Case Report Rapport de cas

A case of tail-biting on a multi-site swine operation in Ontario

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Abstract — This case study describes a severe tail-biting event on a multi-site swine operation in Ontario and outlines the management strategies implemented in an attempt to control the problem. An established social order was clearly present before the tail-biting event occurred. Over 40% of tail-docked pigs in 3 of 8 grower-finisher barns were severely affected, leading to higher mortality and increased numbers of pigs re-housed in hospital pens. Environmental factors, management practices, and animal health in the barns experiencing the tail-biting event are described, including detection of the mycotoxin deoxynivalenol in corn at > 2 ppm. Changes implemented in response to tail-biting included altering the phase-feeding schedule, adding enrichment devices, and increasing surveillance. The subsequent cohort of pigs was followed through the finisher barns and did not engage in the same severity or prevalence of tail-biting as the previous cohort of pigs which experienced the tail-biting event.

Key clinical message:
No single factor was identified as the initiating cause for the severe tail-biting event. The subsequent cohort of pigs in 4 barns of the same operation were monitored for tail-biting from entry until market, and the incidence of tail-biting was very low.

Résumé — Un cas de caudophagie dans une exploitation porcine à sites multiples en Ontario. Cette étude de cas décrit un cas grave de caudophagie dans une exploitation porcine à sites multiples en Ontario et décrit les stratégies de gestion mises en œuvre pour tenter de limiter le problème. Un ordre social établi était clairement présent avant que l'événement de mordillage de queue ne se produise. Plus de 40 % des porcs à la queue coupée dans trois des huit élevages de type croissance-finition ont été gravement touchés, ce qui a entraîné une mortalité plus élevée et un nombre accru de porcs relogés dans des enclos hospitaliers. Les facteurs environnementaux, les pratiques de gestion et la santé animale dans les porcheries où sévissaient la caudophagie sont décrits, y compris la détection de la mycotoxine désoxynivalénol dans le maïs à > 2 ppm. Les changements mis en œuvre en réponse à la caudophagie comprenaient la modification du calendrier d'alimentation par phases, l'ajout de dispositifs d'enrichissement et l'augmentation de la surveillance. La cohorte suivante de porcs a été suivie dans les porcheries de finition et n'a pas eu la même gravité ou prévalence de caudophagie que la cohorte précédente de porcs qui ont subi l'événement de caudophagie.

Message clinique clé :
Aucun facteur unique n'a été identifié comme la cause initiale de l'événement grave de caudophagie. La cohorte suivante de porcs dans quatre porcheries de la même exploitation a été surveillée pour la caudophagie depuis l'entrée jusqu'au marché, et l'incidence de la caudophagie était très faible.

