

A PRACTICAL APPROACH TO THE ELIMINATION OF SWINE DYSENTERY (*BRACHYSPIRA HYODYSENTERIAE*) FROM SINGLE-SITE, FARROW-TO-FINISH HERDS

*Een praktische benadering van de eliminatie van dysenterie (*Brachyspira hyodysenteriae*) op
gesloten varkensbedrijven*

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ABSTRACT

Swine dysentery is causing severe economic losses in affected herds. In the present study an elimination protocol without depopulation was developed and evaluated on three farrow-to-finish farms using fecal examination. The elimination protocol consisted of stringent rodent control, hygienic measures and an elimination treatment of the sows using tiamulin 10 mg/kg BW or valnemulin 4 mg/kg BW for 3 weeks, followed by a 3 week treatment at half the dose. On day 10 of antimicrobial supplementation, treatment was accompanied by washing of the sows and cleaning of the environment. Once treated and washed according to this protocol, the sows were considered clean. Thus the piglets born from these sows in a clean environment were considered clean and were kept separated from the rest of the piglets and fatteners. For the piglets and fatteners born before the elimination treatment, no elimination treatment was done. Only pigs showing clinical symptoms were treated, in combination with hygienic measures to prevent spreading. Fecal samples from sows and clean pigs were monitored monthly until one year after the start of the treatment program. In two herds, elimination of the disease was successful: no clinical signs were seen and fecal samples remained negative until the end of the testing period. In one herd, clinical symptoms reappeared in the fatteners. The findings of this study confirm the potential usefulness of the elimination protocol described in single-site, farrow-to finish herds. In addition, the results of the prolonged follow-up strongly indicate that the causal bacterium itself, *Brachyspira hyodysenteriae*, can be eliminated at the farm level when this elimination protocol is applied.

SAMENVATTING

Dysenterie veroorzaakt zware economische verliezen op aangetaste varkensbedrijven. In deze studie werd een eliminatieprotocol zonder depopulatie ontwikkeld en geëvalueerd op drie gesloten bedrijven aan de hand van een mestonderzoek. Het eliminatieprotocol bestond uit een strikte knaagdierbestrijding, strikte hygiëne en een eliminatiebehandeling van de zeugen, hetzij via tiamuline 10g/kg LG, hetzij via valnemuline 4 mg/kg LG gedurende drie weken gevolgd door drie weken nabehandeling aan een halve dosis. Op dag 10 van de behandeling werden de zeugen gewassen en de omgeving werd gereinigd. Zeugen die via dit protocol behandeld en gewassen werden, werden als vrij van ziekte aanzien. Bijgevolg werden biggen geboren uit deze zeugen in een gereinigde omgeving, als vrij van ziekte beschouwd en werden gescheiden gehouden van de rest van de biggen en vleesvarkens. Biggen en vleesvarkens ondergingen geen eliminatiebehandeling maar werden enkel behandeld wanneer symptomen optraden en strikte hygiënische maatregelen werden toegepast om verspreiding te voorkomen. Meststalen van zeugen en symptoomvrije vleesvarkens werden maandelijks gecontroleerd tot één jaar na de start van de behandeling. Op twee bedrijven was de eliminatie succesvol: klinische symptomen werden niet meer waargenomen en het mestonderzoek bleef negatief tot het einde van de monitoringperiode. Op een derde bedrijf werden opnieuw symptomen vastgesteld bij vleesvarkens. De gegevens uit deze studie bewijzen het potentiële nut van het voorgestelde eliminatieprotocol op gesloten varkensbedrijven. Daarnaast wijzen de resultaten van de langdurige opvolging erop dat de causale bacterie zelf, *Brachyspira hyodysenteriae*, met dit protocol van het bedrijf geëlimineerd werd.

