, 2022

Resumen - Infección aguda por Mycoplasma hyopneumoniae en una piara libre desde la cría hasta el destete de los lechones

La infección por *Mycoplasma hyopneumoniae* (MHP) se presenta en todo el mundo y produce pérdidas económicas. La infección aguda ocurre en poblaciones inmunológicamente libres y afecta a cerdos de todas las edades causando signos clínicos que incluyen fiebre, tos, dificultad respiratoria aguda, y muerte. Se investigó una infección aguda por MHP en una piara de 4200 cerdas libres desde el pie de cría hasta los cerdos que iban a ser destetados. Hubo un aumento en la mortalidad de cerdas (4.16%, 8.33%, y 3.89%) y mortalidad de lechones antes del destete (10.45%, 12.38%, y 12.06%) cuando se compararon los períodos antes de la infección, durante la infección aguda, y post infección, respectivamente. Otras diferencias de producción incluyeron 166.3, 158.3, y 164.2 kg destetados/cerda/año y 29.43, 28.35, y 22.8 lechones destetados/hembra inseminada/año en los períodos antes de la infección, durante la infección aguda, y post infección, respectivamente.

Résumé - Infection aiguë à Mycoplasma hyopneumoniae dans un troupeau naïf de type saillie-au-sevrage

L'infection à *Mycoplasma hyopneumoniae* (MHP) se produit dans le monde entier et contribue à des pertes économiques. Des infections aiguës surviennent dans des populations immunologiquement naïves affectant des porcs de tous âges et provoquant des signes cliniques tels que fièvre, toux, détresse respiratoire aiguë, et mort. Une infection aiguë à MHP a été étudiée dans un troupeau naïf de 4200 truies de type saillie-au-sevrage. Une augmentation de la mortalité des truies (4.16%, 8.33%, et 3.89%) et de la mortalité avant le sevrage (10.45%, 12.38%, et 12.06%) s'est produite lors de la comparaison des périodes naïve, d'infection aiguë, et post-infection, respectivement. D'autres différences de production comprenaient 166.3, 158.3, et 164.2 kg sevrés/truie/an et 29.43, 28.35, et 28.28 porcs sevrés/femelles accouplées/an dans les périodes naïves, aiguës, et post-infectieuses, respectivement.

Mycoplasma hyopneumoniae (MHP) is the primary pathogen of enzootic pneumonia, and a dynamic component of the syndrome labeled porcine respiratory disease complex.[1] The dynamics of MHP infection are becoming better known by practitioners as improved diagnostic methods are used in determining the infectious state of animals.[2-5] An examination of the Infection Chain (Boehringer Ingelheim Vetmedica, Inc) in endemically MHP-infected populations revealed both horizontal and vertical spread of MHP.[3] Longitudinal studies within the downstream flow of MHP-endemic sow herds have shown detection of the same MHP strain in offspring illustrating vertical transmission.[6] The best way to control MHP within a sow herd is elimination,[7,8] improving the economic potential of the offspring during the finishing phase.[7]

A common practice of introducing naive replacement gilts or gilts of mixed immune status into an MHP-positive sow herd promotes horizontal transmission and an endemically infected population.[1-3] The spread of MHP is insidious, sporadic, and continuous with a persistent cough, although asymptomatic infection in a breeding herd has also been described.[4] The duration of an infection in convalescent carriers has been shown to be around 200 days post infection with clearance of MHP infection in less than 254 days.[5]

Mycoplasma hyopneumoniae is commonly introduced directly into a naive population by contact with infected animals.[1] However, airborne detection of MHP near and within sites with active infection demonstrates that transmission

TG: Performance Health, PC, Battle Ground, Indiana.

OGD: Boehringer-Ingelheim Vetmedica GmbH, Ingelheim, Germany.

Corresponding author: Dr Tom Gillespie, 2989 Jaydin Drive, Battle Ground, IN 47978; Tel: 219-866-2645; Email: **tom.gillespie3@gmail.com**.

Supplementary materials available at **https://doi.org/10.54846/jshap/1279suppl1**.

Gillespie T, Gomez Duran O. Acute *Mycoplasma hyopneumoniae* infection in a naive breed-to-wean herd. *J Swine Health Prod*. 2022;30(5):298-307. **https://doi.org/10.54846/jshap/1279**

does occur by aerosol over short distances.[9-11] Air samples containing infectious MHP have been detected as far as 9.2 km from an infected site.[12] Other routes of pathogen introduction into herds, including contaminated personnel and fomites, have been suspected but not conclusively proven.[13]

Epidemic infections occur when MHP enters an immunologically naive population affecting pigs of all ages. Acutely infected animals present a combination of clinical signs including fever, coughing, acute respiratory distress, and even death.[1] Information on an acute infection in a naive population, especially in pregnant sows, and the impact of MHP infection on performance is limited.[14] This case report documents the clinical characteristics of an acute MHP infection, along with performance parameters in a naive breed-to-wean herd with an on-site gilt development unit (GDU) by comparing the naive, acute infection, and post-infection periods.

Animal care and use

All animals in this study and all procedures were performed in accordance with the swine production and welfare policy of the production system. The farm was Pork Quality Assurance Plus certified and followed the animal care criteria of the National Pork Board's standards.