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Case description

The present case involved a 750-sow, farrow-to-finish multi-site swine operation in Ontario that experienced a severe tail-biting event (TBE) in the summer of 2019. Three of the swine operation's 8 grower-finisher barns (F1, F2, F3), all located within 30 km of each other, were affected by the sudden onset of tail-biting (TB). All 8 grower-finisher barns used all-in/all-out pig flow, had fully-slatted cement flooring and each was filled over a 2-week period with tail docked pigs. The same management procedures and pig genetics were used to produce grower-finisher pigs for the entire production system. One of the 3 affected grower-finisher barns (F1) housed 680 pigs, whereas the other 2 affected barns (F2 and F3) each housed approximately 1000 pigs. Pigs entered the grower-finisher barns at roughly 25 kg body weight and at about 70 days-of-age and remained in the barn for approximately 120 d, until they reached 130 kg body weight. The pigs housed in F1, F2, and F3 were moved into the respective barns in May and June 2019 (Cohort 1). The severe TBE occurred in August and September 2019 when pigs were approximately 100 to 160 days-of-age and weighed 50 kg or more. The 3 affected barns averaged 25 pigs/pen with stocking density ranging between 0.73 m^2/pig and 0.81 m^2/pig which was in accordance with the Canadian Code of Practice minimum space allowance for finisher pigs weighing 40 to 130 kg housed on slatted floors of 0.39 to 0.86 m^2/pig (1). Barn F1 had natural ventilation, barn F2 had negative-pressure mechanical ventilation, and barn F3 used fans to augment natural ventilation, when necessary. All barns used artificial lighting while the stockperson was performing daily tasks, whereas other light sources included natural light provided by the ventilation curtains in barns F1 and F3 and windows in barn F2. In August and September of 2019, TB became widespread throughout the F1, F2, and F3 barns, with a minimum of 40% of pigs in each barn exhibiting tail damage, and at least half of these affected pigs had severe wounds (defined as open wounds, actively bleeding and with a loss of greater than 50% of docked tail length). The all-cause mortality was 85/2680 (3.17%) collectively in barns F1, F2, and F3, whereas mortality attributed to TB represented 20/85 (23.5%) of deaths. The swine operation routinely tested feed for nutrients and anti-nutritional factors, such as mycotoxins. This was the case for corn harvested on-farm and fed to all finisher barns in May–June 2019, prior to the TBE. The mycotoxin, deoxynivalenol (DON), concentration of the corn grown on the farm was measured as 2.3 to 2.7 ppm, which exceeds the maximum tolerated level of 1.0 ppm for pigs (2). Interestingly, the same feed ration, including the corn grown on-farm, was fed in all 8 finisher barns, with no sign of TB reported in 5 of the 8 grower-finisher barns. The design of the feeders in all barns, including F1, F2, and F3, were wet/dry (dry mash feed with water nipples in the feed troughs), with 3 pig spaces per feeder and 1 feeder per pen. Feed was provided *ad libitum.* Water access included 2 waterers located inside each feeder. As well, there was 1 drinking bowl or nipple drinker in each pen, with water meter readings and water usage measured daily. No feed or water disruptions had been experienced in the months leading up to the TBE. As per standard operating procedure, the same barn staff conducted daily animal health inspections, including walking the length of each grower-finisher barn and ascertaining that feed and water were accessible in each pen. The sow herd was vaccinated annually with a modified live vaccine for porcine reproductive and respiratory syndrome. Pigs were vaccinated against porcine circovirus type 2 and *Mycoplasma hyopneumoniae* (Circo/Mycogard; Pharmgate Animal Health, Erin, Ontario) between 2 and 4 d of age, and were vaccinated against porcine circovirus, *M. hyopneumoniae,* and *Lawsonia intracellularis* (Porcilis ileitis; Merck Animal Health, Omaha, Nebraska, USA) at weaning. Health records were maintained and included information such as injuries, treatments, and observations of pig behavior throughout the finishing period.

Prevention strategies for TB including docking all pigs' tails to half of the original length with an electric tail docker in the first week of life and housing pigs in single-sex pens during the finishing phase were routinely used. Intervention methods for the TBE included: altering the phase feeding schedule to allow higher protein content in the feed of older pigs, identifying, and separating the affected animals from conspecifics, and using hospital pen(s) in F1, F2, and F3 for recovery of affected animals. The standard operating procedure was to feed a 5-phase diet through the grower-finisher phase; however, due to the TBE, the fifth phase was replaced by phase-4 diet in order to maintain a higher protein content than standard practice originally dictated. Pigs with severe tail wounds were treated intramuscularly with procaine penicillin (Vet Pen 300, 300 000 IU/mL; Rafter 8, Calgary, Alberta), 1 mL/20 kg BW and isoflupredone acetate (Predef2x, 2 mg/mL; Zoetis Canada, Kirkland, Quebec), 1 mL/28 kg BW once daily for 3 d, and if necessary, were placed in a hospital pen. Removing the injured pigs worked well as an intervention method because it allowed increased monitoring of the injured pigs and resulted in less competition for resources within the pen. However, the hospital pens in each barn reached maximum capacity during the TBE and injured pigs became too numerous to be accommodated. Severe cases of pigs with bitten tails were euthanized. In all pens experiencing a TBE, staff attempted to identify the biter during the daily animal health inspections by observing the pigs for biting behavior. When a biter pig was identified it was removed from the affected pen. Identification of the biter pig(s) led to difficulties, as several pigs in each pen were observed to be biting and alternative housing quickly became limited.

An investigation as to what factor(s) may have triggered the severe TBE in the 3 grower-finisher barns in this multi-site swine system was undertaken following a checklist presented in Table 1. The checklist was derived from a scoping review performed at the time of the case investigation (3). However, the pigs involved in the TBE were in the final stages of production which created difficulties for determining a possible cause. Possible causal factors included high environmental temperatures outside the barns, leading to high internal barn temperatures; greater than the maximum tolerated level of DON (2) in the corn; and a lack of enrichment in pens. However, only F1, F2, and F3 experienced the severe TBE, whereas the other 5 grower-finisher barns, which experienced the same weather events, were fed diets made with farm-grown corn, and had similar stocking

Table 1. Considerations for determining risk factors and possible causes of tail-biting on-farm.

