IV. Data Analysis

This report summarizes data collected as part of the animal component of NARMS.

A. *Salmonella*

The total number of *Salmonella* isolates tested by year since 1997 is shown in Table 1A.

The top 10 serotypes by commodity for 2007 are shown in Table 2A. Overall, Kentucky, Hadar, Montevideo and Derby ranked as the most prevalent serotype for chicken, turkey, cattle and swine, respectively. Using 2007 as the baseline, the relative distributions for the top five serotypes per commodity are shown in Figures 1A-4A. While Kentucky was the most frequently recovered serotype for chicken, the upward trend observed since 1997 appears to have halted in 2006, slightly declining in 2007 to 44.6% of isolates. Since 2002, an overall decline in Heidelberg has also been observed while Enteritidis increased starting in 2002 through 2006 and remained constant for 2007. Conversely, recovery of Typhimurium variant 5- (1997-2007), and I 4,[5],12:i:- (2004-2007) has remained relatively stable (Figure 1A).

The most remarkable change in serotype distribution occurred among isolates recovered from turkey (Figure 2A); Hadar increased from 13.1% in 2004 to 43.5% in 2007 while Heidelberg declined from 19.5% in 2004 to 8.5% in 2007. The decline in Heidelberg from turkey parallels the decline observed for chicken from 2002 to 2004. Overall, Heidelberg from turkey continued to decline from 2004 to 2007. From 2005 to 2007, Montevideo and Dublin increased in prevalence among cattle isolates while the other top serotypes remained relatively constant (Figure 3A). From 2005 to 2007, Derby decreased in prevalence among swine (Figure 4A) while slight increases were observed in Johannesburg from 2004 to 2007 and in Typhimurium from 2006 to 2007. Infantis and Typhimurium variant 5- showed little change.

The 2007 MIC distributions by antimicrobial and commodity for all *Salmonella* serotypes combined are shown in Table 3A. Because the distribution of serotypes between commodities varies greatly, it is important to determine resistance at the serotype and commodity level. It is not unusual for resistance to be driven by only a few serotypes.

The overall percent resistance by year, antimicrobial and commodity of all *Salmonella* is shown in Table 4A. These data provide a macro analysis on a yearly basis alerting analysts to any changes which may have taken place over time. Most notably, total percent resistance to gentamicin appears to be declining among chicken and turkey isolates. With the exception of one isolate from chicken in 2003, resistance has yet to emerge to ciprofloxacin while resistance to nalidixic acid remained very low ($\leq$2.0%) for all commodities except turkey. Resistance to the other antimicrobials varied by commodity.

A micro analysis of the data is presented in Tables 5A through 8A which shows total percent resistance and MIC distribution by commodity and top serotypes for 2007. Therefore, percent resistance can be evaluated independently by serotype. For instance, among serotypes from chicken *Salmonella* isolates, Enteritidis (n=124) was susceptible to 11 antimicrobials (amikacin, amoxicillin/clavulanic acid, cefoxitin, ceftiofur, ceftriaxone, chloramphenicol, ciprofloxacin, gentamicin, kanamycin, nalidixic acid and trimethoprim/sulfamethoxazole) and exhibited $\leq$2.4% resistance to ampicillin, streptomycin, sulfonamides or tetracycline. Conversely, Kentucky (n=443) was susceptible to three antimicrobials (amikacin, ciprofloxacin and trimethoprim/sulfamethoxazole) and exhibited varying levels of resistance to 12 antimicrobials (amoxicillin/clavulanic acid, ampicillin, cefoxitin, ceftiofur, ceftriaxone, chloramphenicol, gentamicin, kanamycin, nalidixic acid, streptomycin, sulfonamides and tetracycline).

Amikacin resistance was observed in only one *Salmonella* isolate from 2007, a *S.* Typhimurium from swine.

The frequency of *S.* Typhimurium including Typhimurium variant 5- exhibiting ACSSuT or ACSuT resistance patterns is shown in Table 9A. Although not streptomycin resistant, ACSuT isolates are often confirmed as DT104. Therefore, we believe this phenotype has clinical significance and should be reported.

Further, it is important to note that presentation of the ACSSuT or ACSuT pattern does not always confirm isolates as DT104 or its complex (Table 10A). Therefore, careful analysis of the data to the lowest denominator possible enables a more accurate assessment of the prevalence and importance of DT104 alone. Table 11A shows the prevalence of phage types among isolates with the ACSSuT phenotype. It is interesting to note the variability of phage types between Typhimurium and Typhimurium variant 5-.

Not all laboratories differentiate between Typhimurium and Typhimurium variant 5-. The data in Tables 9A through 11A illustrate the importance of making this differentiation. *Salmonella* Typhimurium variant 5- tends to present more frequently with the ACSSuT or ACSuT patterns and are more often confirmed as DT104 than the non-variant Typhimurium.

Overall, DT104 was most often recovered from swine followed by cattle, chicken and turkey (Table 12A).

MDR by commodity is presented in Tables 13A through 16A. These tables list data by CLSI subclass as well as by phenotypes thought to be of clinical importance in humans (at least ACSSuT, ACT/S, ACSSuTAuCf or ceftiofur and nalidixic acid resistance). Overall, pan-susceptible isolates most often originated (in order) from cattle, chicken, swine and turkey. Among the clinically important phenotypes reported, resistance was least often observed to ACT/S and to ceftiofur plus nalidixic acid, for all sources.

B. *Campylobacter*

The number of *Campylobacter* isolates recovered by species from chicken rinsates is shown in Table 1B. *Campylobacter jejuni* were more frequently recovered than *C. coli*. The distribution of *Campylobacter* species recovered from chicken has remained relatively stable since 1998 (Figure 1B).

MIC distributions by antimicrobial and species are shown in Table 2B. No resistance to florfenicol was observed for either species. In 2007, resistance was higher for *C. coli* than *C. jejuni* for all drugs with the exception of the quinolones and tetracycline. *Campylobacter jejuni* exhibited more resistance to ciprofloxacin, nalidixic acid and tetracycline.

Percent resistance by year, antimicrobial, and species are shown in Table 3B. In 2007, an increase in resistance was observed in *C. coli* to the lincosamides and macrolides/ketolides and in *C. jejuni* to the quinolones. Tetracycline resistance decreased in *C. coli* and remained stable for *C. jejuni* in 2007. *Campylobacter coli* were more resistant to tetracycline than *C. jejuni* from 1998 to 2004; from 2005 to 2007 *C. jejuni* exhibited more resistance to tetracycline. Testing methods (Etest® from 1998-2004 and broth microdilution from 2005 to present) may have influenced this change.

MDR by CLSI subclass is presented in Tables 4B and 5B. Overall, MDR has been more frequently observed in *C. coli* than *C. jejuni.*

C. *Escherichia coli* (generic)

The number of *E. coli* isolates from chicken rinsates tested is shown in Table 1C. MIC distribution by antimicrobial is shown in Table 2C.

Percent resistance by year is shown in Table 3C. No resistance has been observed to amikacin for any year. Since 2004, resistance to ceftriaxone has remained very low (≤0.1%). A decrease in resistance was observed between 2006 and 2007 for kanamycin, streptomycin, ampicillin, amoxicillin-clavulanic acid, ceftiofur, cefoxitin, trimethoprim/sulfamethoxazole, nalidixic acid, and tetracycline. Resistance to ciprofloxacin remained sporadic and low; only one isolate was resistant in 2007. Resistance to all other drugs (gentamicin, sulfonamides, and chloramphenicol) increased.

MDR by CLSI subclass is presented in Table 4C. Over time, pan-susceptibility has increased.

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