Case description

Farm history

The acute MPH infection occurred on a 4200-head breed-to-wean farm (unit 1) with an on-site GDU in the Eastern Hog Belt of the United States. The closest swine unit was a 1900-sow sister site (unit 2), which was part of the same production system and located 2.9 km to the southwest. The unit 1 site was remodeled from a 600-head single-site unit in 2008 after a complete herd repopulation allowing the site to be empty for several months over winter. The site was repopulated with MHP- and porcine reproductive and respiratory syndrome virus (PRRSV)-naive animals in early 2009. The sources of the replacement animals were monitored monthly by means of 15 (MHP) and 30 (PRRSV) serum samples for serology by enzyme-linked immunosorbent assay (ELISA; IDEXX PRRS X3 Ab Test and IDEXX M hyo Ab Test) and polymerase chain reaction (PCR; Thermo Fisher Scientific VetMAX NA and EU PRRSV 1.0 kit). The same monitoring program was implemented after placement into the remodeled facility and continued until the acute MPH infection occurred. An on-site GDU in a nonattached building consisting of 2 nursery rooms and 5 finisher rooms was permitted for a closed-herd approach for replacement animal production after repopulation. The first repopulated sows farrowed in June 2009. Monthly clinical observations included, but were not limited to, coughing, fever, off-feed events, mortality, and production performance parameters in addition to the serologic monitoring. If an unusual clinical event occurred, then additional diagnostic tests were performed. This clinical monitoring program continued after the repopulation until the acute MPH infection occurred.

Diagnostic investigation of the MHP infection

In 2016, 2 MHP-positive (sample to positive [S/P] ratio of 0.877 and 0.441 with a positive cutoff ≥ 0.4) and 2 MHP-suspect (S/P ratio of 0.324 and 0.347) samples were detected using an ELISA from 15 samples collected during routine serologic sampling of sows in gestation on week 51 (Table 1). Thirty samples were collected for PRRSV detection, and all samples were negative by ELISA. The results of the confirmatory test (Oxoid Mycoplasma hyopnuemoniae DAKO ELISA kit) on the 4 MHP-positive and -suspect samples were negative (Table 1). Since no clinical signs were present, no further diagnostic work was performed.

Routine profiling of 30 animals (approximately 5 months of age) located in the on-site GDU was performed during week 3, 2017, and all results were MHP negative. After receiving these diagnostic results, the first clinical sign observed was coughing by sows in the farrowing room. An aggressive diagnostic investigation was launched early in week 4, 2017. Thirty laryngeal swabs, 10 nasal swabs, and 30 blood samples from parity 0 to parity 8 sows were taken throughout the site including in the farrowing and gestation barns. The selection of animals was random, although some coughing sows and nearby non-coughing sows were sampled. The investigation included real-time PCR detection tests for influenza A virus (IAV), PRRSV, and MHP. The results for IAV and PRRSV were negative. The results confirmed that clinical symptoms were due to an acute MHP infection (Table 2).

A second sampling was performed early in week 5, 2017. Environmental samples, laryngeal swabs from clinical adult animals, and nasal swabs from coughing near-to-wean aged piglets were collected. Three of nine piglet nasal swabs were MHP positive by PCR testing (cycle threshold [Ct] values = 36.83; 34.09; and 35.4). An environmental swab of a cell phone tested MHP suspect by PCR (Ct = 39.0). Other environmental swabs from farrowing crates, office equipment, ultrasound machine, feed cart, and boots of two different employees all tested MHP negative. Laryngeal swabs were collected from 17 adult animals that were showing clinical signs including, but not limited to, coughing, off feed, and fever > 39.5°C. The samples were submitted to the University of Minnesota Veterinary Diagnostic Laboratory for MHP detection via PCR and sequencing. Sixteen of the laryngeal swabs were MHP positive (Table 3). The complete P146 adhesion-like gene from MHP was sequenced from 5 of the submitted samples. The acute respiratory infection in the formerly naive herd was confirmed to be caused by MHP.

Clinical symptoms and treatment therapies

During week 3, 2017, sows started coughing in farrowing rooms with nursing piglets that were 12 to 18 days of age. Initially only sows presented with a cough, but by 2 weeks post infection, an occasional piglet near weaning age presented with a dry cough. The starting incidence rate was 6% to 12.5% (2 to 4 adults per 32 farrowing crates) and increased within 3 weeks post infection to approximately 33% (9 to 12 adults per 32 farrowing crates). The incidence rate of sows with a fever paralleled that of coughing sows. Rectal temperatures of clinically affected sows ranged from 39.5°C to 40.5°C and persisted for several days. During the acute outbreak, the number of sows off feed or with reduced feed intake varied from 5% to over 20%. The variation was due to how MHP spread throughout the site and the number of newly infected animals each day. The off-feed events in sows were segregated into 2 groups. One group of sows presented with a high fever and very little, if any, feed consumed for days; the second group had a low fever and was back to normal feed consumption within days. Most off-feed sows had a feed intake reduction of 50% or more within a day of presenting with a fever. Sows of all parities were equally

Table 1: Serologic sampling results for *Mycoplasma hyopneumoniae* during week 51, 2016

Animal ID	S/P (Result)*	OD, % (Result)†
6272	0.877 (Pos)	82.621 (Neg)
3682	0.441 (Pos)	82.292 (Neg)
7229	0.149 (Neg)	NT
6337	0.123 (Neg)	NT
4627	0.159 (Neg)	NT
3658	0.149 (Neg)	NT
6361	0.073 (Neg)	NT
7173	0.008 (Neg)	NT
7334	0.324 (Sus)	83.361 (Neg)
8004	0.178 (Neg)	NT
5245	0.031 (Neg)	NT
3777	0.102 (Neg)	NT
7318	0.128 (Neg)	NT
4441	0.347 (Sus)	91.283 (Neg)
6403	0.055 (Neg)	NT

* Samples tested using IDEXX M hyo Ab Test. An S/P ratio ≥ 0.4 was considered positive and an S/P ratio between ≥ 0.3 and < 0.4 was considered suspect.

† Samples tested using Oxoid ELISA MHP. Samples with an OD ≥ 65% was considered negative.

