

Antimicrobial resistance in *Salmonella* isolates recovered from swine: A NARMS report

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Abstract

In 1996 the Food and Drug Administration Center for Veterinary Medicine established the National Antimicrobial Resistance Monitoring System – Enteric Bacteria (NARMS) as a post-approval monitoring program. From 1997 through 2005, 10,565 *Salmonella* isolates originated from swine slaughter/processing (n=3,848), diagnostic (n=4,579) and on-farm (n=2138) sources as part of the animal arm of NARMS. Relative to 2005, the top five *Salmonella* serotypes from slaughter/processing (in decreasing frequency) were *S. Derby*, *S. Typhimurium* var. 5-, *S. Infantis*, *S. Anatum*, and *S. Johannesburg* while diagnostic serotypes were *S. Typhimurium* var. 5-, *S. Choleraesuis* var. *kunzendorf*, *S. Derby*, *S. Typhimurium*, and *S. Heidelberg*. Increased antimicrobial resistance was most often observed for diagnostic versus slaughter/processing isolates although there were exceptions for some drug and serotype combinations. For all years, greater than 55% of the slaughter/processing isolates were either pan-susceptible or resistant to only one antimicrobial, which was most often tetracycline. Since 1997, approximately 41% of the isolates exhibited multi-drug resistance, defined as resistance to ≥ 2 antimicrobials. Of the 723 *S. Typhimurium* DT104 isolates from swine only 24% (n=176) originated from slaughter/processing. These data reaffirm that overall patterns of resistance are highly dependent on the *Salmonella* serotype distribution and is variable when measured at different points along the farm to fork continuum.

Introduction

Salmonella species, which are ubiquitous in nature, have been recovered from meat and meat products (including swine), poultry, and eggs, as well as from fruits, vegetables and non-food sources. Food-borne illness attributed to *Salmonella* infections is one of the leading causes of gastroenteritis in the United States and elsewhere. The acquisition of multiple antimicrobial resistant *Salmonella* in animals and humans can impact treatment regimens for infections requiring antimicrobials. Treatment failures can result in increased morbidity, requiring revision of recommended therapies and an increase in healthcare costs.

The National Antimicrobial Resistance Monitoring System (NARMS) was established in 1996 by the Food and Drug Administration (FDA), the United States Department of Agriculture (USDA), and the Centers for Disease Control and Prevention (CDC) to monitor changes in antimicrobial susceptibilities of zoonotic pathogens from humans and animal diagnostic specimens, from healthy farm animals, and from raw product collected from federally inspected slaughter and processing plants. Non-typhoid *Salmonella* were selected as the sentinel organism and have been continuously tested for antimicrobial susceptibility to a panel of antimicrobials of human and veterinary importance since 1997. This poster focuses on antimicrobial resistance observed in *Salmonella* spp. isolated from swine as part of the NARMS program from 1997 through 2005.

Materials and Methods

Isolates

Slaughter samples were collected and cultured by USDA-FSIS and diagnostic samples were collected and cultured by state veterinary laboratories throughout the United States or obtained from the USDA-APHIS National Veterinary Services Laboratories (NVSL), Ames, IA.

Testing

Antimicrobial susceptibility testing was conducted using the Sensititre™ semi-automated system (Trek Diagnostic Systems, Inc., Cleveland, Ohio) as per manufacturer's directions. Antimicrobials were configured in a 96 well custom made panel for susceptibility testing using the broth microdilution method. Clinical and Laboratory Standards Institute's (CLSI) guidelines were followed throughout the testing procedure. The following quality control strains were used: *E. coli* ATCC 25922, *P. aeruginosa* ATCC 27853, and *E. faecalis* 29212 (*S.aureus* ATCC 29213 replaced *P.aeruginosa* in 2004).

Results

From 1997 through 2005, 10,565 *Salmonella* isolates originated from swine slaughter/processing (n=3,848), diagnostic (n=4,579) and on-farm (n=2138) sources as part of the animal arm of NARMS. Rankings of top isolated serotypes differed depending on animal status although five serotypes were common to both diagnostic and slaughter (Anatum, Derby, Heidelberg, Infantis, and Typhimurium var. 5-) (Table 1).

Table 1. Top isolated *Salmonella* serotypes from swine in 2005 – diagnostic and slaughter

Diagnostic (n=496)	Percent	Slaughter (n=301)	Percent
Typhimurium var 5-	23.0%	Derby	28.2%
Choleraesuis var. kunzendorf	14.5%	Typhimurium var 5-	12.0%
Derby	12.3%	Infantis	9.0%
Typhimurium	9.5%	Anatum	5.3%
Heidelberg	7.1%	Johannesburg	5.0%
Agona	3.6%	Reading	3.7%
Infantis	3.0%	Saintpaul	3.7%
Anatum	2.8%	London	3.7%
Untypable	2.6%	Adelaide	3.3%
6,7 Nonmotile	1.8%	Heidelberg	2.7%

Overall, increased antimicrobial resistance was most often observed for diagnostic versus slaughter isolates with the highest levels of resistance seen to streptomycin, sulfonamides, and/or tetracycline. The largest disparity in antimicrobial resistance between animal status was seen with ampicillin where almost four times more diagnostic isolates were resistant than slaughter isolates (Figure 1).

