REPORT OF THE COMMITTEE ON *SALMONELLA*

Chair: Patrick L. McDonough, Ithaca, NY
Vice Chair: Douglas Waltman, Oakwood, GA

Joan M. Arnoldi, WI; Deanna L. Baldwin, MD; Marilyn F. Balmer, MD; Richard E. Breitmeyer, CA; Max Brugh, GA; Jones W. Bryan, SC; Karen E. Burns-Grogan, Ga; Tony A. Caver, SC; Stephen R. Collett, GA; Kevin G. Custer, IA; Sherrill Davison -Yeakel, PA; Robert J. Eckroade, PA; John I. Enck, Jr., PA; James M. Foppoli, HI; Rose Foster, MO; Tony G. Frazier, AL; Richard K. Gast, GA; Hashim M. Ghori, AR; Eric N. Gingerich, PA; Randy R. Green, DC; Jean Guard-Bouldin, GA; Chris S. Hayhow, KS; Carl J. Heeder, MN; Ruud Hein, DE; Bill W. Hewat, AR; Tom Holder, MD; Carolyn Inch, CAN; Hailu Kinde, CA; Dale C. Lauer, MN; Elizabeth A. Lautner, IA; Howard M. Magwire, MD; Jerry D. Maiers, NC; Edward T. Mallinson, MD; Beth E. Mamer, ID; James D. McKean, Ia; Hugo Medina, MN; David L. Meeker, VA; Donald S. Munro, PA; Thomas J. Myers, DC; Kakambi V. Nagaraja, MN; Steven H. Olson, MN; Robert L. Owen, PA; Stephen Pretanik, DC; Nancy Reimers, CA; John P. Sanders, WV; H. L. Shivaprasad, CA; Philip Stayer, MS; Bruce N. Stewart-Brown, MD; Hilary S. Thesmar, DC; Liz K. Wagstrom, IA; Gary L. Waters, MT; Scott J. Wells, MN; Nora E. Wineland, CO; Ching-Ching Wu, IN.

The Committee met from 12:30 p.m. to 6:00 p.m. on October 21, 2007, at John Ascuaga's Nugget Hotel, Reno, Nevada. There were 39 members and guests in attendance. Dr. Patrick L. McDonough, Chair, and Vice Chair Dr. Doug Waltman, presided. The meeting was called to order at 12:30 p.m. and members were encouraged to sign-in. Dr. McDonough gave a brief overview of the Committee and its mission statement, reviewed the minutes of the 2006 Minneapolis meeting, gave a brief look at *Salmonella* in the world's scientific literature, and then reviewed the speaker topic list as the meeting began.

Overview of *Salmonella* in the United States Report including FoodNet and National Antimicrobial Resistance Monitoring System (NARMS) updates – Centers for Disease Control and Prevention (CDC)

Dr. Casey Barton Behravesh, Centers for Disease Control and Prevention (CDC), Enteric Diseases Epidemiology Branch, provided this update

Each year in the U.S. *Salmonella* infections cause an estimated: 1.4 million illnesses, 168,000 physician office visits, 15,000 hospitalizations, and 400 deaths. The National *Salmonella* Surveillance System collect reports of isolates of *Salmonella* from human sources from every state in the United States. This information is reported through the Public Health Laboratory Information System (PHLIS), an electronic reporting system, by the State Public Health Laboratory Directors and State and Territorial Epidemiologists to the CDC. The top 10 *Salmonella* reported including their frequency are as follows (Figure 1): Typhimurium-19.3 percent (including var. 5-, formerly var. Copenhagen), followed by Enteritidis-18.6 percent, Newport-9.1 percent, and Heidelberg-5.3 percent were the top 4 serotypes encountered; the next in order of frequency (all less than 4 percent) are Javiana, 1, 4,[5], 12:i:- , Montevideo, Muenchen, Saintpaul, and Braenderup. This report for 2005, the most recent data available, may be found at http://www.cdc.gov/ncidod/dbmd/phlisdata/*Salmonella*.htm and at http://www.cdc.gov/ncidod/dbmd/phlisdata/salmtab/2005/*Salmonella*AnnualSummary2005.pdf).

Figure 1.
PHLIS Annual Summary of *Salmonella* 2005
http://www.cdc.gov/ncidod/dbmd/phlisdata/salmtab/2005/*Salmonella*AnnualSummary2005.pdf
Salmonella Annual Summary, 2005 1 T A

Human 2005			
Rank	**Serotype**	**Reported**	**Percent**
1	Typhimurium *	6982	19.3
2	Enteritidis	6730	18.6

3	Newport	3295	9.1
4	Heidelberg	1903	5.3
5	Javiana	1324	3.7
6	I 4,[5],12:i:	822	2.3
7	Montevideo	809	2.2
8	Muenchen	733	2.0
9	Saintpaul	683	1.9
10	Braenderup	603	1.7
11	Oranienburg	590	1.6
12	Mississippi	565	1.6
13	Infantis	505	1.4
14	Paratyphi B var. L(+) tartrate+	460	1.3
15	Thompson	428	1.2
16	Agona	367	1.0
17	Typhi	348	1.0
18	Hartford	239	0.7
19	Stanley	224	0.6
20	Berta	209	0.6
21	Hadar	205	0.6
22	Bareilly	201	0.6
23	Anatum	197	0.5
24	Poona	196	0.5
25	Mbandaka	190	0.5
26	Panama	148	0.4
27	Litchfield	141	0.4
28	Sandiego	138	0.4
29	Schwarzengrund	138	0.4
30	Brandenburg	134	0.4
Sub Total	**29507**	**81.5**	
All Other Serotyped	3841	10.6	
Unknown	1113	3.1	
Partially serotyped	1684	4.7	
Rough or nonmotile	39	0.1	
Sub Total	**6677**	**18.5**	
Total	**36184**	**100**	

NOTE: * Typhimurium includes var. 5-(Formerly var. Copenhagen)

Next Dr. Casey Barton Behravesh reviewed *Salmonella* serotype isolation rates in the United States per 100,000 population: 1970-2005 highlighting trends over this time period.

FoodNet

The next surveillance system reviewed was the Foodborne Diseases Active Surveillance Network or FoodNet (http://www.cdc.gov/foodnet/). FoodNet was established in 1996 and is the principal foodborne disease component of CDC's Emerging Infections Program. FoodNet is a collaborative project of the CDC, the United States Department of Agriculture (USDA), the Food and Drug Administration (FDA) and 10 participating state health departments. FoodNet began active, population-based surveillance for laboratory-confirmed cases of infection caused by *Campylobacter*, *Listeria*, *Salmonella*, STEC O157, *Shigella*, *Vibrio*, and *Yersinia*. FoodNet personnel ascertain cases through contact with all clinical laboratories serving their surveillance areas. In 2004, FoodNet began collecting data on which laboratory-confirmed infections were associated with outbreaks.

The FoodNet catchment area accounts for 45 million persons or approximately 15 percent of the U.S. population. FoodNet conducts active laboratory-based surveillance at more than 650 clinical laboratories serving the catchment area to ascertain all laboratory-confirmed infections due to seven bacterial foodborne pathogens including *Salmonella*. Dr. Barton Behravesh outlined how the relative rates of *Salmonella* are calculated by FoodNet, i.e., the rate each year is compared with the 1996-1998 baseline, rates below 1 represent a decrease since baseline. Estimates show that the rate of *Salmonella* has remained steady compared to the baseline period. In fact, no statistically significant change was seen for *Salmonella* between 2006 and baseline. (see MMWR April 13, 2007 / 56(14);336-339 at http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5614a4.htm?s_cid=mm5614a4_e)

Enhanced surveillance of foodborne infections as measured in FoodNet sites estimates that the rate of *Salmonella* has changed the least compared to the 1996 to 1998 baseline period versus other common foodborne bacterial infections monitored by FoodNet.