Considerations	Yes	No
Have you experienced tail-biting previously?		
• At a similar severity?		
• At the same age?		
• At what time of year?		
Did pigs enter the finisher barns with tail lesions?		
• If yes, a thorough investigation of the nursery barns should be undertaken		
Do pigs have optimal access to resources?		
• Feed (palatable and enough feeder spaces)		
• Water (water pressure, water quality, placement of drinkers)		
• Lying space		
• Dunging space		
What is the temperature in the barn, in the pens, and at floor/pig level?		
• Are there drafts?		
• Is there air movement for optimal air quality?		
Is there further evidence of pig discomfort?		
• Sharp edges		
• Poor flooring quality		
• Stray voltage		
What lighting program is being used in the barn?		
• Does the lighting program allow for normal circadian rhythm?		
What genetic line are the pigs from?		
• Are the pigs from a new genetic line?		
Is the stocking density appropriate?		
• At the beginning of the finishing stage?		
• During the finishing stage?		
• As pigs reach market weight?		
Is there mixing of pigs and disruption of the social order within pens?		
• At what frequency?		
Are pigs segregated based on sex?		
Is tail-docking a normal practice on-farm?		
• Is the length of the docked tail appropriate?		
• Are the tails a consistent length?		
Is there enrichment in the pens?		
• What is the enrichment; is it species-relevant?		
• Is the enrichment regularly added to or changed?		
• When was the enrichment supplied?		
Have nutrient deficiencies been found, or addressed?		
• Anti-nutritional factors		
• Amino acid balances (tryptophan content?)		
• Salt		
Other: Loud noises, mechanical failures, new staff, illness in the barns		

density and pen design, did not have a TBE. The unaffected barns all followed the same management, feeding, and housing protocols as the 3 affected barns.

The primary author (MH) conducted visits from November 2019 to March 2020 to observe the subsequent cohort of grower-finisher pigs (Cohort 2) to record observations regarding stocking density, the presence or absence of enrichment devices, and housing specifics, such as flooring, feed systems, temperature, and ventilation in 4 of the system's finishing barns, including the original F1, F2, and F3 barns. No severe TBE occurred during Cohort 2. Management practices remained consistent from Cohort 1 to Cohort 2; however, corn from the farm's 2019 harvest was used in the diet in Cohort 2, and the levels of DON were lower than the farm's 2018 corn crop and below the maximum tolerated levels (2). Temperatures inside the barns during Cohort 1 averaged between 28°C and 19°C, whereas outdoor temperatures averaged between 25°C and 12°C (4). During Cohort 2, temperatures within the barns averaged between 22.5°C and 18°C, whereas outdoor temperatures averaged between 7°C and −8°C (4). The optimal temperature for finisher pigs (55 to 110 kg) is 18°C (1). No humidity readings were available from the TBE; however, no recent ventilation failures had been reported. Ventilation systems within each barn varied; F1 was naturally ventilated, F3 was dual-ventilated, and F2 and F4 were mechanically ventilated. Artificial lighting was used during the day, while necessary tasks within the barn were being performed; however, dark periods existed overnight allowing a minimum of 11 h of darkness each day. Prior to the arrival of Cohort 2 pigs, air inlets in F2 were converted from a counterweight to an air actuator to achieve a more controlled environment. All-cause mortality for Cohort 2 was 112/3820 (2.93%) in barns F1–F4, whereas mortality attributed to TB was 4/112 (3.57%).

Discussion

The 40% prevalence and severity of tail-biting leading to deaths of pigs illustrates the animal welfare and economic importance of an outbreak of TB in a grower-finisher barn. The widespread nature of the outbreak in the 3 affected barns is typical of the problem (5). Accurately recording prevalence of TB on farms is difficult, as the abnormal behavior is multifactorial (6). Studies have attempted to record the prevalence of TB using observations at abattoirs, as a simplified and cost-effective strategy. Data from Irish abattoirs demonstrated that 72.5% (7) and 58.1% (8) of tail-docked pigs had mild TB lesions, whereas a Danish study reported on average, 13 to 15% of undocked pigs had tail damage (9). Studies have cautioned using abattoir data as a prevalence benchmark, as the amount of tail damage at the abattoir underestimates the level on farm, especially in instances of severe TB (9,10).