INTRODUCTION

Swine dysentery, a muco-hemorrhagic colitis in pigs, is caused by the spirochete *Brachyspira hyodysenteriae*. The most obvious symptom is a greyish, watery to hemorrhagic diarrhea, accompanied by acute mortality, most frequently encountered in fattening pigs (Harris *et al.*, 1999). In chronically affected herds, the clinical symptoms may be mild but the economic losses are significant. Next to mortality, the costs of the antimicrobial therapy and especially the decreased growth and poor feed conversion are substantial (Wood and Lysons, 1988). These economic implications have motivated producers and veterinarians to use elimination strategies. To avoid total depopulation, elimination without depopulation has been attempted in programs combining antimicrobial therapy, rodent control and sanitation (Songer and Harris, 1978; Taylor, 1980; Blaha *et al.*, 1986). Although all these protocols are essentially based on the same principles, they differ in their approach and in the kind of antimicrobials used. Three characteristics of the disease are key points for the protocol. Firstly, the long-term survival of *B. hyodysenteriae* in fecal material (for 7 days at 25°C or 61 days at 5°C, Chia and Taylor, 1978) underlines the importance of strict hygiene and the need to avoid any contact of clean pigs with fecal material from infected pigs, either directly or by mechanical carriers such as boots, equipment and pets. Thorough cleaning is important not only in terms of preventing contact with infective fecal material, but also in terms of enhancing the effectiveness of the disinfectants (Corona-Barrera *et al.*, 2004). Secondly, rodents, especially mice, have been identified as important carriers, as they shed the bacteria for up to 180 days (Joens 1980) and are responsible for the reinfection of successive batches (Fellström *et al.*, 2004). Hence, strict rodent control is necessary to prevent reinfection. Thirdly, treatment of the sows should be done with antimicrobials capable of eliminating *B. hyodysenteriae* from the colon, and these antimicrobials must be administered at an adequate dose (Burch *et al.*, 2004). The success rates of these elimination protocols are variable and depend to a large extent on the commitment of the farmer and on the susceptibility of the organism to the antimicrobial (Wood and Lysons, 1988).

The resistance of *B. hyodysenteriae* to several different antimicrobials has been described (Hommeze *et al.*, 1998b; Lobová *et al.*, 2004; Vyt and Hommeze, 2006). In addition, antimicrobial growth promoters that are active against *Brachyspira* species and therefore suppress clinical symptoms, such as salinomycin, are no longer allowed in the EU (since January 1st 2006, Directive 1831/2003 EU). An elimination protocol applicable on single-site farms

was developed using tiamulin or valnemulin. This protocol is aimed at producing dysentery-free piglets that must be separated from older, infected pigs. In the present study, this protocol was applied on three farms and adapted to their individual pig flow.

MATERIALS AND METHODS

Selected farms

The farms were selected on the basis of three criteria. The first was the eagerness of the owner to eliminate the disease and to comply with the presented measures. Secondly, the farm structure was chosen to make disease eradication possible: all-in/all-out management or willingness of the owner to change to this system. Individual housing of sows and the use of slatted floors were also incorporated into the criteria. Thirdly, prior to treatment, rodent control was carried out by a specialized company. All three farms were farrow-to-finish farms with single-site production and had a chronic dysentery problem with continuous (farm B) or intermittent (farms A and C) medication and with failed attempts to eliminate the disease at the farm level (farms A and B). An overview of the farm structure and treatment is presented in Table 1.

On farm A, the pigs were housed in 4 buildings. The feces from the sow building were drained to the slurry pit of a fattening unit. This system was changed prior to treatment in order to prevent the transport of infectious material between buildings. Prior to treatment, the gilts were housed in the sow unit and underwent the same treatment protocol as the sows in order to avoid additional costs for replacement stock. Before sow treatment, the nursery compartments in the sow building were emptied by selling the weaned piglets (24 days) over a period of six weeks, followed by repopulation with clean piglets. Next, the second building was filled with clean pigs. Strict hygiene was applied and an empty compartment buffered between the clean and the infected piglets. Before treatment, the fatteners were moved to other compartments in order to empty the buildings consecutively at slaughter age.