S/P = sample to positive ratio; OD = optical density; NT = not tested.

affected. Medical intervention therapies consisting of an antibiotic, steroid (Predef 2x; Zoetis), and flunixin meglumine (Banamine-S; Merck Animal Health Intervet) resulted in clinical improvements in off-feed and febrile animals. The health effects from MHP were most severe in the 10-week period post infection, although the clinical signs in the farrowing rooms continued for 16 weeks post infection. The number of sows expressing severe clinical signs (high fever and long-duration anorexia) during the infection period created the need to mass medicate 6 farrowing rooms with tetracycline (Pennchlor 64; Pharmgate Animal Health) via the water for control of *Pasteurella multocida* and other susceptible bacteria. The severely affected sows also presented with either agalactia or hypogalactia in addition to reduced feed intake. The mass therapy approach in farrowing rooms allowed farm workers to focus on supplemental piglet feeding and care to save as many piglets as possible. Individual sow treatments were the primary therapy used and consisted of injectable lincomycin at 1 mL/27 kg body weight once a day (Lincomix injectable; Zoetis). The severely affected individuals were injected with enrofloxacin at 3.4 mL/45 kg of body weight one time (Baytril; Bayer HealthCare, LLC, Animal Health Division) or tulathromycin at 1 mL/41 kg of body weight one time (Draxxin; Zoetis). Despite the therapies implemented, sow mortality increased during the infection period compared to the naive period. The increase in sow mortality was directly due to the MHP infection, eg, pneumonia, or indirectly from perforated gastric ulcers in off-feed sows as determined by field necropsies and gross appearance.

Piglet mortality was primarily affected by agalactia or hypogalactia in the dam. In severe cases, entire nurse litters were created increasing cross-fostering management dramatically post infection. Cross fostering piglets included an evaluation of the piglet's birth weight. If the birth weight was low (< 1.6 kg), cross fostering was delayed as long as possible (2-3 days). Commercial milk replacer was used to supplement piglets where needed. In some dire situations, piglets were humanely euthanized due to their condition or because nurse sows were not available. Preweaning mortality improved as the number of sick sows decreased.

Farm goals and activities to maximize MHP immunity

After confirmation of an acute MHP infection, the first goal for this production site was to minimize production losses. A second goal was to establish that 90% or more of the replacement and adult animals were exposed to MHP before a herd elimination process could begin, which is commonly called Day 0. The decision to use natural exposure to infect the entire gilt and adult populations meant that all animals were tested, with some being tested more than once to determine if the goal to have over 90% positive/exposed animals was achieved. A complete timeline of events from when clinical signs were first documented until the end of the elimination program is shown in Table 4. Because the farm produced its own replacement animals, the farm's animal movements were altered to achieve "closure" by not retaining any replacement females until after MHP elimination. When a site is closed, replacement animals no longer enter into the site for breeding purposes allowing for exposure to occur in the remaining animals within the site and avoiding continuous introduction of animals with a different immune status. The elimination program activities started once ≥ 90% exposure level was achieved in all replacement females in the GDU and adult animals in the sow unit using both serology and PCR on laryngeal swabs. To achieve the desired exposure level, natural exposure occurred by placing coughing animals next to asymptomatic animals. The same exposure procedure was implemented in the on-site GDU by housing MHP-positive (by PCR) and coughing animals in rooms containing asymptomatic or negative gilts. Eventually, the two youngest nursery rooms in the GDU were moved to an off-site finisher location because the 90% exposure goal could not be reached in a short enough time compared to the rest of the animals. All populations within the site were repeatedly tested using laryngeal swabs for PCR and serum for ELISA to establish the goal of ≥ 90% exposure rate. The exposure program required minimal antibiotic treatments except for severely affected animals. Following herd closure and confirmation of broad MHP exposure in all age populations at

Table 2: Diagnostic results for *Mycoplasma hyopneumoniae* during week 4, 2017 using laryngeal swabs (real-time PCR) and serum (ELISA)

	Serum		Laryngeal swab (pooled)	
Animal ID (parity)	**Result**	**S/P**	**Result**	**Ct40 level**
9632 (0)	Negative	0.06		
9662 (0)	Positive	0.49	Positive	34.37
7067 (3)	Negative	0.08		
4464 (5)	Positive	0.77		
6940 (3)	Suspect	0.36	Positive	29.55
5353 (5)	Positive	0.66		
6303 (4)	Positive	0.78		
4202 (5)	Positive	0.93	Positive	33.92
8082 (2)	Positive	0.67		
5239 (5)	Positive	1.71		
6191 (4)	Positive	2.69	Positive	30.00
5410 (5)	Positive	0.94		
7948 (2)	Positive	1.96		
4296 (6)	Positive	1.86	Positive	35.29
7835 (2)	Positive	0.50		
6654 (3)	Positive	0.47		
6298 (4)	Positive	0.81	Positive	28.94
2598 (8)	Positive	1.33		
7153 (3)	Positive	1.03		
4410 (6)	Positive	0.42	Positive	35.86
5411 (5)	Positive	1.29		
4373 (6)	Positive	0.87		
5981 (4)	Positive	1.85	Positive	36.04
4313 (6)	Positive	1.53		
8806 (1)	Positive	1.47		
5261 (5)	Positive	2.42	Positive	29.65
7885 (2)	Positive	2.00		
8062 (2)	Positive	1.51		
6299 (4)	Negative	0.01	Positive	36.92
3467 (2)	Negative	0.05		

PCR = polymerase chain reaction; ELISA = enzyme-linked immunosorbent assay; S/P = sample to positive ratio; Ct = cycle threshold.

