Antimicrobial Susceptibility Testing of *Salmonella* Isolates from Nebraska, 2006

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The Spring 2007 newsletter gave an overview of the *Salmonella* serotypes identified in Nebraska during 2006. The top 5 serotypes detected in Nebraska during this time were serotype Typhimurium (Group B, 15.5%), Enteritidis (Group D, 13.2%), Typhimurium 5 null (Group B, 12.3%), Newport (Group C2, 7.3%), and Heidelberg (Group B, 4.6%). All *Salmonella* submitted to the NPHL also underwent antimicrobial susceptibility testing (AST) for the 12 antimicrobial agents listed in **Table 1**. This article compares AST results from Nebraska isolates with the CDC national testing program[1].

Table 1. Comparison of the percentage and number of non-Typhi *Salmonella* isolates resistant to antimicrobial agents between Nebraska and historical data from the CDC.[a]

	% of isolates resistant (Number of isolates tested)				
	Nebraska[b]			NARMS[c]	
Antimicrobial Agent	2004 (120)	2005 (221)	2006 (219)	2003 (1864)	2004[d] (1793)
Ampicillin	6.7	14.7	15.1	13.7	12.4
Cefoxitin	2.5	5.9	4.1	4.3	3.5
Chloramphenicol	7.5	12.7	11.9	10.0	7.6
Ciprofloxacin	0.0	0.5	0.0	0.2	0.2
Ceftriaxone[e]	1.7	1.8	3.2	0.4	0.6
Gentamicin	0.0	3.6	2.7	1.4	1.3
Kanamycin	1.7	5.0	3.7	3.4	2.8
Naladixic acid	1.7	1.8	4.1	2.3	2.6
Sulfamethoxazole	12.5	18.1	15.5	15.1	13.2
Streptomycin	19.2	24.4	21.9	15.0	11.8
Trimethoprim/Sulfa	1.7	2.3	0.5	1.9	1.8
Tetracycline	15.0	21.3	17.8	16.3	13.5

[a]CDC. National Antimicrobial Resistance Monitoring System for Enteric Bacteria (NARMS) [1]
[b]The Kirby Bauer disk diffusion method, set up and interpreted using the CLSI recommendations, was used for antimicrobial susceptibility testing. Reduced susceptibility results (intermediate) were categorized as "sensitive".
[c]The Sensititre TREK Diagnostic System was used for antimicrobial susceptibility testing. MIC results were reported as sensitive or resistant and isolates with reduced susceptibility (intermediate) were categorized as "sensitive".
[d]Data for 2005-06 not available (11/07).
[e]Resistant ceftriaxone results by Sensititre and disk diffusion methods were confirmed using the MIC method (CDC) or E-test method (NPHL), respectively.

A comparison of the percentage and number of non-Typhi *Salmonella* isolates resistant to antimicrobial agents between Nebraska and historical data from the CDC is shown in **Table 1**. A consistent yearly percentage increase in resistance for the Nebraska strains from 2004, 2005, and 2006 was noted for ampicillin (6.7 to 14.7 to 15.1), ceftriaxone (1.7 to 1.8 to 3.2), and naladixic acid (1.7 to 1.8 to 4.1). The percentage of the 2006 isolates resistant in Nebraska were higher for all the antimicrobials tested when compared with the 2004 CDC National Antimicrobial Resistance Monitoring System (NARMS) data, with the exception of ciprofloxacin (Nebraska 0% to NARMS 0.2%). Ciprofloxacin had the lowest percent resistance in both the local and national data while streptomycin had the highest resistance in Nebraska (21.9% compared with NARMS for 2004 at 11.8%) and tetracycline had the highest resistance in the NARMS data (13.5%).

Among the 219 non-Typhi *Salmonella* serotypes isolated in Nebraska in 2006, 72.6% had no detectable resistance to all agents tested (**Table 2**). This increase in sensitivity (68.3% and 72.6% showed no resistance in 2005 and 2006, respectively) has

Table 2. Resistance patterns of non-Typhi *Salmonella* isolated from humans in Nebraska compared with historical data from the CDC.[a]

	% of isolates per time period (Number tested)				
	Nebraska			NARMS	
Pattern	2004 (120)	2005 (221)	2006 (219)	2003 (1864)	2004[b] (1793)
No resistance	74.1	68.3	72.6	77.7	79.6
Resistance to ≥ 1 agent	25.9	31.7	27.4	22.3	20.4
Resistance to ≥ 2 agents	15.0	22.6	20.1	17.7	15.0
Resistance to ≥3 agents	12.5	19.0	17.8	14.3	11.7
Resistance to ≥4 agents	12.5	15.8	15.5	11.6	9.4
Resistance to ≥5 agents	6.7	13.6	12.3	9.9	8.1
At least ACSSuT resistant[c]	5.8	10.4	11.4	9.3	7.1
At least ACSuTm resistant[d]	0.8	0.9	0.5	1.2	0.6