On farm B a teasing boar was kept on straw. In building 3, there was a corridor on one side. The following specific measures were taken prior to onset of the treatment: cleaning of the outside mating area and not using it for at least two months, and the selling of the piglets at 20 kg until two compartments were empty. The infected pigs were then moved towards the compartments close to the loading area, thus creating a one-way pig flow in the third building.

Table 1. Farm structure and elimination treatment on the selected farms.

	Farm A	Farm B	Farm C
Number of sows	130	100	130
Buildings (n)	4	4	2
Use of building	1: sows + NU 2: NU + PU 3, 4: FU	1: mating area 2: gestating sows 3: PU + NU + FU 4: FU	1: sows + PU + NU 2: FU
Replacement gilts	bred on farm	purchased	purchased
Start of treatment	02/2004	05/2004	07/2004
antimicrobial administration	valnemulin in feed	tiamulin individual oral doses	valnemulin in feed

PU: farrowing unit; NU: nursery unit; FU fattening unit

On farm C, compartments were arranged on both sides of a central corridor in both stables. No piglets were sold to create an empty compartment. Instead, nurseries with infected piglets were treated with valnemulin at 2 mg/kg body weight from the moment sow treatment was completed until the last infected piglets left the sow building. In this case, treatment of the piglets was preferred, since the infection of clean sows going to maternity remained a risk factor, even with frequent cleaning of the central corridor. In the building with fattening compartments, a physical barrier in the central pathway was applied. A rest compartment for retarded pigs was emptied, cleaned and used only for clean pigs.

Elimination protocol

The protocol used in this study aims at eliminating the infection from the sow herd and hence producing dysentery-free piglets. After initiation of intensive rodent control, the sows were treated orally with tiamulin 10 mg/kg bodyweight (BW) or valnemulin 4 mg/kg BW for three weeks, followed by a three week treatment with tiamulin 5 mg/kg BW or valnemulin 2 mg/kg BW. On day 10 of antimicrobial administration, all sows were washed and moved to a clean and disinfected area. Preventing contact of washed sows and cages with wash water was done by installing plastic separations within the building and by moving the sows to their new, clean cage on a carpet soaked with disinfectant. The sows in the farrowing rooms at the start of the treatment were washed at weaning and treated for three more weeks at the low dose. The piglets born from the sows that had been treated for three weeks,

washed and moved to a clean farrowing unit were considered clean and kept separated from all other pigs. Keeping the clean compartments as far away as possible from the contaminated compartments and preventing the mechanical transmission of fecal material was done by leaving one or two empty compartments in between and using a mechanical barrier in the corridor. Regular cleaning of common pathways was done, at least when infected pigs or dead pigs passed. Different boots and materials, marked in red or green for infected and clean zones respectively, were used in infected and clean zones. Slaughter pigs were loaded without passing through clean zones. Empty compartments were cleaned and disinfected using a formaldehyde-containing disinfectant and then dried afterwards for at least seven days. Slurry pits were emptied as thoroughly as possible to obtain a slurry level as low as possible. A one-way direction for people from the clean zone to possibly infected areas was applied and visitors and pets were not allowed on the farm. Special attention was paid to hygiene around the loading area and when handling dead pigs.

In addition, therapeutic treatment of infected fatteners born before the sow treatment was initiated once clinical symptoms appeared using tiamulin 5mg/kg.

On all farms the elimination protocol was thoroughly prepared. Schemes for piglet movement were made in advance in order to have a clear idea of occupied and empty compartments, cleaning times and disinfection. The protocol for washing the sows and their environment was prepared in detail and discussed with the authors prior to the start of the treatment program. A list of practical de-

Table 2. Critical measures for the successful elimination of dysentery.