Table 3: Diagnostic results for *Mycoplasma hyopneumoniae* during week 5, 2017

Sample ID/Location	Results	Ct40 level
Laryngeal swab*		
4448	Positive	35.03
7683	Positive	28.52
8909	Positive	31.48
6438	Positive	36.24
7174	Positive	28.41
6201	Positive	32.13
6062	Positive	27.84
7253	Positive	28.26
7989	Positive	29.94
5537	Suspect	37.4
7915	Positive	26.18
8327	Positive	35.95
6236	Positive	28.46
8506	Positive	27.03
8883	Positive	23.18
8856	Positive	28.48
6360	Positive	26.53
Nasal swab†		
1	Negative	-
2	Positive	36.83
3	Negative	-
4	Negative	-
5	Suspect	37.7
6	Negative	-
7	Positive	34.09
8	Negative	-
9	Positive	35.4

this site, the herd was mass vaccinated with a commercial MHP vaccine (Respi-Sure; Zoetis) three times (18, 22, and 30 weeks following confirmation of acute infection). The multiple vaccination approach might be considered excessive; however, this program was used to maximize immunization in the entire population to promote reduction of MHP transmission. Successful MHP elimination was documented by testing sentinel animals post entry (starting week 12, 2018) using both laryngeal swabs and serum tests (Table 4).

Post-infection impact on sow and suckling piglet productivity

Sow performance records were entered into Minitab statistical process control (SPC) charts (Minitab V19.0; Minitab, Inc) for a period of 23 weeks when the farm was MHP naive (week 31, 2016 - week 2, 2017), for 13 weeks during the acute infection (week 3-15, 2017), and for another 13 weeks post infection (week 16-28, 2017).[15] The 13 weeks post infection was chosen as a period for monitoring the MHP health program for a potential relapse. Mean values of these production parameters during naive, acute infection, and post infection phases were analyzed using the before-after control charts of Minitab. A marked increase of the annual sow death rate (4.16% naive, 8.33% acute infection, and 3.89% post infection; Figure 1) and preweaning mortality (10.45% naive, 12.38% acute infection, and 12.06% post infection; Figure 2) from the naive to acute infection period was documented in SPC charts. A difference in kg weaned per sow per year (166.3 naive, 158.3 acute infection, and 164.2 post infection; Figure 3) and pigs weaned per mated female per year (29.43 naive, 28.35 acute infection, and 28.28 post infection; Figure 4) are also illustrated in SPC charts. Both production parameters are arguably important to the economics of a sow herd and can be compounded by the quality of weaned piglets.

Determination of route of introduction of MHP infection

During the outbreak, an in-depth investigation of possible risks for MHP introduction was conducted. Since repopulation in 2009, the farm's written biosecurity policies were reviewed quarterly with key personnel. Unit 2, located 2.9 km southwest of unit 1, had clinical signs suggestive of MHP in late week 46 with diagnostic confirmation of MHP

Table 3: Continued

Sample ID/Location	Results	Ct40 level
Environmental swab‡		
Ultrasound machine	Negative	-
Office	Negative	-
Side	Negative	-
Side	Negative	-
Side	Negative	-
Back gate of farrowing stall	Negative	-
Front gate of farrowing stall	Negative	-
Back gate of farrowing stall	Negative	-
Ultrasound machine	Negative	-
Boots #1	Negative	-
Boots #2	Negative	-
Cell phone	Suspect	39.00
Sort board	Negative	-

* Laryngeal swabs were collected from 17 adult animals showing clinical signs and tested using real-time PCR.

† Nasal swabs were collected from coughing near-to-wean aged piglets.

‡ Environmental swabs were tested using real-time PCR.

Ct = cycle threshold; PCR = polymerase chain reaction.

infection in week 47, 2016 after several years of MHP-naive status. Weather conditions starting week 51, 2016 are illustrated in the supplementary materials (Table S1).

A detailed review of unit 1 biosecurity procedures was conducted and did not find breaches in the protocol. The unit 2 MHP infection confirmed in the weeks preceding this outbreak together with weather conditions conducive to area spread are suspected to be responsible for this outbreak.

Discussion

Reports that describe clinical signs of acute MHP infection in MHP-naive breeding herds are limited in the literature despite 46% of veterinarians reporting experience with outbreaks in sow farms.[14] When MHP is introduced into a naive sow herd, the infection affects all ages of pigs.[1] The production impact of MHP in breeding herds, even in endemically infected herds, is poorly understood, although it is reported to cause increased preweaning mortality and abortions in rare occasions.[14] For this reason, it is important to understand the impact of MHP infection in naive herds. For this case, production losses were caused by increased sow mortality of all parities. Other economic effects were a reduced number of piglets weaned and reduced weaning weights. Examination of the production records using SPC charting did not detect marked variances but did show trends in other production parameters like farrowing, repeat breeding, stillbirths, and mummy rates. While the production records during the acute infection period did not show a significant increase in the number of abortions, the farm manager stated that abortions associated with the outbreak did occur. A small proportion of swine practitioners have reported abortions as a possible outcome of MHP infections in breeding herds.[14]

The main clinical sign observed in this acute MHP infection was coughing, with some individual sows having severe coughing, similar to previous reports.[13] In addition, this outbreak was characterized by febrile sows (≥ 39.5°C), partially or completely off-feed sows, and an increase in mortality despite implementing an aggressive treatment program. Results corroborate findings of a survey of 493 practitioners that reported fever as a typical clinical sign in MHP-infected sows.[14] In the farrowing house, the main problem was sow hypogalactia that resulted in numerous problems for the nursing offspring. Weak piglets at birth were not a major concern. During the infection period, a few litters had smaller than usual piglet birth weights but were not considered weak. In the litters exhibiting weak normal size piglets, the dam was clinically ill presenting with fever and partially or completely off-feed.