Of the six most common *Salmonella* serotypes in 2006, only *typhimurium* has declined since the baseline, and its incidence since 2003 has been stable. Although *Salmonella* incidence did not decrease significantly overall, the incidence of *S. typhimurium* decreased significantly (41% [CI = 34%--48%]). In contrast, significant increases in incidence compared with baseline occurred for *S. enteritidis* (28%, CI = 4%--57%), *S. newport* (42%, CI = 7%--87%), and *S. javiana* (92%, CI = 22%--202%). The estimated incidence of *S. heidelberg* and *S. montevideo* did not change significantly compared with baseline (Figure 2). Of the 5,957 (90 percent) *Salmonella* isolates serotyped, seven serotypes accounted for 64 percent of infections: typhimurium, 1,157 (19 percent); enteritidis, 1,109 (19 percent); newport, 531 (9 percent); javiana, 292 (5 percent); montevideo, 250 (4 percent); Heidelberg, 239 (4 percent); and a monophasic serotype identified as *Salmonella* I 4,[5],12:i:-, 239 (4 percent).

NARMS

Data from the human arm of the NARMS at the CDC was reviewed (http://www.cdc.gov/narms/). The NARMS program monitors changes in antimicrobial drug susceptibilities of selected enteric bacterial organisms in humans, animals, and retail meats to a panel of antimicrobial drugs important in human and animal medicine. The NARMS program consists of three areas: the CDC-human surveillance; the FDA Center for Veterinary Medicine (CVM)-retail food surveillance; and the USDA-animal surveillance (on-farm and slaughter).

NARMS results for *Salmonella* are available since 1996. NARMS started in 14 sites in 1996 and expanded nationwide in 2003. The trends in multidrug-resistant (MDR) *Salmonella*, and resistance to clinically important drugs: fluoroquinolones, nalidixic acid, ciprofloxacin, 3rd generation cephalosporins, and ceftriaxone were discussed. The percentage of non-typhi *Salmonella* Resistant to nalidixic acid, by Year, 1996-2005 showed that fluoroquinolone (e.g., ciprofloxacin) resistance is not yet widespread, although an increase in quinolone (e.g., nalidixic acid) resistance along with decreased susceptibility to ciprofloxacin has been observed since 1996. The percentage of non-typhi *Salmonella*-resistant to ceftiofur, by year, 1996-2005 have primarily been driven by the emergence of MDR AMPc in *Salmonella newport*. The MDR pattern is seen in at least 12 other non-typhi serotypes; resistance to extended-spectrum cephalosporins appears to be mediated by similar mechanisms found in a variety of *Salmonella* serotypes and is horizontally transmissible by plasmids.

***Salmonella* Outbreaks in the USA**

In general, salmonellosis outbreaks of a common serotype or pulsed field gel electrophoresis (PFGE) pattern may be initially detected by CDC or by a state or local health

department. Outbreaks of a common serotype may be detected from data collected through the National *Salmonella* Surveillance System. The Statistical Outbreak Detection Algorithm (SODA) is applied to these surveillance data to compare current vs. historical number of a serotype. Molecular subtyping is a critical investigation tool especially for the more common *Salmonella* serotypes. PFGE can be performed by PulseNet, the molecular subtyping network for foodborne disease surveillance) and OutbreakNet, the network of public health epidemiologists who investigate foodborne illnesses nationwide. Increases in a PFGE pattern can be detected at the state or national level. CDC is also notified of outbreak reports by investigators at local or state health departments. OutbreakNet is the network of public health epidemiologists who investigate foodborne illness nationwide. Reports from multiple states can be linked by CDC and information is shared between states. Most outbreaks are detected, investigated and controlled by local and state health departments. The CDC's Enteric Diseases Epidemiology Branch collects reports of outbreaks investigated through the Electronic Foodborne Outbreak Reporting System (eFORS). Reporting is voluntary and is therefore incomplete. The definition of an outbreak used is: two or more cases of a similar illness resulting from the ingestion of a common food, which in investigation are linked to a food consumed in common. CDC collects reports of outbreaks investigated by local and state health departments including data on number of cases, implicated food, and etiology. The role of the Foodborne Disease Outbreak Response and Surveillance Team (ORST) is to conduct national surveillance on foodborne infections and outbreaks of foodborne illness and to assist in the investigation of foodborne disease outbreaks that take place in the United States or affect its population. From 1998 to 2002, *Salmonella* outbreaks with a single food vehicle identified implicated a wide range of food categories (http://www.cdc.gov/foodborneoutbreaks/index.htm). As reported in the most recent surveillance summary, of 162 outbreaks with a single food vehicle identified, the top five categories associated with illness included: poultry, accounting for 31 percent of these outbreaks; vegetables, fruits and nuts with 26 percent; eggs with 13 percent; pork with 10 percent; and dairy with seven percent. As this data shows, multiple major food categories serve as important sources of *Salmonella* infections making *Salmonella* a difficult pathogen to control. Investigation of *Salmonella* outbreaks is very important to understand this wide range of food sources. Vegetables and fruits together caused nearly as many outbreaks as poultry during this time period, underscoring concern that produce items are an important source of infections due to *Salmonella*.

Tomato Outbreaks of Salmonellosis

Several recent outbreaks were reviewed in detail. First, Tomatoes are a well-documented vehicle for *Salmonella* outbreaks. Known multistate tomato-related *Salmonella* outbreaks have been occurring since 1990 to the present time. *Salmonella* infections were first linked to tomatoes in 1990, when *S. javiana* caused 176 illnesses in four Midwestern states. Since 1990, at least 11 multistate outbreaks were reported to CDC's Electronic Foodborne Outbreak Investigation and Reporting System (EFORS).

These outbreaks have been due to multiple *Salmonella* serotypes though several are repeatedly associated with tomatoes. Tomato-associated salmonellosis is an accelerating issue as an increasing number of outbreaks have been reported in more recent years.
Outbreaks are typically large and widely dispersed and have ranged in size from 43 cases to 510 cases. Typically Round or Roma tomatoes were implicated. When identified by trace back, the source of tomatoes has been farms in Virginia, Florida, South Carolina, Georgia, and Ohio. The majority of outbreaks were associated with restaurants or a substantial proportion of cases had tomato exposures at restaurants. Some outbreaks also involved pre-cut tomatoes. At least 1, 990 culture-confirmed infections were detected in the 11 tomato-associated outbreaks since 1990. These outbreaks may have resulted in an estimated 79,600 infections since an estimated 97.5 percent of *Salmonella* infections are not culture-confirmed.

A review of the four most recent tomato associated *Salmonella* outbreaks was presented. In 2005 and 2006, four large multistate salmonellosis outbreaks were linked to contaminated tomatoes. All four of these multistate outbreaks involved tomatoes served at restaurants and involved both whole and pre-sliced tomatoes. Affected states were primarily in the Eastern U.S. and the distribution of cases typically corresponds to the tomato source as shown by trace back investigations in previous outbreaks. Massachusetts, Pennsylvania, and Ohio are the states involved in all 4 tomato-associated outbreaks. There were few cases in western states all of

which had a travel history to the eastern US during their incubation period. One of the three outbreaks involved pre-cut tomatoes at a restaurant. Though a variety of *Salmonella* serotypes were seen in the multistate outbreaks, of special notice is a recurring outbreak of *Salmonella* Newport due to the same strain, PFGE Pattern A, in 2002, 2005 and 2006. The history of all *Salmonella* Newport isolates versus pattern A isolates since 2002 shows that PFGE pattern A, has a seasonal trend with peaks between September and January. The illnesses occurred during the same season and in a similar geographic distribution in all 3 outbreaks. This recurring pattern indicates that *Salmonella* is likely to be present in the tomato growing environment. To date, contaminated tomatoes most commonly originate from Florida, Virginia, or South Carolina. Contamination of tomatoes is likely occurring early in the distribution chain, such as at the farm or packinghouse, rather than at the individual restaurants. Possible sources of environmental *Salmonella* contamination include feces from domestic or wild animals in the growing environment.

Dog food and *Salmonella schwarzengrund*

(http://www.cdc.gov/*Salmonella*/schwarzengrund.html)

Next Dr. Casey Barton Behravesh discussed the *Salmonella schwarzengrund* outbreak in humans linked to dog food. A multi-state case-control study demonstrated an association between illness and purchase of dry pet foods produced by Mars Petcare US. Households with ill persons were significantly more likely than matched households without ill persons to usually purchase a brand of dry pet food made by Mars PetCare US that may have been produced at a single facility in Pennsylvania.

