The Influence of Change in Feeding and Management on the Prevalence of Multi-Resistant *Salmonella* Typhimurium DT 104 in Danish Pig herds. Four Case Stories.

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**Summary**

In the period June-December 1998 attempt were made to reduce the apparent prevalence of multi-resistant *Salmonella* Typhimurium DT 104 in four infected herds. The interventions were intensive rodent control, thorough cleaning, inclusion of organic acid in feed/water, and feeding non heat treated feed (to mimic home mixed feed). Every month 50-70 pooled faecal samples were collected from each herd. The four herds showed great variation in apparent prevalence between age groups in the same herd.

It was not possible in any of the herds to be test negative in two consecutive samplings. This indicates that the interventions may reduce the apparent prevalence, however not to a test negative level. Due to the missing control groups in the herds it is not possible to establish any causal relations between interventions and change in apparent prevalence of DT104. It is only possible to establish which interventions occurs simultaneously with statistically significant changes in apparent prevalence, and the direction and magnitude of the change.

The statistical analysis showed that weaned piglets, and grower-finishers had 3.5 times higher apparent prevalence than sows. Feeding non heat treated diet occurred simultaneously with a 65% reduction in the apparent DT104 prevalence. Inclusion of organic acids in feed/water occurred simultaneously with a 50% reduction in the apparent DT104 prevalence. It was not possible to establish any correlation between prevalence and depopulation of barns, and thorough cleaning and disinfection.

**Introduction**

Since 1996 it has been possible to diagnose multi-resistant *Salmonella* Typhimurium DT 104 in Denmark. In the period from November 1996 to April 1999 DT104 has been isolated in 16 swine herds, 12 combined swine and cattle herds, and 2 cattle herds. In Denmark finding of DT104 implicate restriction on transport of pigs and other products from the farm. Pigs are slaughtered under special hygienic precautions and all carcasses are heat treated. In DT104 infected herds the restriction can be removed either by being test negative in two consecutive testings with minimum of 45 days interval or by depopulation followed by washing and disinfection. In general eradication of DT104 has been attempted in the infected herds by depopulation, very thorough washing/disinfection, and restocking. Although one herd had to repeat the procedure twice this method has been very successful in the remaining herds (1). However fighting the disease this way is very expensive and labour intensive. In order to find easier and less expensive strategies to handle DT104 infected herds this study was carried out. The objective of this study is to evaluate the effect of changing feed and management on the apparent prevalence of DT104 in four Danish pig herds.

**Material and methods**

In the period June 1998-December 1998 attempt were made to reduce the apparent prevalence of DT104 in four Danish pig herds by changing feeding and management. The goal was to get herds test negative. The herds included in the trials were: an outdoor sow herd with 400 sows (herd A), an farrow to finish herd with 300 sows (herd B), a farrow to grower herd (herd C) with 300 sows selling growers to a finishing herd with 1500 pen places (herd D).

The rational behind the different interventions are practical experiences from the Danish *Salmonella* programme in grower-finisher (2, 3, 4, 5, 6) and results from epidemiologic studies on risk factors for *Salmonella* (7).

In all the indoor herds the rodent control programmes were carried out by specialized pest control companies.

In herd A, the diet to sows was changed from cobs to meal in the period mid September 1998 to end of October 1998. In November 1998 4000 ppm Bact-a-cide (Fornic acid; ammoniumformiate, propione acid, ammoniumpropiionate. Dosage 0.2-0.4 %; AGIL, Reading; Great Britain) were included in the feed (cobs). From mid September approximately 150 pregnant sows were housed indoors and the herd had only sows and suckling piglets.

In herd B where sows were feed home mixed feed (until they were slaughtered in August 1998) and where DT104 prevalence in sows was very low, partial depopulation was carried out. All animals except sows and suckling piglets
were removed from the farm followed by very thorough washing and disinfection. From the beginning of September 1998 the nurseries were repopulated and better washing between batches was initiated. At the end of the finishing period the pigs were fed partially non-heat treated diet (to mimic home mixed feed).

In herd C new nurseries were established and the hygiene between batches was improved. All feed with exception of the weaning diet were pelleted but not heat treated.

In herd D the grower unit was depopulated, washed and disinfected. Before the trial started 4000 ppm Bactacid were included in the diets. From the beginning of August 1998 all pigs were fed partially non-heat treated feed (ground barley), had drinking water with 2000 ppm formic acid included (from mid September), and the hygiene was improved.

Every 4-6 weeks 50-70 pooled faecal samples were collected from the herds and submitted for laboratory examination. From every pen in nursery, grower and finishing units samples representing up to 5 different animals were pooled in one sample. Faeces from individually housed sows were pooled from 5-7 sows. From the indoors herd a number of rodents were submitted for laboratory examination. Dogs were examined 2 or 3 times. A neighbouring herd close to herd C had their cats, dog, and chickens examined by culture of faeces for DT104.