Efforts to eliminate MHP in North American herds have increased in recent years with most attempts being successful.[7,8] Natural exposure was used to spread the MHP organism throughout the site after confirmation of the positive diagnostic results. It took 14 weeks from confirmation for MHP to spread throughout the sow site to achieve the goal of 90% or more sows testing positive by laryngeal swabs, serum, or both, which was determined to be critical for successful elimination.[7,8] An additional 6 weeks were needed to confirm the same exposure rate in the replacement gilts housed in the GDU. The two youngest nursery rooms in the GDU were moved off-site to allow for the elimination program to start since these groups were not achieving a ≥ 90% level of exposure. Alternate exposure methods, ie, using herd specific lung homogenate given intratracheally or by fumigation, were considered to shorten the time required to reach a 90% exposure rate.[16] The management decision to use natural exposure instead of lung homogenate was primarily based on concerns it would result in severe clinical disease in far more animals and minimize the risk of entry of another major infection.

The question remains on how MHP entered unit 1. The biocontainment practices were of a high standard and no obvious breaches were detected during the biosecurity audit. In addition, farm staff were not allowed to move between units reducing the likelihood of people being carriers of MHP.[13,17] Other authors have agreed that the source of an MHP infection can be hard to determine.[12,16,17] The short time between the acute infection in unit 2 and the subsequent infection in unit 1 supports the hypothesis of possible aerosol transmission. This hypothesis is further supported by the finding of genetically identical MHP strains in both production sites.[6] Favourable weather conditions (cold, low wind speed, and high humidity) gives additional support to probable aerosol transmission from

Table 4: *Mycoplasma hyopneumoniae* (MHP) elimination timeline on a 4200-head breed-to-wean farm (2017-2018)

Calendar week	Project week	Description
3	-21	First suspicious serological evidence and coughing in lactating sows.
4	-20	Diagnostic confirmation of MHP in the sow herd.
18	-6	Exposure and confirmation in GDU started.
24	0	Exposure considered complete - start 36 weeks of immunity.
27	0	Exposure confirmed by diagnostics. Lots 10, 11, and 12 in GDU finisher was 100% serologically positive on ELISA. Lots 14 and 15 were not used for replacement but finished off site.
42	18	First whole-herd MHP vaccination of sow herd and GDUs.
46	22	Second whole-herd MHP vaccination of sow herd and GDUs.
49	25	Breed project started breeding gilts 15 wks prior to wk 7, when "sentinel" replacements could enter the sow herd.
52 to 2	30	Third whole-herd MHP vaccination of sow herd and MHP-positive replacements.
3	31	Veterinarian visit to sow farm to collect 60 laryngeal samples (30 in youngest replacements at sow farm and 30 in quarantine).
4 to 8	32-36	Period of additional antimicrobial usage to supplement the elimination of possible remaining MHP organisms.
4 to 7	32	Began Pulmotil (tilmicosin) administration in sow feed in both gestation (363 g/ton) and lactation (21 d at 181g/ton). End Pulmotil feed 8 wk, 2018.
4 to 7	32	Injected piglets with Draxxin (tulathromycin) at 1 and 10 d of age (25mg/mL, 0.25 mL IM at birth and 0.5 mL at 10 d of age]. End Draxxin 8 wk, 2018.
4	32	Piglets weaned early, maximum wean age was 18 d.
7	35	Off-site bred replacement females entered the sow herd and were used as sentinels on future samplings.
8	36	Immunity considered complete and shedding stopped.
8	36	First piglets born assumed to be MHP negative.
8	36	Selected potential replacement gilts were weaned from sow herd and entered the on-site GDU.
11	39	Began introduction of the outsourced MHP-negative sentinels into isolation at the sow herd. Entry may be delayed for added confidence. Time in quarantine was > 3 wks.
11	39	Began weaning at normal age.
11	39	Began monitoring phase of project - sentinels and weaned pig flow.
12	40	Normal replacement gilts used as sentinels entered sow herd.

GDU = gilt development unit; IM = intramuscular.

Figure 1: Statistical process control chart of sow mortality by each 13-week health status and calendar week. Sow mortality rate significantly increased during the acute infection period contributing to the cost of disease. UCL = upper control limit; CL = center line; LCL = lower control limit.