The Pennsylvania Department of Health (PADOH) conducted environmental testing in this pet food production facility. One of the environmental samples collected by PADOH yielded the outbreak strain of *Salmonella schwarzengrund*. In tests by the FDA of unopened bags of finished dog food produced by this facility, two brands yielded the outbreak strain of *Salmonella schwarzengrund*. First investigation occurred in March 2006 with four cases in Pennsylvania, all who owned dogs or cats. The second investigation occurred in June 2006 with two cases in Pennsylvania, infants with turtle exposure. The third investigation was in May 2007 with five cases (three infants, one toddler, one adolescent), Ohio also had infant cases. There was a link to dog ownership, no common dog food or treat, and three cases had matching PFGE pattern (JM6X01.0015). During June 2007, the PADOH conducted interviews of several case-patients identified during 2007 using a hypothesis generating questionnaire. These interviews suggested exposure to dogs and/or dry dog food as a possible source of infection. Thirteen cases from Pennsylvania were then re-interviewed using a canine-specific questionnaire; eight (62 percent) owned one or more dogs and remaining cases reported canine exposure. Seven of the eight persons who owned dogs recalled the types of dog food recently purchased. Several brands were purchased, but the households of six (75 percent) case-patients purchased dog food products made by Manufacturer X. Opened bags of dog food (two different brands made by Manufacturer X) from the homes of two patients yielded *S. schwarzengrund* with an PFGE pattern indistinguishable from cases identified during 2006 and 2007 (JM6X01.0015). Both brands were produced by Manufacturer X at a facility in Western Pennsylvania. During May 2007, the PDOH recognized a cluster of *Salmonella schwarzengrund* infections with PFGE pattern 15 or the outbreak strain. *Salmonella schwarzengrund* is a rare serotype of *Salmonella*. Between January 1st, 2006 and September 28, 2007, 66 persons infected with the outbreak strain have been reported to CDC from 18 states, primarily in the north eastern United States. Approximately 40 percent of these cases are in infants. From January 1, 2006 to September 28, 2007, there were 66 cases in 18 states primarily in the northeastern United States. The outbreak strain was identified in samples from two Pennsylvania case households, from two brands of dry dog food (open bags) made by Manufacturer X, and from two dog stool specimens. A total of 45 case households and 144 geographically matched control households were interviewed in eight states including Delaware, Maine, Michigan, Minnesota, North Dakota, New York, Ohio and Pennsylvania. A total of 36 matched case-control sets were completed and analyzed. Contact with a dog was reported by 80 percent of case-patients; this was significantly associated with illness (Matched Odds Ratio (mOR) = 2.8, 95 percent Confidence Interval (CI) = 1.1, 8.0). Among these households, two different brands of dry dog food were associated with human illness. One brand may have been produced at a single facility in Pennsylvania; additionally, several other

brands produced at this facility by a single manufacturer (Mars Petcare US) were weakly associated with case status. Purchase of a brand produced at this facility was reported by 19 case-patient households and was significantly associated with human illness (mOR=5.3, 95 percent CI: 1.8, 17.2). Purchase of one of the facility brands by case-patient households in the two weeks before illness (or last two weeks for control households) was also significantly associated with human illness (mOR=4.1, CI: 1.4, 14.0). Purchase of the other brand associated with illness (mOR=15.8, 95 percent CI: 1.8, 748.9) was reported by only five case-patient households. As far as finished product sampling: on July 26, 2007, Manufacturer X stopped production at Plant 17 for inspection and cleaning; on July 27, 2007, the FDA made a second visit to Plant 17 collecting 150 samples representing seven brands and found that two samples of two brands of finished product were positive. On August 21, 2007, there was a voluntary recall of Krasdale Gravy and Red Flannel brands of dog food, and neither brand linked to human illness. The implications are that pet food is not a sterile product, and that pet owners must be aware of cross-contamination after feeding pets. The conclusion are that human illnesses have been linked with multiple brands of dry pet foods produced by Manufacturer X at a single Pennsylvania facility from persistent contamination in products from Plant 17. This is the first documented *Salmonella* outbreak of human illness associated with pet food in the U.S. Investigations are ongoing to determine why human illness, especially among infants, is associated with dry pet food. Factors under investigation include handling and storage of dry pet food, hand-washing practices, exposure of children to dry pet food, and location in the home where pets are fed.

***Salmonella tennessee* and Peanut Butter**

An epidemiologic study comparing foods that ill and well persons said they ate showed that consumption of Peter Pan peanut butter and Great Value peanut butter were both statistically associated with illness and therefore the likely source of the outbreak. Product testing has confirmed the presence of the outbreak strain of *Salmonella tennessee* in opened jars of peanut butter obtained from ill persons.

From August 1, 2006 to July 31, 2007, there were 714 cases of *Salmonella tennessee* in 48 states. The outbreak was slow-growing from August through November, with a broad peak from December to January. A second peak occurred during the week of the product recall, suggesting increased detection in the setting of media attention and awareness. After the peanut butter recall, there was a marked decline in cases. This was the first U.S. outbreak linked to peanut butter and it was detected by routine *Salmonella* surveillance, enhanced by PFGE. The product was implicated by intensive multistate investigation and detected and unusually high frequency of urinary tract infections.

Contamination at single plant over months and widespread product distribution resulted in large, national outbreak which was controlled after product was recalled and production was halted.

(MMWR June 1, 2007 / 56(21);521-524).
(http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5621a1.htm)

***Salmonella typhimurium* and *S. wandsworth* Outbreak**

A multi-state case-control study demonstrated a strong association between illness and consumption of Veggie Booty, a snack of puffed rice and corn with a vegetable coating. CDC OutbreakNet staff shared this information with colleagues at the FDA on June 27, 2007. After being informed about the outbreak by FDA, the company that manufactures the product issued a voluntary recall on June 28. None of the 60 known illnesses from *Salmonella wandsworth* had onset after the product recall date. Persons were advised to discard any product in their possession. Interviews comparing foods eaten by ill and well persons show that consumption of Robert's American Gourmet brand Veggie Booty was statistically associated with illness and therefore the most likely source of the outbreak. This was the first documented U.S. outbreak and only the second outbreak of *Salmonella wandsworth* documented worldwide. The outbreak almost exclusively affected toddlers, the exact reasons remain unknown; bloody diarrhea was prevalent among affected individuals who reported high and frequent product consumption.
(http://www.cdc.gov/*Salmonella*/wandsworth_071107.htm?s_cid=ccu071607_*Salmonella*_r_e)

Recurring Multistate Outbreak of *Salmonella* Serotype Montevideo Illnesses Among Persons Exposed to Baby Birds

This report was also provided by Dr. Casey Barton-Behravesh. Note: this report discusses mail order hatcheries in the United States, which are not the hatcheries used by commercial poultry producers to acquire chicks. As an overview of the hatchery industry in U.S., there are estimated to be less than 100 hatcheries in the United States that supply baby birds.

Few published data exist that describe bird distribution patterns in the U.S., and any one hatchery may supply birds to customers in several states. Moreover there is no public health oversight in this industry, warning labels for consumers, or housing conditions of birds. From eggs hatched in hatcheries, the baby chicks are sent to agricultural feed stores or residences in cardboard boxes containing as many as 100-120 chicks or 80 turkey poults or 60 ducklings or 32 goslings. In feed stores, baby birds are often promoted for sale as pets for children and are dyed attractive colors. Chicks are easily accessible to customers in the store. Sales of birds peak in the spring and summer, and decline in winter.