1. Mixing of slurry pits to prevent the survival of rodents on crusts.
2. Removing all cats and dogs (or confining them within one building if they are more efficient as rodent control).
3. Culling a number of sows. Cleaning is impossible in overcrowded buildings.
4. Planning and preparing sow washing with clear instructions to all personnel.
5. Avoiding contacts between animals during the treatment period (mating area, teasing boar, ...).
6. Not using outside areas without cleaned, concrete floor.
7. Cleaning all material: brushes, transport equipment, driving devices, ...
8. Temporarily selling piglets to create time and space for cleaning and physically separating clean from infected animals.
9. Creating physical barriers in alleyways as a constant reminder for all personnel.
10. Constant cleaning of pathways, crossing points and loading areas.
11. Never returning to clean areas when infected zones have been entered (also applicable to occasional visitors).
12. Avoiding the passage of infected pigs or dead pigs in clean zones.

Table 3. Susceptibility of *Brachyspira hyodysenteriae* isolates from farm B (n=1) and C (n=2) and from the reference strains B78 and DC185. S: susceptible; I: intermediately susceptible; R: resistant.

Isolate	Tiamulin		Valnemulin
	MIC ($\mu\text{g/ml}$)	interpretation*	MIC ($\mu\text{g/ml}$)
B	0.06	S	< 0.03
C1	0.125	S	< 0.03
C2	0.06	S	< 0.03
B78	< 0.03	S	< 0.03
DC185	2	I	1

* breakpoints proposed by Ronne and Scanzer, 1990

tails that are important for successful elimination is presented in Table 2.

Diagnosis and Susceptibility testing

On farm A, *B. hyodysenteriae* was diagnosed by PCR (Adiavet[®] Brachy, Labconsult, Brussels) on feces. On farm B (n=1) and C (n=2), fecal culture was performed and isolates were identified biochemically (Hommeze *et al.*, 1998a). The susceptibility of these isolates was determined using the agar dilution method (Hommeze *et al.*, 1998b). *B. hyodysenteriae* B78 ATCC27164^T and the internal control strain *B. hyodysenteriae* DC185 were included as reference strains. In addition, the intestines of rats (n=2) from farm B were tested by bacteriological culture for the presence of *Brachyspira* species.

The susceptibility of the isolates from farms B and C is shown in Table 3. The MIC for the antimicrobial used for elimination was low and within the susceptible range.

Monitoring

Rectal feces from sows (n=10 per farm) were taken at 30, 90, 180, 270 and 360 days after the start of the treatment. Clean piglets and fatteners were sampled similarly at 90, 120 and 150 days (n=5 per farm) and at 180, 210, 240, 270, 300, 330 and 360 days (n=10 per farm) after the onset of sow treatment. Equal parts of three samples were pooled in the laboratory and tested by PCR for *Brachyspira* species (Adiavet[®] Brachy, Labconsult, Brussels). Individual samples were kept at -20°C for individual examination by culture if the pooled sample was positive.

RESULTS

Elimination protocol

Farm A: Rodents were almost absent before the start of the treatment program. No therapeutic treatments in infected compartments were necessary during the elimination protocol. Clinical symptoms of dysentery were not seen for two years on this farm and the technical results clearly improved: daily growth increased 40g and feed conversion between 20 and 100 kg improved improved by a factor of 0.15.

Farm B: Rodents were clearly reduced, but rats were still present on two farm visits. A therapeutic treatment was done twice in fatteners born before the start of the treatment. Strict hygiene was applied and two (sometimes three) compartments were empty since many piglets were sold at 20 kg. Five months after the start of the treatment program, clinical symptoms reappeared in fatteners of about 70 kg. No apparent reason was found for this relapse. Four weeks before, corn cob maize in the diet had been replaced by triticale.

Farm C: Strict rodent control was applied. The sows were reluctant to eat the diet containing valnemulin for the first three days. Consequently, the treatment was prolonged for three days in order to respect the elimination protocol. During the trial, one infected compartment with fatteners was treated with tiamulin at the onset of clinical symptoms, along with the pigs in the sickbay. Until the end of the observation period, no more symptoms of dysentery were seen. Although no objective data on daily growth are available, the owner mentioned that there was more homogeneous growth and less mortality.