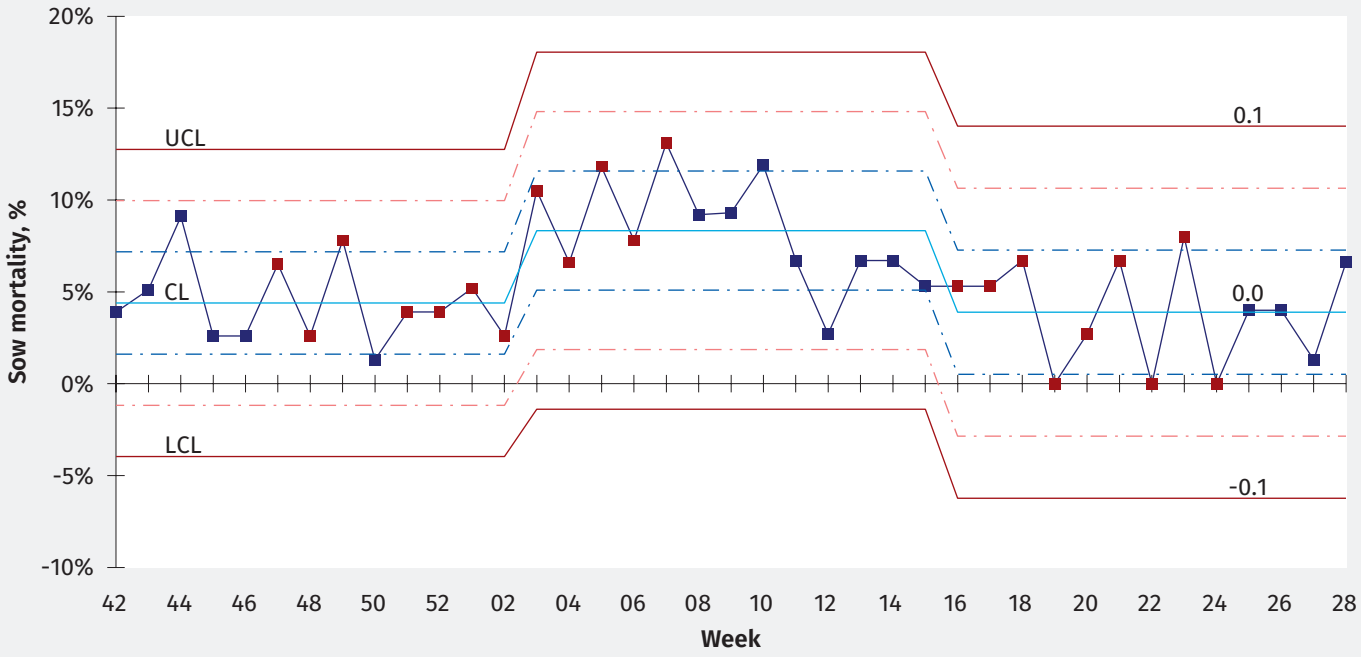
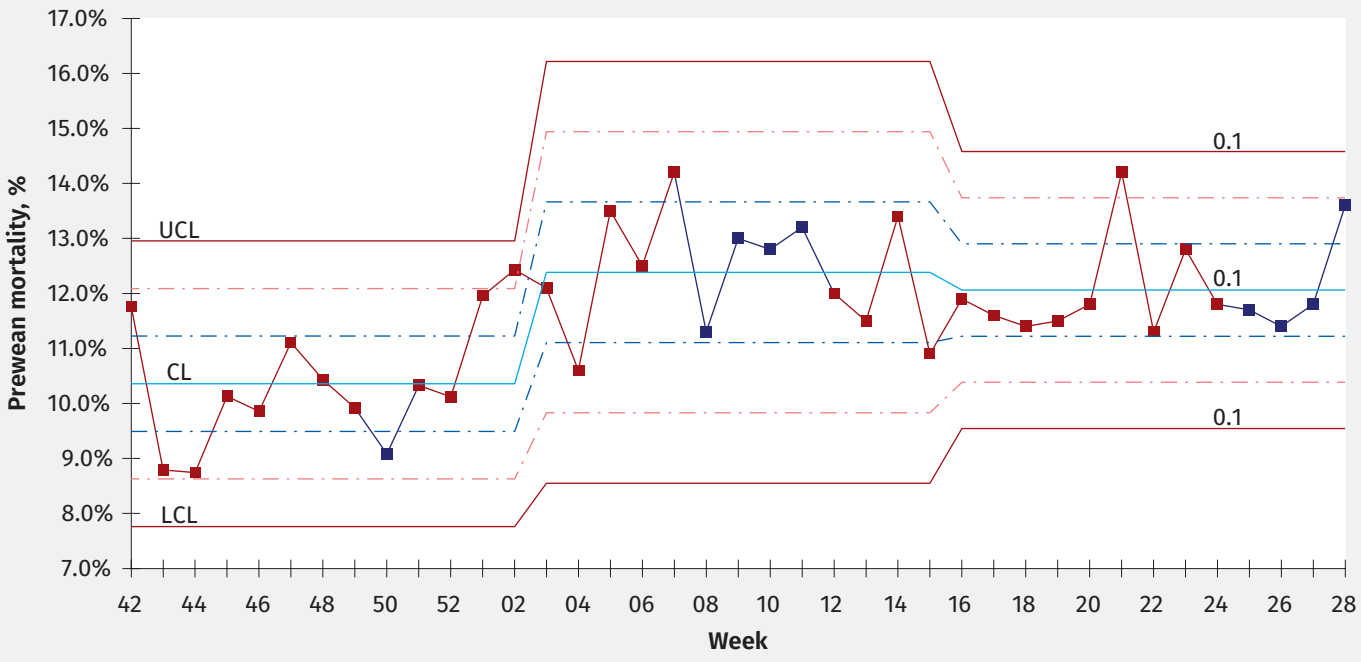


Figure 2: Statistical process control chart of preweaning mortality by each 13-week health status and calendar week. Preweaning mortality rate increased during the acute infection period contributing to reduced number of piglets weaned. UCL = upper control limit; CL = center line; LCL = lower control limit.



unit 2. The hypothesis is supported by previous reports in the literature of aerosol transmission.[9-12]

Determining if weather conditions are conducive to aerosol transmission is difficult using standard weather reports since the information provided are daily maximum, average, and minimum. During a study of long-range detection of airborne MHP, data indicated that the odds of detecting MHP in a long-distance air sample increased by 46%, 80%, and 200% with each unit increase in mean barometric pressure, minimum temperature, and maximum gust velocity, respectively.[12] The maximum relative humidity during the 4-week period in this case clearly shows most days were near or equal to 100%. Likewise, the average relative humidity during the same time was near or over 90% on several days. Slow wind speed is another factor that could influence aerosol transmission. Data for daily sun hours was not available for analysis.

Even though practitioners have dealt with MHP infections in naive sow herds for years, more case reports need to be documented. In this outbreak, production losses occurred in sow mortality, reduction in the number of piglets weaned, and reduced weaning weights. This case report illustrates clinical responses in adult and neonatal animals, and timelines that practitioners might consider when discussing acute MHP infection and elimination procedures with their clients.

Implications

Under the conditions of this study:

- Clinical outcomes of MHP infection in naive breeding herds were confirmed.
- Production impacts of MHP in breeding herds are underestimated.
- Reliable methods of rapid MHP exposure are needed.

Acknowledgments

The authors would like to acknowledge the help and support of Drs Jer Geiger and Maria Clavijo for their professional direction on sampling numbers and techniques, pitfalls, and other disease challenges that could happen in achieving a successful elimination. Thank you to the farm personnel and management team for their constant support in collecting samples for diagnostics. In addition, thank you to the staff at Rensselaer Swine Services, PC for their help in processing and preparing all samples for delivery to the proper laboratory.