In the spring of 2006, a multistate cluster of *Salmonella montevideo* isolates from human stool samples were detected by OutbreakNet. Isolates had a rare PFGE pattern and were all indistinguishable from one another by PFGE, the pattern termed the outbreak strain, or Pattern A. PFGE data suggested a common source of contamination. Initial interviews with patients in three states indicated that exposure to baby poultry was frequently reported. Public health officials in New Mexico identified four patients with outbreak strain exposed to baby poultry and isolated the outbreak strain from environmental samples from New Mexico Hatchery A. On May 21, 2006, an EIS officer from CDC arrived in Santa Fe, New Mexico, to assist with multistate outbreak investigation, and two studies were conducted: case-patient interviews, and an agricultural feed store study. Case definition was a person submitting a stool sample isolate with outbreak strain from January 1 to June 30, 2006. Then a baby poultry-specific questionnaire was developed including dates and severity of illness, exposure to birds, location of purchase of baby poultry, and public health officials interviewed case-patients. Case-patient interview were conducted with 48/56 (86 percent) individuals, females 29/48(60 percent), median age was two years (27 days-82 years), children less than six months were 12/46 (22 percent), bloody diarrhea 25/48 (52 percent), hospitalized 8/48 (17 percent), and deaths were zero.

As far as exposure data: case patients exposed to baby poultry in the five days before illness were 42/48 (88 percent), purchased poultry for pets 18/42 (43 percent), purchased poultry for meat 14/42 (33 percent), purchased poultry for eggs 7/42 (17 percent), kept poultry inside the house 17/42 (40 percent). With regard to purchase information: those warned of health risk at purchase were 3/42 (7 percent), purchased birds from feed store 28/34 (82 percent), hatchery of origin identified 9/42 (21 percent), hatchery of origin was Hatchery A 7/9 (78 percent). It was determined during the investigation that a list of feed stores in New Mexico that advertise in internet Yellow Pages included 54 of 120 feed stores that sold baby birds. A questionnaire specific to baby bird sales was administered and representatives of all 54 feed stores interviewed. The scale of bird sales among the 54 feed stores selling baby birds in New Mexico revealed that 89,557 baby birds were sold in New Mexico feed stores. A median of 675 birds were sold by an individual feed store (range 50 - 23,100). Feed stores that were aware birds can cause salmonellosis were 46/54 (85 percent), warn customers that birds can cause salmonellosis 26/54 (56 percent), gave verbal warning 21/26 (81 percent), written warning 6/26 (62 percent), purchase chicks from Hatchery A 50/54 (93 percent). Actions taken by the 2006 inspection team included an unsuccessful attempt to visit Hatchery A, the New Mexico Livestock Board made it mandatory to place warning signs, and the MMWR with specific recommendations and educational messages published in March, 2007 (http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5612a1.htm): To reduce the risk for illness or death from salmonellosis, persons should be educated about the risks of contact with baby poultry, avoid contact with bird feces, wash their hands after handling baby poultry or anything in contact, children aged less than five years should not handle baby chicks or other baby birds, hatcheries should provide information to prevent transmission of *Salmonella* organisms from birds to humans to customers at agricultural feed stores, and to customers who purchase directly from hatcheries.

Pattern A outbreak continues and CDC is still investigating the situation. As of October 17, 2007, there were 60 case-patients in 23 states with stool samples yielding *Salmonella montevideo* with a PFGE pattern indistinguishable from 2006 outbreak strain (Pattern A). CDC

staff are continuing to investigate this ongoing outbreak, with continued surveillance, identification of additional cases of Pattern A, and a focus on tracking cases over Summer 2007. Case-patient interviews included 38 of 60 (63 percent) case-patients, females 27/59 (46 percent), median age 5 years (3 months-85 yrs), children < 6 mo 7/58 (12 percent), bloody diarrhea 14/26 (54 percent), hospitalized 8/34 (24 percent), deaths 0. Purchase information included those exposed to baby birds in the 5 days before illness 27/38 (71 percent), hatchery of origin identified 20/27 (74 percent), hatchery of origin was Hatchery A 18/20 (90 percent). Case-patients with exposure to baby birds originating from Hatchery A reside in 8 different states (California, Colorado, New Hampshire, New Mexico, Pennsylvania, Utah, Washington and Wyoming). Environmental lab samples in 2007 from Hatchery A match outbreak strain. Conference calls with CDC, NM Department of Health and Livestock Board, USDA, National Poultry Improvement Plan are part of active work to address this problem including planning a Hatchery A site visit and assessment. Hatchery A is aware of ongoing issues and has instituted vaccination of flocks and fumigation of premises. Hatchery A is in rural New Mexico; it advertises 24 types of chickens, ducks, geese, guineas, and turkeys, 300 breeds of chickens. Orders may be done by mail, internet, or phone; the hatchery distributes to other hatcheries. This is similar to other hatcheries across the United States.

There has been a second outbreak of *Salmonella montevideo* with a different PFGE pattern (pattern B) occurring in 54 cases identified in 14 states. The illness onset dates range from March 7 to September 9, 2007. Case-patient interviews were again conducted and showed that there was significant expose to baby birds in the 5 days before illness 18/26 (69 percent), the hatchery of origin identified in 16/26 (62 percent), and the

Hatchery of origin was Hatchery D, Iowa, in 9/16 (56 percent). Specimens from chickens and their environment matched the outbreak strain, but no hatchery samples have been collected to date. The CDC and state health departments continue to monitor this cluster, and to share information with USDA-APHIS-VS, NPIP.

A review of outbreaks of human *Salmonella* infections associated with exposures to baby birds was presented: Hatchery A, New Mexico, *Salmonella montevideo* (pattern A), outbreaks in 2002, 2005, 2006 and 2007. Hatchery B, Michigan, *Salmonella infantis*, outbreaks in 1999 and 2000; *Salmonella* serotype 4, 5,12,i:-, outbreak in 2006. Hatchery C, Washington, *Salmonella ohio*, outbreak in 2006, 1995, 1996, 2003, 2004, and 2005.

It was concluded that some *Salmonella* serotypes do not cause clinical illness in poultry. The 2007 actions included new educational efforts: Zoonoses Education Coalition created stickers and flyers available at the CDC Healthy Pets Healthy People website, and distributed through National Association of State Public Health Veterinarians (NASPHV) listserv; contacts are being made within the poultry feed industry to discuss putting health messages on feed bags; labeling shipping boxes is being considered; information about baby chicks will be sent through the School Nurses Association and other groups; and they are currently exploring other ideas.

Conclusions about *Salmonella montevideo*: Human illnesses due to *Salmonella montevideo (Pattern A)* are an ongoing and recurring problem in the U.S. Hatchery A has been implicated repeatedly. Hatchery A is attempting a vaccination program for control, though no effective intervention has been undertaken to date. CDC continues to conduct surveillance for baby bird-associated outbreaks. Human infections with multiple serotypes of *Salmonella*, particularly montevideo, are linked to baby birds. There is an ongoing outbreak of *Salmonella montevideo (Pattern B)* where several hatcheries were repeatedly implicated in outbreaks of human illness. Serious human illness has occurred including hospitalizations especially in children. Current educational efforts are insufficient. Few patients (seven percent) recalled receiving education. Despite efforts, human illnesses still occur, especially in children. No coordinated efforts exist to target this problem.

Recommendations: State agriculture and public health agencies should collaborate to address problem of human illness associated with exposures to baby birds from these hatcheries. State agriculture and public health agencies should continue to advise the public on risks associated with baby bird contact, especially to children. State agriculture agencies should continue to work directly with hatcheries to reduce the likelihood of any *Salmonella* contamination. Agricultural feed stores should provide educational material to customers concerning risk of *Salmonella* infections from baby birds. CDC's Healthy Pets Healthy People

website is available and state health agencies are available to enhance messages. Hatcheries should provide educational materials to mail order customers. CDC is exploring partnerships with local, state, and federal agencies. We need to more accurately define this niche of hatchery industry, and provide specific recommendations for the clean-up of hatcheries. **(**http://www.cdc.gov/mmwr/preview/mmwrhtml/00046940.htm, MMWR 56(12) March 30, 2007, MMWR 46(11) March 21, 1997).