The case illustrates the difficulty of controlling an outbreak. Due to the variable time interval between pre-injury and the injury stage, which can be as short as 24 h (11), it can be difficult for farmers to detect a TB problem before it has increased to an outbreak level. There is evidence that pigs become more active in the immediate days leading up to a TBE (12), and that pigs demonstrate tail-tucking behavior (12,13) and lowered tails (13) prior to a TB outbreak as well. Initially, injured pigs from the affected barns could be removed from their pens, but with large numbers of pigs affected in severe cases such as this, a re-homing approach becomes impractical. Likewise, identification of a "biter" pig and removing that pig from the original pen, becomes impractical when multiple pens are involved and multiple pigs per pen are identified as aggressors. This emphasizes the importance of understanding why certain behaviors and environmental stressors may lead to an outbreak of TB (12).

The most common advice regarding control of TB is to emphasize prevention, due to the decreased animal health and welfare, as well as the negative impact on an economic return (14). Prevention includes avoiding stressors such as cold or hot environments, overcrowding, and inadequate resources including feeders and drinkers. In this case there were no obvious deficiencies in housing or environment. The barns in which TBE occurred were populated with pigs that were relatively small compared to other barns in the system in which pigs were approaching market weight and would clearly be more crowded as a result. The TBE did occur during hot weather which has been noted as a contributing factor (15,16), and temperatures both inside and outside of the barn were higher during Cohort 1 than in Cohort 2. Mechanical ventilation has been associated with increased levels of TB; however, in this case, TB was a challenge in barns with different ventilation systems, thus ruling out ventilation as a significant variable in TB for F1, F2, and F3 barns. Air quality was measured subjectively, as the primary author did not experience any irritation or poor air quality within the barns. It can be difficult to efficiently monitor pigs for possible signs of TB behavior, as some outbreaks can occur in the absence of these predictive stressors or behaviors (12), highlighting why prevention practices are prescribed.

One of the most common strategies used to prevent TB is to surgically shorten the tails of piglets during the first week of life. Tail-docking has been proven to be a useful method of reducing the likelihood of TB occurring at an older age (6,17). Docked tails are shorter and therefore less of a target, but it is also thought that docked tails are more sensitive and a pig is less tolerant of exploratory mouthing of the shortened tail (6). Like almost all Ontario swine herds, the farm in this case was docking tails and yet a severe outbreak of TB occurred in barns F1, F2, and F3. There is pressure from animal welfare groups to discontinue the practice of tail-docking, as has been done in the European Union (18). The fact that tail-docking is not always effective (8), as in this case, is one criticism; in addition, there is concern that the procedure itself results in pain; therefore, under the Canadian Code of Practice for the Care and Handling of Pigs (1), there is a requirement to use analgesia when pigs are tail-docked.

Another strategy to prevent TB is to segregate sexes. Gilts are believed to instigate more tail damage to barrows when they are housed in mixed-sex pens (19,20). The producer in the current case was using single-sex pens in both affected and unaffected barns; however, the sex of the victims and instigators of the TBE was not recorded. The prevention methods of single-sex pens and tail-docking are not absolute, as the producer involved in this case study was employing both management strategies before the TBE began.

Natural rooting behavior and exploration are innate for all pigs, regardless of the rearing facility, and when rooting material is unavailable, this may contribute to the expression of TB behavior (21,22). Straw has been demonstrated to be the most effective prevention method against TB (1,6,11,17,22). The inclusion of straw in small quantities every day can redirect a pig's attention from tails to the rooting material (11,19,20) and the addition of straw may discourage boredom (21). All finishing barns on this case farm had fully slatted floors with liquid manure systems, which are incompatible with the use of straw due to possible blockages (1,11). Point source enrichments, in the form of chains, were not present in F1, F2, or F3 barns in the summer of 2019 (Cohort 1) when the TBE first occurred but were added to many pens and were present in the subsequent cohorts. The introduction of enrichment devices for the pigs prior to Cohort 2 may have helped prevent TB in the second cohort.