Conflict of interest

Gomez Duran is an employee of Boehringer Ingelheim Vetmedica GmbH.

Disclaimer

Scientific manuscripts published in the *Journal of Swine Health and Production* are peer reviewed. However, information on medications, feed, and management techniques may be specific to the research or commercial situation presented in the manuscript. It is the responsibility of the reader to use information responsibly and in accordance with the rules and regulations governing research or the practice of veterinary medicine in their country or region.

References

1. Pieters MG, Maes D. Mycoplasmosis. In: Zimmerman JJ, Karriker LA, Ramirez A, Schwartz KJ, Stevenson GW, Zhang J, eds. *Diseases of Swine*. 11th ed. Wiley-Blackwell; 2019:863-883. **https://doi.org/10.1002/9781119350927.ch56**

2. Fano E, Pijoan C, Dee S. Dynamics and persistence of *Mycoplasma hyopneumoniae* infection in pigs. *Can J Vet Res*. 2005;69(3):223-228.

3. Oh Y, Baek J, Lee J, Cho SH, Park C. The first assessment to detect *Mycoplasma hyopneumoniae* by sampling laryngeal swabs to investigate sow stability in South Korea. *BMC Vet Res*. 2020;16(1):452. **https://doi.org/10.1186/s12917-020-02663-2**

Figure 3: Statistical process control chart of weight of piglets weaned per sow by each 13-week health status and calendar week. Weaning weight reduction during the acute infection period illustrated the challenges of infection to both sows and piglets in farrowing. UCL = upper control limit; CL = center line; LCL = lower control limit.

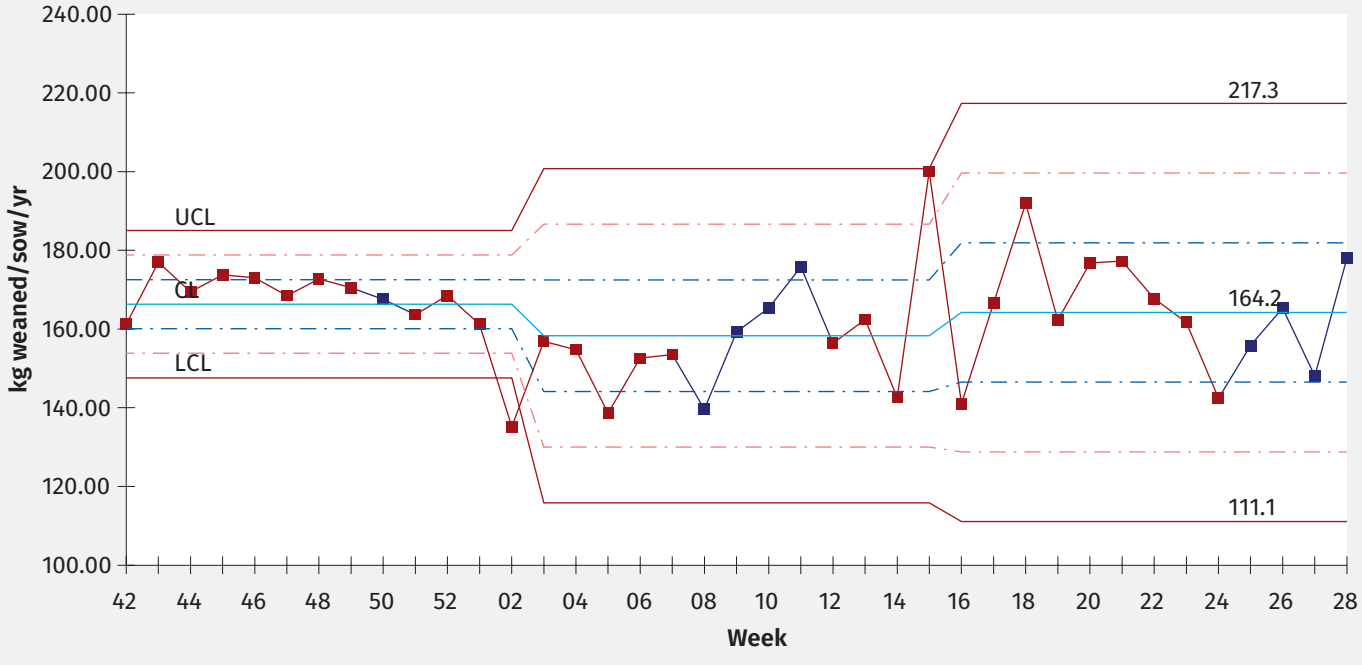
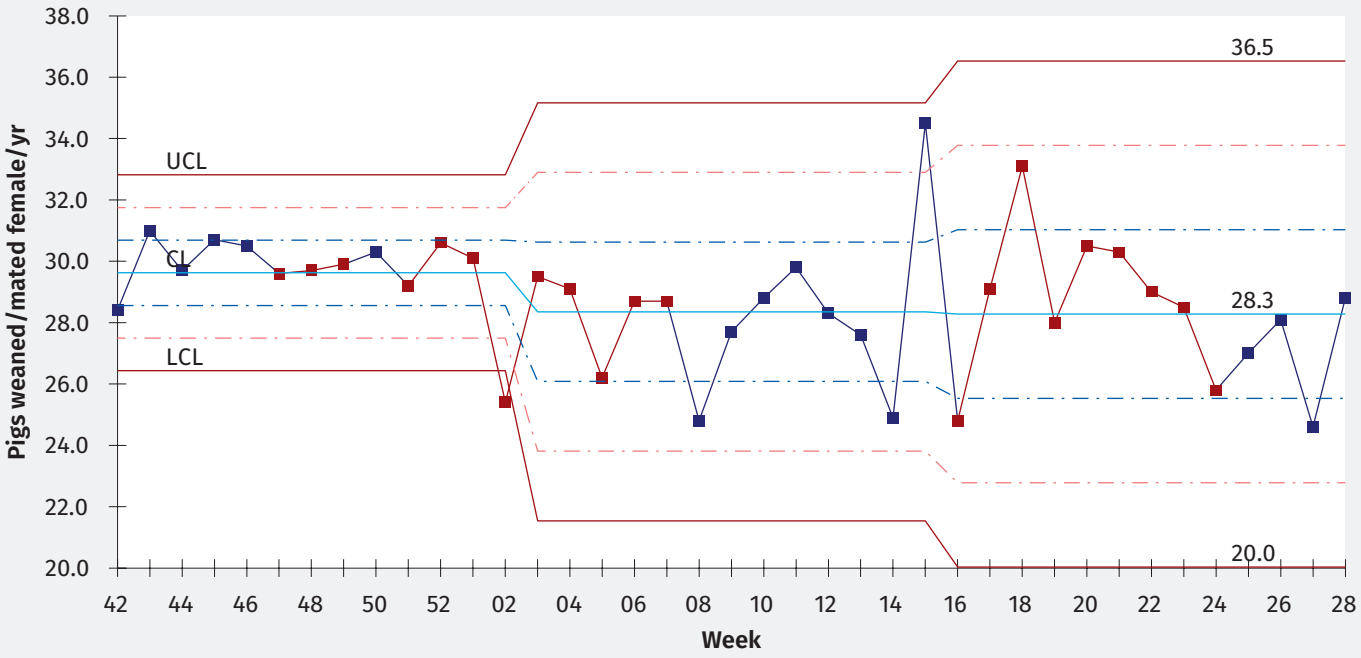