Statistical analysis

Due to the fact that no control groups are included in this trial it is not possible to establish a causal relationship between interventions and the apparent prevalence of DT104 in the herds. It is only possible to establish if interventions and statistically significant changes in prevalence occurs simultaneously. The statistical analysis have been carried out as logistic regression in two different ways. In the first analysis in was assumed that repeated samples taken in the same barn were not independent. This analysis was done in Proc Genmod, SAS (8). In the second analysis it was assumed that pigs within barns and herds are not independent. This was modelled as over dispersion in the Glimmix macro in SAS. Due to the missing control groups only main effects of time (from start of trial), age (sow, young pig, and old pigs), non-heat treated feed, inclusion of acid and hygienic measures were included in the models. The period where sows in herd B were feed home mixed feed was not included in the model.

Table 1. Interventions in the herds

<table>
<thead>
<tr>
<th>Herd</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervention</td>
<td>Non-heat treated meal to sows (mid Sept to end Oct)</td>
<td>Rodent control</td>
<td>Rodent control</td>
<td>Rodent control</td>
</tr>
<tr>
<td></td>
<td>Cobs with 4000 ppm Bact-a-cid (Nov)</td>
<td>Partial depopulation</td>
<td>New nurseries</td>
<td>Bact-a-cid in diet (April-May)</td>
</tr>
<tr>
<td></td>
<td>150 of 400 sows kept indoors from mid sept</td>
<td>Improved hygiene</td>
<td>Improved hygiene</td>
<td>Empty pens between batches</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Partially non-heat treated feed to finisher (from Oct)</td>
<td>All feed pelleted but not heat treated (except weaner diet)</td>
<td>Partially non-heat treated feed (ground barley, Aug-Sept)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2000 ppm formic acid in water</td>
</tr>
</tbody>
</table>

Figure 1. Average apparent prevalence of multi-resistant Salmonella Typhimurium DT 104 in four infected herds.
Results

Figure 1 shows the average apparent prevalence of multi-resistant *Salmonella* Typhimurium DT104 in each sampling from the four herds. Figure 1 indicates a reduction in the overall apparent prevalence in fall 1998 compared to summer 1998. The reduction occurs simultaneously with the implementation of changing feed and management. The individual herds showed a big variation in the % test positive in the different burns/age groups at the same sampling. The 100% test positive animals in August in herd B are only 14 samples from weaned piglets. None of the four tested farms have been test negative for DT104 in to consecutive samplings.

DT104 was isolated in rodents from the three indoor farms. In herd B one of nine were positive, in herd C 1 of 3 were positive, and in herd D 9 of 32 were positive. In herd C's neighbouring farm DT104 was isolated from the chickens, but not from the dog or the cats.

Statistical analysis shows that weaners and grower-finishers have 3.5 times higher Odds Ratio than sows for being test positive. When time was included in the model as the only explanatory variable this had a significant effect corresponding to 18% reduction in DT104 test positive animals per 30 days after the first sampling in the herds. In the final model the significance of time disappear when the effect of change in feeding and inclusion of acid to feed/water are included. In both statistical models weaners and grower-finishers had 3.5 times higher Odds Ratio than sows for being test positive. Feeding non-heat treated feed occurred simultaneously with a significant 65% reduction in DT104 test positive animals. Inclusion of acid occurred simultaneously with a significant 50% reduction in DT104 test positive animals. In this study statistical analysis could not demonstrate any effect of emptying and cleaning of barns (hygienic measures) on DT104 test positive animals.

Discussion

The overall goal to get the four herds test negative for DT104 by change the feeding and including acid in feed/water was not achieved. Due to the missing control groups a causal relation between intervention and reduction in apparent prevalence can not be established. The variation in test positive animals might be due to some unknown factors not included in the analysis. However the reduction in DT104 positive animals in periods where the animals were fed not heat treated feed and/or had acid included in the diet or drinking water are consistent with Danish field trials (5, 6) and epidemiological studies by (7). Field trials shows that feeding finishers with non heat treated feed and/or inclusion of acids in feed/water can reduce the prevalence of serological positive animal (5, 6). The epidemiological studies showed that home mixers who feed non heat treated feed have 3-5 time lower risk of having serological positive animals than producers feeding commercial diets (7). The interventions with changing feed, use of acid, and improved hygiene in the Danish salmonella programme have never been intended to eliminate salmonella from the finishing herds, merely to reduce the prevalence in problem herds.

Conclusions

Rodent control, change in diet, inclusion of acid in diet/feed, emptying and cleaning of barns (hygienic measures) may reduce the number of DT104 test positive animal but not eliminate them from infected herds.

Chickens and rodents in DT104 infected herd can be a potential source of infection.

References