No consensus exists on which type of feed delivery system and feed type (liquid, pellet, or wet/dry) promotes the lowest levels of TB on a commercial farm (6,17). Optimal trough space depends on several management and housing factors, yet it has been suggested that allowing more than 20% of the pigs to feed simultaneously may decrease TB occurrences (6). On average, F1, F2, and F3 feeding troughs allowed 12% of pigs to eat together. Feeding is a social activity for pigs and increased competition at the feeder has been shown to increase frustration which can lead to TB behavior (6). Water access areas at the feeders and the wall-mounted drinkers did not exhibit water quality issues, or water delivery issues before or during the TBE. No feed or water disruptions had been experienced in any of the barns in the months before the TBE. Protein content in the feed is an important component of the finisher pig's diet, and inadequate protein levels have been implicated in TB (23,24) possibly due to the microbiota-gut-brain-axis, as reviewed by Kobek-Kjeldager *et al* (25). The usual diet composition schedule was altered when the TBE began, and pigs were fed Phase 4 until market weight rather than switching to the lower protein Phase 5 diet. Displeasure with the diet, due to inadequate amino acids and protein or poor palatability may increase an animal's frustration and foraging, and this behavior has been demonstrated to lead to TB (26,27). The presence of mycotoxin in the feed may have increased stress in the pigs housed in F1, F2, and F3, leading to TB occurrences, as reviewed by Nordgreen *et al* (28). However, only 3 of the 8 finishing barns were affected and yet the same corn source was used to create the feed for all 8 barns.

Mycotoxins are compounds produced by several fungal species that can be detrimental to the health of all production species and pigs are more susceptible than other livestock (29). The genus *Fusarium* produces numerous mycotoxins, including DON, which has been listed as the most prevalent mycotoxin to infect cereal grains (30). In the case of DON, the maximum tolerated level for pigs is considered to be 1.0 ppm (2). The 2018 corn harvest in Ontario recorded high levels of DON (31), and the corn grown on the case farm was measured at a DON concentration $>$ 2 ppm. The most common clinical sign associated with DON is feed refusal. Consumption of feed containing DON can cause damage to enteric cells, resulting in nutrient malabsorption as well as impaired immune function. Accurate testing is difficult, and total contamination levels of DON may be under-represented in the diet, as various other forms of mycotoxins may be present (28,32). Synergistic interactions are also possible for different mycotoxins, leading to increased adverse effects, even when test values for each specific mycotoxin are within the recommended levels (33). Mycotoxins are not evenly distributed in a silo of corn, and it is possible that corn being fed to F1, F2, or F3 barns could have different DON levels than corn sent to another barn in this multi-site swine operation.

Levels of DON in the diet of F1, F2, and F3 for Cohort 1 may have been even higher than the test results; however, samples were not taken separately and so this is unknown. As reviewed by Nordgreen *et al* (28) the literature with respect to the effects of mycotoxins, specifically DON, on abnormal behavior in pigs is sparse, demonstrating the need for studies regarding pig behavior and anti-nutritional factors.

The sporadic nature of TB makes it difficult to understand why producers who excel in animal husbandry and continually achieve industry targets, may experience destructive and abnormal behavior in pigs under their care. Positive human-animal interactions have been shown to increase positive-affective states in pigs (34,35) and are considered to be an additional form of enrichment (1). Competent stock people, as was the case on this farm, are able to identify and address suboptimal conditions within a barn providing an appropriate environment for the pigs (1). Stockmanship was not specifically evaluated in this case, but it was noted that the same staff worked in all 8 barns, although the problem occurred only in 3 barns. The same staff were present in the second cohort and TB did not become a problem.

The cause of TB is the subject of much discussion in both academia and the swine industry and is recognized as a welfare issue around the world. Detrimental economic impact occurs with high levels of TB, due to lower average daily gain, treatment costs, culls, trimming and carcass condemnations (7,8,14). Possible causal factors of TB have been investigated, including the animal's genetics, nutrition, and housing, as well as overall farm management (19). These associations appear to be component causes, as no single factor has been shown to be the catalyst for TB behavior, demonstrating the etiology is multifactorial (12).

In summary, a severe outbreak of TB occurred in 3 of 8 finisher barns which were part of a multi-site swine operation. No triggering factor was clearly identified but the TB occurred at the hottest time of the year and DON contamination of the corn which was included in the feed ration was identified. Steps to control the TBE were only moderately successful; however, a subsequent cohort of pigs placed in the same barns did not experience the problem, demonstrating the sporadic nature of this condition and illustrating the difficulty in predicting outbreaks.

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