Figure 4: Statistical process control chart of pigs weaned per mated female per year by each 13-week health status and calendar week. UCL = upper control limit; CL = center line; LCL = lower control limit.



4. Vangroenweghe F, Willems E, Malášek J, Thas O, Maes D. Use of trachea-bronchial swab qPCR testing to confirm Mycoplasma hyopneumoniae seropositivity in an SPF breeding herd. *Porcine Health Manag.* 2018;4:12. **https://doi.org/10.1186/s40813-018-0088-3**

5. Pieters M, Pijoan C, Fano E, Dee S. An assessment of the duration of *Mycoplasma hyopneumoniae* infection in an experimentally infected population of pigs. *Vet Microbiol.* 2009;134(3-4):261-266. **https://doi.org/10.1016/j.vetmic.2008.08.016**

6. Mayor D, Zeeh F, Frey J, Kuhnert P. Diversity of *Mycoplasma hyopneumoniae* in pig farms revealed by direct molecular typing of clinical material. *Vet Res.* 2007:38:391-398. **https://doi.org/10.1051/vetres:2007006**

*7. Pieters M, Torremorell T, Pijoan C. Controlling *Mycoplasma hyopneumoniae*: Good to great strategies. In: *"Backseat" Respiratory Diseases Preconference Seminar.* American Association of Swine Veterinarians; 2007:9-10.

8. Silva GS, Yeske P, Morrison RB, Linhares DCL. Benefit-cost analysis to estimate the payback time and the economic value of two *Mycoplasma hyopneumoniae* elimination methods in breeding herds. *Prev Vet Med*. 2019;168:95-102. **https://doi.org/10.1016/j.prevetmed.2019.04.008**

9. Fano E, Pijoan C, Dee S. Evaluation of the aerosol transmission of a mixed infection of *Mycoplasma hyopneumoniae* and porcine reproductive and respiratory syndrome virus. *Vet Rec.* 2005:157(4):105-108. **https://doi.org/10.1136/vr.157.4.105**

10. Browne C, Loeffler A, Holt HR, Chang YM, Lloyd DH, Nevel A. Low temperature and dust favor in vitro survival of *Mycoplasma hyopneumoniae*: Time to revisit indirect transmission in pig housing. *Lett Appl Microbiol*. 2017;64:2-7. **https://doi.org/10.1111/lam.12689**

11. Stärk KD, Nicolet J, Frey J. Detection of *Mycoplasma hyopneumoniae* by air sampling with a nested PCR assay. *Appl Environ Microbiol.* 1998;64(2):543-548. **https://doi.org/10.1128/AEM.64.2.543-548.1998**

12. Otake S, Dee S, Corzo C, Oliveira S, Deen J. Long-distance airborne transport of infectious PRRSV and *Mycoplasma hyopneumoniae* from a swine population infected with multiple viral variants. *Vet Microbiol.* 2010;145(3-4):198-208. **https://doi.org/10.1016/j.vetmic.2010.03.028**

13. Batista L, Pijoan C, Ruiz A, Utrera V, Dee S. Assessment of transmission of *Mycoplasma hyopneumoniae* by personnel. *J Swine Health Prod.* 2004;12(2):75-77.

*14. Schagemann G, Duran OG. Survey of *Mycoplasma hyopneumoniae* clinical symptoms and vaccination in sows. *Proc IPVS.* International Pig Veterinary Society; 2020:295.

15. Wheeler DJ. The first principle of understanding data. In: Wheeler DJ, ed. *Understanding variation; The key to managing chaos*. 2nd ed. SPC Press; 2000:12-14.

16. Robbins RC, Betlach AM, Mondragon-Evans MR, Peters M. Development of a herd-specific lung homogenate for exposure to *Mycoplasma hyopneumoniae* under field conditions. *J Swine Health Prod.* 2019;27(4):221-227.

17. Nathues H, Woeste H, Doehring S, Fahrion AS, Doherr MG, grosse Beilage E. Detection of *Mycoplasma hyopneumoniae* in nasal swabs sampled from pig farmers. *Vet Rec*. 2012;170(24):623. **https://doi.org/10.1136/vr.100817**

*Non-refereed references.