Antimicrobial resistance in *Salmonella* on Ontario swine farms, 2001-2006


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**Abstract**

The *Salmonella* isolates recovered on 61 Ontario swine farms within the time period 2001-2006 were tested for antimicrobial susceptibility. No resistance was determined to amikacin and ciprofloxacin and only one nalidixic acid resistant isolate was recovered in 2001. Only 1% of the isolates were resistance against ceftiofur, ceftriaxone, apramycin, apramycin, cephalothin, amoxicillin/clavulanic acid, cefoxitin, and gentamicin. The most frequent resistance was seen against sulphisoxazole (45%), tetracycline (43%), streptomycin (42%), spectinomycin (42%), chloramphenicol (36%), and ampicillin (35%) followed by neomycin (23%), kanamycin (23%), and nitrofurantoin (19%). In total, 44 (39%), 30 (27%), 39 (35%) farms were categorized into Group 1 (*Salmonella*-negative), Group 2 (*Salmonella*-positive without antimicrobial resistance), and Group 3 (*Salmonella*-positive with antimicrobial resistance), respectively.

Significant trends were detected in the prevalence of antimicrobial resistance during 5 years of this study. These findings indicate that monitoring over time may be useful to detect changes in antimicrobial resistance patterns on swine farms.

**Introduction**

*Salmonella* serovars demonstrating multiple antimicrobial resistance are important worldwide public health concern (Threlfall et al., 2003). Pork products are a source of *Salmonella* infection in humans (Berends et al., 1998; Wegener et al., 2003). Antimicrobial resistance associated to *Salmonella* might be transferred to other swine pathogens causing serious problems in treatment and control of infectious diseases. Therefore, epidemiological studies need to be conducted in order to gain a better understanding of antimicrobial resistance in *Salmonella* on swine farms. The point estimate studies cannot represent the true status of *Salmonella* and antimicrobial resistance in swine and it is very important to test swine farms for *Salmonella* over a period of time. The objective of this study was to describe the prevalence of antimicrobial resistance in *Salmonella* isolated on Ontario swine farms during the years 2001-2006.

**Material and methods**

One hundred and thirteen Ontario swine farms have been tested annually for *Salmonella* 1 to 5 times within the time period 2001-2006 (2001: Year 1; 2002: Year 2; 2003: Year 3; 2004: Year 4; 2005-2006: Year 5). Fecal samples were obtained from 2-3 pigs per pen and an additional pooled sample was collected from the fresh manure found on the floor of each of the 5 selected pens. In total, 599 *Salmonella* strains were recovered on 61 farms. Antimicrobial susceptibility of *Salmonella* isolates was tested by the agar dilution method (Poppe et al., 2001) and susceptibility breakpoint levels and the reference strains were those described by the Clinical and Laboratory Standards Institute (CLSI, 2004 and 2005). A Generalized Linear Latent and Mixed Models (GLLAMM) with farm as a random effect was used (Dohoo et al., 2003) to study the changes in the prevalence of antimicrobial resistance.
Results

No resistance was detected against amikacin and ciprofloxacin and only one nalidixic acid resistant isolate was recovered in 2001. Only 99% of the isolates were resistance against ceftiofur, ceftriaxone, apramycin, apramycin, cephalothin, amoxicillin/clavulanic acid, cefoxitin, and gentamycin. Resistance to ceftiofur, ceftriaxone, and apramycin was observed only in the last year of the study. Resistance to carbadox was carried by six isolates. Resistance against tobramycin, trimethoprim, sulfamethoxazole/trimethoprim, and nitrofurantoin carried only by 5% to 13% of isolates. However, 29% of isolates demonstrated resistance against neomycin and kanamycin. The antimicrobials that the *Salmonella* isolated in this study were most frequently resist to were; sulfisoxazole (70%), ampicillin (54%), tetracycline (66%), streptomycin (65%), spectinomycin (61%), and chloramphenicol (51%). The trend in the farm-level resistance against the most frequent antimicrobials is shown in Figure 1. A significant trend in the prevalence of farm-level antimicrobial resistance was detected ($P < 0.05$). However, the farm-level antimicrobial resistance in the Year 5 did not differ significantly compared to the previous year.

![Figure 1: Farm level occurrence of the five most frequent resistances](image)

Three groups of farms were defined based on *Salmonella* status for each year of the study. A farm was classified either as Group 1 if no *Salmonella* was recovered, as Group 2 if *Salmonella* without antimicrobial resistance was isolated, or classified as Group 3 if *Salmonella* with antimicrobial resistance was cultured. When defining these 3 groups for the entire study period, 44 (39%), 30 (27%), and 39 (35%) farms were categorized into Group 1, Group 2, and Group 3, respectively.

Discussion

The fact that *Salmonella* was not recovered on a group of farms after 4-5 annual visits, the low level of resistance to cephalosporins, and fluroquinolones, and the fact that no resistance was observed on 27% of *Salmonella*-positive farms are promising findings and encouraging for both public health and pork production perspective. However, resistance to the cephalosporins and carbadox was found in the last year of the study. Emerging resistance to cephalosporins is of importance from a public health point of view because these antimicrobials are common choices for treating human salmonellosis. Resistance to carbadox deserves a serious consideration because the use of this drug in swine industry has been banned in Canada since 2001. In this study a general increase in antimicrobial resistance was observed over the study period. This change in the level of resistance at the farm level might be explained in part by...
differences in sampling strategy and culture methods. Yet, it indicates that the antimicrobial resistance in swine is dynamic and that monitoring over time may be useful to detect changes in antimicrobial resistance patterns on swine farms. Among the three groups of farms which defined in the current study, the Group 3 is of particular concern from a public health standpoint and pig production and warrants attention. Further studies need to be conducted to compare the risk factors that distinguish these three groups of farms.

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References