A Multiplex Polymerase Chain Reaction (PCR) Method for the Rapid Serotyping of Common Clinical Isolates of *Salmonella*

This was presented by Dr. Jonathan G. Frye, Bacterial Epidemiology and Antimicrobial Resistance Research Unit, USDA, Agricultural Research Service (ARS). A description was given of work using *Salmonella* genomics to develop a method of serotyping *Salmonella*. The science of genomics was described showing what kind of information it gives us to develop an alternative to traditional serotyping methods. This includes data mining to identify genes that are serotype or clone specific and development of assays to detect them. Dr. Frye presented data from a project of serotype determination by multiplex PCR. First, some background. *Salmonella enterica* is composed of over 2,500 different serotypes. These can be further divided into subtypes and clones. They can differ from each other in their capability to infect specific hosts, cause disease, and become antimicrobial resistant. Some examples include: generalists like *Salmonella typhimurium* that can infect many different hosts, is fairly virulent in most hosts and can also be highly drug resistant. *S. enteriditis* is similar in its ability to cause disease, but is usually isolated from poultry and does not have high levels of antibiotic resistance. *S. kentucky* is also often isolated from poultry, but causes little disease and very rarely ever infects humans or becomes resistant to drugs. *S. newport* on the other hand is isolated mostly from cattle, also causes human disease and is highly drug resistant. The reasons for these differences are reflected in the genetic variation between these serotypes, which is not very well understood. They are studying *Salmonella* genomics to improve our ability to understand these genetic differences responsible for so many serotypes.

What is causing this variation in *Salmonella* and why is it important to study? First, all *Salmonella* are not created equal and some can be more dangerous than others. Second, if we want to be able to trace *Salmonella* back to their sources and understand their epidemiology, we must be able to identify different serotypes, subtypes and clones. This must be done with rapid, high-throughput assays. To do this we must investigate the genetic differences that are responsible for the wide range of serotypes and their varying phenotypes. This will pay off two-fold: we will begin to understand the genes that cause these differences and can target their function with intervention strategies and use them to identify and trace clones and determine their epidemiology.

The technology used to investigate this is genomics. What is genomics? The science of genomics began with the sequencing of whole genomes. This gave us data about every gene in an organisms genome and assigned many of them functions. By looking at the genetic map of the *Salmonella* genome we have learned that once several genomes had been sequenced the next step, comparative genomics can be done. This is where the gene content and arrangement of genes in one genome can be compared to others. This allows us to find common conserved genes that make strains related to each other via a common ancestor and can also tell us things about common phenotypes they may possess. For example, *E.coli* and *Salmonella* have about 80 percent identical genes and they have the common phenotype of being enteric bacteria that live in the gut of animals. This also allows us to do the converse which is finding genes that are different between strains that can also be responsible for the different phenotypic abilities they have. This is exemplified by *Salmonella typhi* and *typhimurium*, who only differ by about 13 percent of their genes. They both are enteric pathogens, but typhimurium usually causes gastroenteritis and is a host generalist, while the typhi causes enteric fever and only infects humans. The several hundred genes that differ between these two serotypes will likely explain these phenotypic differences. To construct the *Salmonella* DNA microarray the whole sequence of the *Salmonella typhimurium* LT2 genome was determined and all of its 4600 genes identified. Then they designed primers to amplify the whole open reading frame for every gene in the genome, amplified these, scored them for quality and then arrayed them with a robot onto glass

slides for hybridizations. There are two basic kinds of analysis that you do with microarrays. The first is the well known application of mRNA analysis. To do this you label mRNA by reverse transcription into labeled cDNA which you hybridize to the microarray. You then scan the microarray and detect the hybridization of the samples to each gene. If you compare mRNA from a control and experimental condition, then the ratio of hybridization correlates with differences in gene expression. The second kind of analysis, which is what I'm going to describe today, looks at the presence of genes. Here genomic DNA from a control strain and a test, or unknown, strain is labeled with different colors and then hybridized simultaneously to the microarray. The ratio of hybridization signals determine the presence or absence of genes in the test strain as compared to the control strain.

So what can you do with that kind of data? First you can do phylogeny. Previously the phylogeny of *Salmonella* was determined by Mutli-Locus Enzyme electrophoresis and gene sequencing by Fidelma Boyd and co-workers. This data split the *Salmonella* into two species and *S. enterica* into seven subspecies and 2,500 serotypes. With analysis of DNA through comparative genomic hybridization you can do things like study the gene content differences between the subspecies and serotypes of *Salmonella*. To determine the gene content that could give useful phylogenetic data, they did comparative genomic hybridizations of the *Salmonella* Reference Collection C using LT2 as the control strain.

This is a one way look and can only detect the genes that strains lack as compared to LT2. All the genes are in gene order on the chromosome from 1 through to 4600.

As test strains get more closely related to LT2 there are fewer deletions as they are compared along the backbone of the genome. When this data is used to draw a phylogenetic tree using Phylogenetic Analysis Using Parsimony (PAUP) software with neighbor joining or maximum parsimony with 100 boot straps, we get a very similar tree to that found with Multi Locus Enzyme Electrophoresis. But what we also get are the identity of genes that are specific for the subspecies of *Salmonella*. For example: if we look at the major evolutionary junctions we can see that where *Salmonella* splits from the other *enterobacteriaceae* about 513 genes are acquired including those in *Salmonella* pathogenicity Island 1. Where enterica splits from the other *Salmonella* we see an acquisition of 111 genes including *Salmonella* pathogenicity Island 2. When diphasic *Salmonella* came along, 105 genes were acquired including the extra flagella genes. There are about 216 genes that appear to be specific for subspecies I, which are the *Salmonella* responsible for most warm blooded animal infections. Finally the typhimurium have about 144 unique genes, many of which are phage specific. With this sort of information the first thing we can do is improve on serotyping. Serotyping relies on reaction of antigens on the cell surface reacting with specific antibody. This is to the O and the H antigens and is scored by the Kaufmann-White scheme. Why replace serotyping by serum? It is difficult, slow, often fails and is expensive. This project's goal was to use genomics to develop a molecular assay for the rapid identification of serotype. To do this we had to: first collect the genomic data by sequence analysis and DNA microarray analysis of serotypes and mine this data for genes that are specific for serotypes or clones. Second develop detection methods, in this case a multiplex PCR, and third evaluate these and adapt them to high-throughput techniques. From that data, we selected genes that could differentiate between the 15 most prevalent serotypes of human isolates. We then used PCR to detect these genes in test strains and then combined them into multiplex reactions. The typhimurium, STM, set is one multiplex and the typhi, STY, is the other multiplex. There are individual PCR reactions used to detect each of these ten genes, some are multiplexed together. The technique worked very well and has been recently published (Journal of Clinical Microbiology, Oct. 2006, Vol. 44, No. 10, p. 3608–3615). We are continuing this work to develop it into a high-throughput technique (real-time detection, automated capillary analysis, Luminex, etc.) are being developed. Future projects include expanding multiplex PCR to identify the top animal isolates and specific clones.

National Anti-Microbial Resistance Monitoring System (NARMS) Update

Dr. Jonathan Frye and Dr. Paula Cray of the Bacterial Epidemiology and Antimicrobial Resistance Research Unit, USDA-ARS, gave a brief update on work with the NARMS. The full report is included in these proceedings.

Understanding the Interaction of *Salmonella* with its Animal Hosts: The Practical Implications of Pathogenesis Research

Dr. Craig Altier, Department of Population Medicine and Diagnostic Sciences, Bacteriology Laboratory, Animal Health Diagnostic Center, College of Veterinary Medicine, Cornell University presented this report.

In the present era when antimicrobial therapy is losing the battle in treating salmonellosis, we need to understand the complex environment in the intestinal tract where bacteria reside and interact with the host. This may allow other treatments to be successfully developed for salmonellosis.

Salmonella invades epithelial cells as a first step in virulence. Invasion is controlled in complex ways, i.e., the needle complex that is part of the type III secretion system encoded on *Salmonella* pathogenicity island I. Bacteria need to sense their environment and in doing so they turn genes on and off. Short chain fatty acids are produced by the intestinal microbiota and affect *Salmonella* invasion. Some fatty acids turn invasion genes on such as acetic and formic acids, while propionic and butyric turn invasion genes off. We wondered whether this had any in vivo application? For example, dietary microencapsulated butyric acid supplementation in chickens results in a reduction of both fecal shedding and cecal colonization with *Salmonella*. Dr. Altier's laboratory is studying how the fatty acids actually work in the gut environment. Dietary supplementation with fatty acids may control *Salmonella* infection of animals. We need to also understand how prebiotics and probiotics work, i.e., their specific factors, since it is likely that these bacteria do not just occupy a niche that blocks invasion by other bacteria.