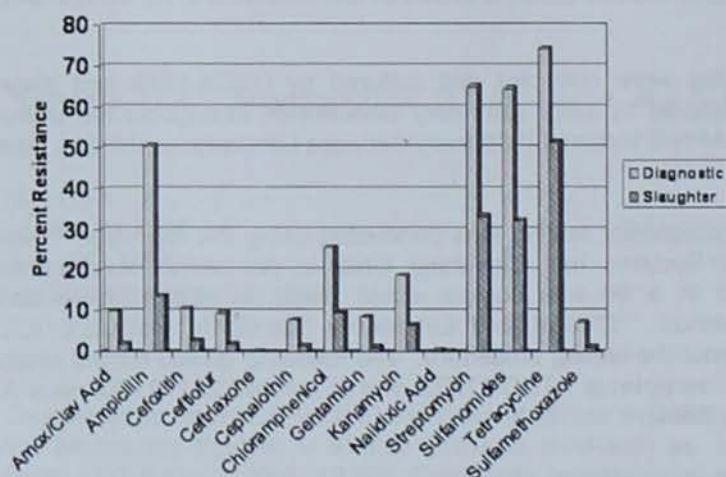


Figure 1. Percent resistance of *Salmonella* spp. isolated from swine by status (1997 – 2005)

For all years, greater than 55% of the slaughter/processing isolates were either pan-susceptible or resistant to only one antimicrobial, which was most often tetracycline (Table 2). From 1997 through 2005, an average of 10% of the isolates was resistant to greater than five antimicrobials with no significant variations observed throughout the years.

Table 2. Multiple drug resistance from *Salmonella* spp. isolated from swine - slaughter

	1997	1998	1999	2000	2001	2002	2003	2004	2005
Total n Tested	111	793	876	451	418	379	211	308	301
Total (%) Pan Susceptible	44.1	49.2	48.9	43.2	43.3	40.1	53.6	37.3	44.5
Total (%) R = 1*	11.7	16.0	15.6	12.2	16.5	16.6	12.3	21.1	15.0
Total (%) R ≥ 5*	16.2	11.9	9.1	12.0	8.4	9.2	10.0	13.0	11.6
Total (%) R ≥ 10*	0.0	0.0	0.3	0.9	1.4	1.9	1.0	0.3	0.7

* Refers to the number of antimicrobials isolates are resistant to

Two-thirds (64%, n=460) of confirmed *Salmonella* DT104 isolates from swine (n=723) from 1997 through 2005 came from diagnostic animals while 24% (n=176) were from slaughter isolates (Figure 2).

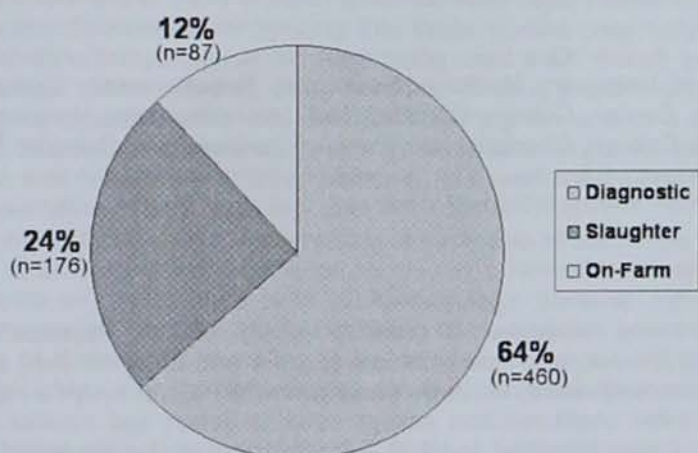


Figure 2. Distribution of *Salmonella* DT104 from 1997 – 2005 by source

Discussion

- *Salmonella* Derby and *S. Choleraesuis* var. *kunzendorf* are among the top 5 serotypes of isolates tested from swine but are not found in the top 20 serotypes identified from humans by the NARMS program (CDC, 2003).
- Animal status influences serotype distribution
- The percentage of *Salmonella* isolates from swine slaughter samples that were susceptible to all tested antimicrobials did not significantly change throughout the years
- Antimicrobial resistance is dependent upon serotypes (data not shown)
- The predominant source of *Salmonella* DT104 is diagnostic animals which are not entering the food chain
- Because of the number of human *Salmonella* cases attributed to food sources, further monitoring and analysis of resistance trends should continue but sample factors affecting resistance such as geographical or seasonal distribution, processing methods or husbandry practices should always be considered.

References

CDC. National Antimicrobial Resistance Monitoring System for Enteric Bacteria (NARMS): 2003 Human Isolates Final Report. Atlanta, Georgia: U.S. Department of Health and Human Services, CDC, 2006.

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