[a]CDC. National Antimicrobial Resistance Monitoring System for Enteric Bacteria (NARMS) [1]
[b]Data for 2005-06 not available. (11/07)
[c]ACSSuT: ampicillin, chloramphenicol, streptomycin, sulfamethoxazole, and tetracycline
[d]ACSuTm: ampicillin, chloramphenicol, sulfamethoxazole, and trimethoprim-sulfa

also been seen in the national data (77.7% in 2003 to 79.6% in 2004). The resistance to multiple agents was similar among 2004, 2005 and 2006 in both groups; however, the number of isolates with resistance to ≥ 5 agents continued to be higher in Nebraska (12.3%) than in the NARMS data (8.1%).

In 2006, serotypes Typhimurium and Typhimurium 5 null accounted for 34 and 27, respectively of the isolates submitted for susceptibility testing. The percentage of these serotypes showing no detectable resistance decreased from 64.8% sensitive in 2005 to 54% sensitive in 2006 while nationally, there was an increase in sensitivity from 55.3% in 2003 to 60.7% in 2004 (**Table 3**). The resistance to multiple agents showed a general increase with the most notable increase observed with 34.4% of the isolates showing resistance to ≥ 5 agents tested, a substantial increase from 2004 (18.1%) and 2005 (22.0%). Overall, the pattern of resistance was higher in Nebraska isolates than that observed with the NARMS data.

Table 3. Resistance patterns of *Salmonella* serotype Typhimurium and Typhimurium 5 null isolated from humans in Nebraska compared with historical data from the CDC.[a,b]

Pattern	% of isolates per time period (Number tested)				
	Nebraska			NARMS	
	2004 (55)	2005 (90)	2006 (61)	2003 (403)	2004[c] (382)
No resistance	58.2	64.8	54.0	55.3	60.7
Resistance to ≥ 1 agent	41.8	35.2	46.0	44.7	39.3
Resistance to ≥ 2 agents	23.6	29.7	37.7	40.9	37.2
Resistance to ≥3 agents	20.0	26.4	34.4	36.5	31.4
Resistance to ≥4 agents	20.0	25.3	34.4	31.8	28.0
Resistance to ≥5 agents	18.1	22.0	34.4	27.5	24.3
At least ACSSuT resistant[d]	12.7	19.8	32.3	25.8	23.3
At least ACSuTm resistant[e]	1.8	3.3	1.6	3.2	1.6

[a]CDC. National Antimicrobial Resistance Monitoring System for Enteric Bacteria (NARMS) [1]
[b]Includes both serotype Typhimurium and serotype Typhimurium 5 null formerly called var Copenhagen.
[c]Data for 2005-06 not available. (11/07)
[d]ACSSuT: ampicillin, chloramphenicol, streptomycin, sulfamethoxazole, and tetracycline
[e]ACSuTm: ampicillin, chloramphenicol, sulfamethoxazole, and trimethoprim-sulfa

The most common multiple resistance pattern for 2006 Nebraska isolates of *Salmonella* serotype Typhimurium and Typhimurium 5 null was resistant to ACSSuT with 32.3% of the isolates showing at least this pattern (an increase from both 2004 and 2005) (**Table 3)**. This pattern is commonly associated with the Definitive Phage Type 104 (DT104) strain, that historically has been circulating in Nebraska [2]. Fifteen of the 27 serotype Typhimurium 5 null isolates from Nebraska showed this resistance pattern. Resistance to trimethoprim-sulfamethoxazole has only been seen in one Nebraska isolate, thus the pattern of resistance to at least ACSuTm, has been rarely observed. The isolate associated with this pattern showed resistance to 8 of the 9 antimicrobial subclasses tested. This isolate, which was determined by the CDC to be a "rough" isolate and thus the O antigen could not be determined, was identified as a unnamed subspecies I with the antigenic formula of "I Rough:-:1,5".

Salmonella serotype Enteritidis, which was the 2nd most common serotype detected in Nebraska in 2006 (29 isolates), only had 5 isolates resistant each to one agent (data not shown). All 5 of these isolates showed resistance to naladixic acid. Nationally, resistance to naladixic acid has been on the increase (2). This resistance is troublesome since naladixic acid is related to the fluoroquinolones and may indicate resistance problems for this class of agents in the future.

For additional information concerning the *Salmonella* Serotyping/Susceptibility Testing Programs at NPHL, contact Beth Schweitzer at 402-559-6098 or Dr. Iwen at 402-559-7774.

References

1. CDC. *Salmonella* Surveillance Annual Summary, 2004. Atlanta, Georgia; U.S. Department of Health and Human Services, CDC, 2005.
2. CDC. Multidrug-resistant Salmonella serotype Typhimurium, United States, 1996. MMWR, Morbidity and Mortality Weekly Report. 1997, 46: 308-10.