Multi-Drug Resistant (MDR) *Salmonella dublin* in New York State Cattle Populations

Dr. Belinda Thompson, Department of Population Medicine and Diagnostic Sciences, Veterinary Support Services, Animal Health Diagnostic Center, College of Veterinary Medicine, Cornell University presented this report. Dr. Thompson discussed a recent cluster of *Salmonella dublin* outbreaks which the Animal Health Diagnostic Center had been involved in providing diagnostic testing and consultation. *Salmonella dublin* was isolated for the first time in 1988 and continued to see it through the middle of the 1990's. Patrick L. McDonough, David Fogelman, Sang J. Shin, Michael A. Brunner, and Donald H. Lein published a paper summarizing the descriptive epidemiology of a cluster of 26 outbreaks in the northeast between 1988 & 1995(J Clin Micro 1999;37(8):2418-2427). Interesting parts of that summary included the fact that the age range tended to be just 7-16 weeks of age, in calves presenting with pneumonia and not diarrhea. Outside of that age range, just 2 adult cases were identified. Since that time there were no isolates between 1996 and 2006, until the first clinical isolate in the current cluster on September 1, 2006. Since that time, we have had confirmed cases on 3 additional New York dairies, and one veal facility outside of New York but close to the New York border.

***Salmonella dublin* Farm 1.** Farm 1 was a 500 milking cow dairy that raises all their own replacement heifers. The first case presented to us following a report of increased calf morbidity and mortality in the previous two weeks, with a loss of 6/20 calves in the 3-4 month age range, from a barn of ~100 weaned calves. When questioned, there were no reported morbidity or mortality issues of significance in any other age or management group on the farm, including fresh cows and the hutch calves about to enter the weaned calf barn. In the previous year, there had been a single isolate of *Salmonella thompson* in a sick animal, and also a viral isolation of bovine viral diarrhea (BVD). The illness was described by the producer and referring veterinarian as beginning with a weak calf which continued eating, and then on about day four or five, developed dyspnea, had a body temperature of 104° to 105°F, was dull with dropped ears, became recumbent and died. The first case which presented was sick for one week, presented with difficulty breathing and was recumbent with a temp of 105°F, and also had loose feces with mucus. A blood culture was collected ante-mortem, and the calf was euthanized in extremis. *Salmonella dublin* was grown on the blood culture and also from the lung and gastrointestinal track. A second case presented 1 week later. A fecal sample was positive for *Salmonella dublin*. The isolates were equally MDR, and alarmingly so. They were only sensitive to gentamycin, enrofloxacin and trimethoprim/sulfamethoxazole. In addition to consulting with the referring veterinarian, we reported the findings to the New York State veterinarian and jointly issued and

animal health alert (http://www.diaglab.vet.cornell.edu/pdf/*Salmonell*adublin.pdf: this report is included in these proceedings). As far as the necropsy findings, all the calves had pneumonia, but they also had fibronecrotic enteritis and hepatitis. One calf also had necrosis and inflammation of the spleen. We were able to culture the *S. dublin* from both lungs and jejunum tissues. The control measures on the farm included not letting any more calves to enter this building, and renting a vacant building as a weaned calf barn. They also improved many aspects of calf care, including hygiene and ventilation. It was unknown if they had fed unpasteurized whole milk to the calves. They also employed the *Salmonella newport* Bacterial Extract SRP vaccine, using 2 doses three weeks apart. Some surveillance testing on the farm was done to try to determine that the outbreak had ended; milk filter socks were negative on *Salmonella* culture 2 weeks, 1 month and 6 months following the initial case. Five months later 35 calves between 10 days and 15 weeks of age were culture negative, and 10 environmental samples from farm also negative; they did not sample the weaned calf barn.

Farm 2. Farm 2 presented approximately 1 month after Farm 1. They reported a total of 8 dead calves in two management age groups, 1 euthanized bred heifer, 1 sick cow 60 days in milk, and 10 abortions in the previous 2 months. This is a dairy milking 500 cows and raising its own replacements. Our bacteriology section cultured *Salmonella dublin* from a fecal sample of an 8 day old sick calf. Little information was given about the clinical illness or means of control employed. Surveillance sampling 1 month later found *Salmonella dublin* in an environmental swab taken from a calf hutch that had housed a sick calf. 12 adult cow fecal samples considered "high risk" and 19 other environmental samples were all negative.

Farm 3. We have little information about Farm 3, a veal grower in Pennsylvania near the New York border. If it was operated like many veal operations, it could conceivable have acquired bull calves from either of the other two far Ideally, most operate on an all in all out basis with thorough cleaning and disinfection between batches.

Farm 4. Farm 4 presented to us in December of 2006. The clinical presentation was described as diarrhea and death in calves. No herd size or morbidity/mortality information were given. However, the veterinarian indicated that the herd bought baby heifer calf replacements from only a single source. That source turned out to be Farm 1. Prior to the positive clinical sample submitted in December, two other *Salmonella* fecal cultures were submitted, during the previous 2 months, that were negative. No clinical information was provided for those cases, either.

Farm 5. Farm 5 presented to us more recently, in August, 2007. This is a farm with about 200 milking cows. It has been a closed herd for 7 years. Of 30 calves in the weaned calf group, 10 were affected with a respiratory illness with high fevers. The majority of the calves fully recovered with Tulathromycin and Flunixin meglumine. Several calves developed severe dyspnea and were also treated with dexamethazone, and made remarkable recoveries, according to the herd veterinarian. The tenth calf was selected for euthanasia for diagnostic purposes. There had been an unrelated *Salmonella* serogroup C3 surveillance isolate in an environmental sample and a milk filter. The lung culture from the euthanized calf was positive for *Salmonella dublin*. A nasal swab taken ante-mortem did not grow *Salmonella dublin*. This calf had a fibrinous-histiocytic pneumonia and a hepatitis. No intestinal samples were submitted from this calf. At the time of the diagnosis, the herd veterinarian and producer thought the outbreak was coming to a close. The herd veterinarian reported generally exceptional calf management. Because this herd is not trying to expand, and tends to have an aggressive voluntary cull program, the herd veterinarian expressed some interest in testing heifer calves for carriers, and also using the *Salmonella newport* SRP vaccine. One month later, lung from a 7 day old dead calf was positive for *Salmonella dublin*. A milk filter sock was *Salmonella* culture negative. The main biosecurity concerns voiced by the producer and herd veterinarian were rendering trucks and veterinarians visiting the farm.

In 1980, in fact, there was a paper which described cases of *Salmonella dublin* dermatitis in 3 bovine veterinarians (Br Med J. 1980 March 22; 280(6217): 815–818). One of the individuals was apparently infected twice, 3 years apart, the first time delivering a stillborn calf, and the second time attending a cow for a retained placenta. The other two veterinarians were apparently infected delivering stillborn calves. At the time, the article speculated in the role of bovine veterinarians as vectors, rather than just fomites.

In summary, we are trying to learn about this emerging disease presentation in our geographical location. We are very concerned about the public health risks of this potentially dangerous, multi-drug resistant *Salmonella dublin*. We are seeing less consistent age ranges just in this small group of farm outbreaks, and a more varied clinical picture, than was seen in the 1988-1995 group of outbreaks. Necropsy findings include pneumonia, enteritis and hepatitis. We have identified an epidemiological link between two of the five far. There is also a difference between farms in the morbidity and mortality reported.

The full Animal Health Advisory follows this Committee report.

Emergence of Type 035/187 MDR *Salmonella typhimurium* Clone; 60 Farm Dairy Study

Dr. Thomas E. Besser, Department of Veterinary Microbiology and Pathology, College of Veterinary Medicine, Washington State University, presented an update on this study.

Studies were funded through a National Institutes of Health (NIH) Food and Waterborne Diseases Integrated Research Network (FWD-IRN) contract; beginning January 2004, Washington human- and animal-source isolates were compared by serovar, antimicrobial resistance and PFGE type. Since 2004 we analyzed 510 avian, 18 65 bovine, 2347 human, and 750 other *Salmonella* isolates. When we compare serotype and resistance patterns across species, it does seem as though bovine source isolates share these phenotypes with human source isolates more frequently than other species.