Monitoring

On farms A and C, all samples were negative for *B. hyodysenteriae*. A PCR signal for the group *B. intermedia* / *B. innocens* was recovered frequently. Bacteriological cultures of these samples revealed *B. innocens* in all cases. On farm B, all samples were negative for *B. hyodysenteriae* until clinical symptoms reappeared. At that moment, further monitoring was stopped. Bacteriological culture for *Brachyspira* species of the intestines of two rats captured after elimination failure on farm B was negative.

DISCUSSION

Elimination of dysentery from pig farms is difficult (Wood and Lysons, 1988). In this study, three farms were intensively monitored. Only on two of them was the elimination program successful. An explanation for the

failure on farm B could not be found in management or hygiene failures. Rats were not completely controlled on this farm. Although two rats tested were negative for *B. hyodysenteriae*, rodents could not be excluded as an infection reservoir. Fermentable substrates entering the large intestine are important factors in the expression of clinical symptoms (Pluske *et al.*, 1996). The causative role of the dietary change on this farm in the re-emergence of *B. hyodysenteriae* may have influenced the clinical symptoms, but this cannot be fully ascertained. The use of tiamulin on farm B, in contrast with the use of valnemulin on the two farms where the elimination was successful, was not regarded as the cause of failure since the isolate tested from this farm was found susceptible. Whether the protocol failed on this farm or whether there was recontamination from the environment could not be determined. Successful elimination of dysentery using tiamulin has been described before (Blaha *et al.*, 1986; Walter and Kinyon, 1990) and has been observed frequently by the authors using the protocol described in this study. The activity of valnemulin against *B. hyodysenteriae* at lower concentrations (Karlsson *et al.*, 2001) is an indication of the usefulness of this compound in eliminating the disease.

Elimination protocols based on similar principles and not involving depopulation vary in terms of the length of the antibiotic treatment and the categories of pigs treated (Blaha *et al.*, 1986; Walter and Kinyon, 1990; Fossi *et al.*, 2001). The protocol in this study can be used on farrow-to-finish herds in a single location by creating dysentery-free sows from which dysentery-free piglets are born. The disadvantages of using this protocol on single-site farms include its dependence on the compliance and accuracy of the owner and his staff, as well as the long duration of the stringent control procedure. Indeed, the simultaneous presence of clean sows and piglets and infected slaughter pigs on the same farm constitutes a daily threat of disease spread. Therefore, other protocols not involving depopulation also use a prolonged period of treatment. In the present study, the three week treatment of the sows, followed by three weeks at half the dose, was aimed at eliminating reinfection from the direct environment of the sows. Reinfection from other categories of pigs or from other buildings was prevented by management and hygienic measures. Since only the sows received an elimination treatment, the costs of treatment were reduced compared to whole-herd treatment programs, but the management and hygiene then became more critical. Consequently, farms without all-in/all-out management in all compartments or with complex pig movements between compartments should be advised to change their system prior to applying an elimination protocol for dysentery.

Follow-up of the elimination procedure by the herd veterinarian is necessary.

Temporary feed refusal at the onset of valnemulin treatment was only seen on farm C. Similar effects were described in tolerance studies when higher doses were administered and were considered to have been due to unpalatability (EMEA Procedure no EMEA/V/C/042/01-06/0/0).

To evaluate the success of eradication treatments, Harris *et al.* (1999) suggested banning antimicrobials that are active against swine dysentery, which may mask the continuing presence of *B. hyodysenteriae* for a period of three to six months, and monitoring the reappearance of symptoms. Other studies have monitored the success of the protocol by making additional bacteriological cultures on colon scrapings at slaughter (Wood and Lysons, 1988) or by PCR on rectal feces (Fossi *et al.*, 2001). In this study, fecal samples taken at regular intervals were examined by PCR. The negative results obtained over a period of one year after treatment, combined with the absence of clinical signs and the banning of antimicrobials active against swine dysentery after the sow treatment and in their clean offspring, strongly indicate that the bacterium is no longer present on these two farms. As a consequence, we conclude that the protocol here presented can be used for the elimination of swine dysentery on single-site farms without depopulation, although even when it is intensively supervised, unexplainable disease relapses may occur.

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