Salmonella typhimurium TYP035 and TYP187: A newly emerging *S. typhimurium* was detected that was distinct from DT104 by PFGE, was variably resistant (2 – 9 antimicrobials), and had Washington PulseNet PFGE profiles TYP035 and TYP187. The features of TYP035 and TYP187 were as follows: Plasmid Profiles - 15/38 ~ 120 kb plasmid, 23/38 had variable plasmid profiles, and there was no correlation with resistance phenotype or PFGE banding variations. Phage Typing – (Dr. Rafiq Ahmed at the National Microbiology Laboratory, Winnipeg, Manitoba, Canada) all 31 TYP035 isolates were phage type 'untypable' with the Colindale phage panel. The percent of S. Typhimurium that are TYP035 and TYP187 have been steadily increasing since 2000 to a greater extent from cattle versus human sources.

In summary TYP035/TYP187 is a newly emerged epidemic clone of MDR *Salmonella typhimurium*; it is apparently regional (Pacific Northwest), primarily from a bovine reservoir(?).

Longitudinal study of *Salmonella* introductions into Washington: For Sixty farms that had a previous history of diagnostic laboratory submissions resulting in *Salmonella* were reviewed. These farms had seven visits over 2.5 years, with various samples taken for *Salmonella* culture including fecal pools, slurry, milk filters, feeds. We characterized all *Salmonella* isolates to identify new strain types. The seventh sampling now underway, and the introduction rate of *Salmonella* strains is so far higher than study design assumption; on-farm and in-commerce feeds *Salmonella* isolation rates are similar. Our goal is to estimate the percentage of new *Salmonella* introductions due to animal movement and feeds. We are currently analyzing the completed data set.

Update from the National Pork Board was given by Dr. Paul Sundberg, National Pork Board. *Salmonella* background information: there are an estimated 1.4 million cases per year in United States. There is no declining trend in human cases, in spite of declines seen in Food Safety Inspection Service (FSIS) in-plant pork carcass testing. There are more than 2,500 serotypes, and there is some disconnect seen between common serotypes found in pigs versus humans. *Salmonella typhimurium* is common in both. Confirmed food-borne outbreaks with known etiology 1990-1997 showed that four percent were from pork, 64 percent from a vehicle other than pork and 32 percent had no known etiology. Industry objective is to lower the incidence of salmonellosis in a Farm to Fork Team approach using pre-harvest on-farm interventions, and dealing with the issues of transportation, lairage, harvest, and post-harvest. Feed/water interventions have provided mixed results that are inconsistent at best. On-farm interventions are perhaps not the best location, re-infections occur at lairage. The Pork Quality Assurance Program (PQA PlusTM) was launched in June 2007 as a hazard analysis critical control points (HACCP)-based approach dealing with physical, chemical and biological hazards.

There have been opportunities for on-farm *Salmonella* testing: the National Animal Health Monitoring System (NAHMS) 2000 study tested 5420 samples (6.2 percent positive);

Collaboration for Animal Health, Food Safety an Epidemiology (CAHFSE) program tested a total 26/39 sites positive (67 percent), 155/596 pens positive (26 percent), 371/3654 individual samples positive (10.1 percent). Cleaning and disinfection may reduce or eliminate exposure, and limiting exposure may be achieved by limiting transportation times. Stress from transportation is not fully understood, and either may increase shedding and exposure, or may not have an effect on shedding and infection. Lairage (holding pens at a packing plant) may have an impact on carcass contamination. One should reduce or limit exposure in pens because infection can occur within 30 minutes; two hours is the limit of holding and no holding actually decreased *Salmonella* in sows. This approach is not practical for market hogs. Moisture in pens correlates to increased *Salmonella* infections. Cleaning and disinfection of pens has had variable success; perhaps there is too large a fecal load to deal with successfully.

Salmonella Performance Standards: FSIS issued the Pathogen Reduction Act, Final Rule on July 25, 1996. Plants must develop Standard Operating Procedures, develop a Hazard Analysis and Critical Control Point (HACCP) System, implement testing for E. coli and *Salmonella*. HACCP is based on prevention and not detection. The Pathogen Reduction Act sets *Salmonella* performance standards (the maximum allowable prevalence of *Salmonella*) for slaughter establishments. In the packing plant the combination of scalding and de-hairing, and carcass wash does a good job at reducing *Salmonella*; pork carcasses are well below the performance standard. FSIS has new Performance Standards Sample, i.e., set data will be recorded in 3 categories: Category I - low exposure of *Salmonella* to public, Category II - elevated exposure of *Salmonella* to public, and Category III – greatest exposure of *Salmonella* to public. FSIS expects to conduct Food Safety Assessments (FSA) in establishments in Category III and may conduct FSA's in establishments in Category II. FSIS will monitor the change in control from Category III as well as from Category II to Category I for a determined timeframe, and is considering more aggressive steps to ensure increased control of *Salmonella* Negative incentive, i.e., publishing the names of establishments and their performance status within each category. The positive incentive, however, is allowing establishments to increase slaughter volume based on consistent control of low exposure to *Salmonella* and other performance indicators.

Summary: Raw pork had only a 0.9 percent *Salmonella* incident rate in 2004 on the NARMS national retail meat survey. Pork carcasses testing positive for *Salmonella* are 75 percent below the *Salmonella* standard set by the USDA and going down each year; only four percent of foodborne illness outbreaks with a known cause were due to pork or pork-containing foods.

National Veterinary Services Laboratory (NVSL) National *Salmonella* serotype Report July 2006- June 2007 was presented by Brenda R. Morningstar, Diagnostic Bacteriology Laboratory, NVSL-VS-APHIS-USDA. Details of this report are included in these proceedings.

Update from the National Poultry Improvement Plan (NPIP) was presented by Dr. C. Stephen Roney, NPIP-VS-APHIS-USDA. Dr. Roney provided a historic look at Pullorum reactors in the NPIP from 1921 to today, as well as at the Pullorum/Typhoid NPIP from 1975 to 2007. Details of this report are included in these proceedings.

There was not a report from the Subcommittee on *Salmonella* Diagnostics, but Dr. Gingerich provided a brief update for the Subcommittee to monitor the *Salmonella enteritidis* (SE) Food and Drug Administration (FDA) Proposed standard. Basically the Subcommittee had been on hold after finishing its initial charge by former Chair Dr. David Castellan, and had been waiting for a declaration from FDA. Dr. Gingerich agreed to re-activate the Subcommittee to determine the status of the SE Layer Flock Program.

The Chair reported on the following topics that were discussed at the Committee on Program meeting, Saturday, October 20, 2007:

1. Conference calls with Executive Committee (EC);
2. USAHA recommendation and resolution process;
3. Value of Committee reports;

4. Dr. Breitmeyer will be the EC member liaison to the Committee;
5. Importance of year-round communication for Committees; and
6. USAHA developing policy on recording and videoing of meetings.

Committee activities and projects for the coming year should be:

1. Promote the availability and ease of use of fingerprinting strategies such as phage typing (*S. typhimurium, S. enteritidis*), pulse-field gel electrophoresis (PFGE), Multi Locus Sequence Typing (MLST), microarray, other that would facilitate (a.) the sharing of fingerprint data between agencies (USDA, FDA, CDC, state departments of health and state departments of agriculture), and (b.) microbial source tracking (MST) in order to detect the emergence and spread (in real time) of (new/reemerging) *Salmonella* strains or perhaps clones.
2. The Committee needs to develop a resolution regarding the fingerprinting strategies for consideration at next year's Annual Meeting. Our plan of action may involve letter writing to various agencies' discussions with Dr. Paula Cray at NARMS and USDA VetNet, NVSL in order to determine the best course of action to promote re-funding for Veterinary Sentinel sites for detecting trends in antimicrobial resistance, to promote creation and funding for a Veterinary PulseNet (now termed USDA VetNet) as a counterpart to FoodNet/PulseNet.
    a. Members were urged to have a look at Med-Vet-Net site and WHO Salm Surv web pages (http://www.medvetnet.org/cms/ and http://www.who.int/salmsurv/en/) for examples of national reports that are routinely disseminated from Canada, the United Kingdom, and other countries. It was thought that the United States agencies at USDA and CDC need to provide for quicker reporting of *Salmonella* serotypes in some sort of web-based format to members of the U.S. *Salmonella* research, regulatory, other government constituencies.
3. The Committee identified a need to better assess *Salmonella* detection methods and fingerprint methodology by reviving and enlarging the scope of Subcommittee on Diagnostics; Donald Munroe from the University of Pennsylvania School of Veterinary Medicine was interested in assisting in this important effort. Plan a mini-symposium for next year (to be held during the general meeting) and seek help from the Executive Committee in the planning of this mini-symposium.
4. The Committee wants to consolidate and update the nation/states' SE activities. What is the status of the FDA layer flock program?; what is the current real time prevalence in flocks and human disease incidence? Dr. Gingerich from the University of Pennsylvania agreed to revive/activate the Subcommittee on FDA Proposed SE Rule and to start to gather information on the various state's SE plans, just in case the FDA's SE Layer Flock program is not implemented, i.e., what is plan "B" for the nation?
5. The Committee wants to review information and trends in antibiotic resistance, and in doing so promote the re-funding for Veterinary Sentinel sites for detecting trends in antimicrobial resistance (see point 1 above about a Resolution that needs to be brought forth). Ha comprehensive review of mechanisms of antimicrobial resistance that are being detected, e.g., *S. typhimurium*, versus *S. newport*, etc. This might be another topic for a mini-symposium, if not next year, then the meeting after that.
6. What is the status of the animal industries with alternatives to antimicrobial treatment, e.g., vaccination strategies and probiotics? This is a very important area of investigation in light of the fact that we are losing the battle with antimicrobial therapies. Might this be another mini symposium topic?
7. The Committee needs to revive our work on Best Management Practices (BMP), HACCP, the New York State Cattle Health Assurance Program (NYSCHAP)-like programs; have these strategies been compiled and validated? (see Dr. Scott Wells comments from last year's meeting in which he stated that while we need BMP type practices as a means to prevent and control salmonellosis, they also need to be validated measures). Past USAHA *Salmonella* Subcommittees have attempted to compile these and promote both their development and use/dissemination.

8. There is real concern for veterinary clinics and hospitals with historical and ongoing MDR *Salmonella* infections, for a review of Infection Control (IC) Programs that may or may not be available for such premises, for frequent nosocomial infections and ensuing spread to the community and to non-source farms/flocks. It was thought that we should initiate collaborations with such groups as the Veterinary Infection Control Society (VIC-S, vics-l@colostate.edu), with the Association for Professionals in Infection Control and Epidemiology (APIC, http://www.apic.org//AM/Template.cfm?Section=Home), or the American College of Veterinary Internal Medicine (ACVIM, http://www.acvim.org/) to promote IC programs in clinics, hospitals, and veterinary clinics. Perhaps we should aim to write a position paper on this very important topic, which often involves food-fiber type animals, horses, and on occasion companion animal patients in our private and university veterinary clinics/hospitals.

We also wanted to collate or create the resources to monitor and detect resistance that may be developing to antiseptics commonly used in veterinary facilities. Several members volunteered to share information on protocols to do such testing.

NARMS Update

Jonathan Frye
Paula Cray
Bacterial Epidemiology and Antimicrobial Resistance Research Unit,
Agricultural Research Service

The Bacterial Epidemiology and Antimicrobial Resistance Research Unit is the animal arm of the National Antimicrobial Monitoring System (NARMS), while the Food and Drug Administration (FDA) works on food isolates, and the Centers for Disease Control and Prevention (CDC) works on human isolates. There are over 2500 serotypes of *Salmonella* and serotype is important when discussing resistance.

Since 1997 the animal arm of NARMS has tested over 52,000 isolates, all of which are stored at the Russel Research Center. These isolates come from a variety of sources including on-farm, diagnostic and slaughter/processing plants. For the purposes of this talk, the majority of isolates originate from slaughter/processing. Serotypes appear to vary overtime for reasons unknown. They also vary by source, particularly animal source and may be affected by host adaptation and/or environmental adaptations. Information on the top 5 serotypes recovered from human and animals since 2000 was provided (Table 1). Note that data for human isolates beyond 2004 is currently unavailable.

For the human serotypes it is interesting to note that the top 5 serotypes did not change over the years, they only changed in frequency of isolation. More variability is noted for the animal isolates, particularly the emergence of newport from 2001 to 2004 at which time it dropped out of the top 5 [but did remain in the top 10]. Note also that we differentiate between typhimurium and typhimurium 5- and believe there are important differences regarding acquisition of resistance between the two. Overall, regardless of serotype, approximately 50 percent of the isolates are pan-susceptible. In contrast, approximately 79 percent of human isolates are pan-susceptible.

We see important differences when we look at pan-susceptible levels by animal source. Isolates originating from swine and turkey are least susceptible, although in part, this is driven by serotype. With regard to multidrug resistance it was noted that resistance to 5 or more antimicrobials has been declining over the last 2 years (Table 2). With regard to cattle isolates in 2006, *S. newport*, *S. reading* and *S. dublin* are the serotypes which exhibit more resistance than the others (Table 3). If we look at swine isolates we can see similar differences. We can also see differences within serotypes as shown by typhimurium 5 which has high levels of resistance (Table 4). If we look at chicken isolates, again there are differences. *S. kentucky* is the most often isolated serotype and is only moderately resistant. If we compare *S. typhimurium* to *S. typhimurium* 5- we can see some differences in resistance levels (Table 5a, 5b). Turkey isolates are also different from chicken isolates. *S. hadar* is the most often isolated serotype, while *S. kentucky* is rather rare. But we do see high levels of resistance in *S. heidelberg, S. agona* and *S. st. paul*.

Percentage of *Salmonella* resistant to nalidixic acid and/or with decreased susceptibility to ciprofloxacin, 1997-2006* (Slaughter isolates) differ from human versus animals; human data show a slight increase since 2002, conversely, a decrease among animal isolates has been observed.

From 1997 to 2006 isolates representing *S. typhimurium* DT104 were noted that 48 percent of the isolates are from swine while 43 are from cattle and dairy cattle. Among slaughter isolates of DT104, it is interesting to note that in 2005 more isolates were from the combination of the total chicken and swine, than from cattle, and in 2006, chicken is the primary source of isolates. Regardless, the overall number of DT104 isolates has been declining each year.

The majority of *S. newport* isolates are recovered from diagnostic sources. Since reaching a high of 9 percent in 2003, the percentage of newports per year has declined. In contrast, for available data, a similar decline has not been observed among human isolates (Table 6).

In conclusion, in general, multidrug resistance (MDR) appears to be declining, this includes *S. newport*; there is a lag observed in isolates from humans; many other serotypes have an MDR phenotype and the implications remain unknown. Can we predict what the next MDR serotype of clinical importance will be?

Table 1. This table highlights the top 5 serotypes recovered from human [top] and animals [bottom] since 2000.

2000	2001	2002	2003	2004	2005	2006
Enteritidis	Typhimurium	Typhimurium	Typhimurium	Typhimurium	ND	ND
Typhimurium	Enteritidis	Enteritidis	Enteritidis	Enteritidis		
Newport	Newport	Newport	Newport	Newport		
Heidelberg	Heidelberg	Javiana	Heidelberg	Javiana		
Javiana	Javiana	Heidelberg	Javiana	Heidelberg		
2000	2001	2002	2003	2004	2005	2006
Typh 5-	Heidelberg	Heidelberg	Kentucky	Kentucky	Kentucky	Kentucky
Montevideo	Kentucky	Kentucky	Typh 5-	Typh 5-	Heidelberg	Heidelberg
Typhimurium	Typh 5-	Newport	Newport	Typhimurium	Typh 5-	Enteritidis
Kentucky	Newport	Typh 5-	Heidelberg	Heidelberg	Typhimurium	Typh 5-
Heidelberg	Typhimurium	Typhimurium	Typhimurium	Newport	Enteritidis	Typhimurium

Table 2. *Salmonella* Multiple Drug Resistance

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Animal Tot. # Tested	2391	3318	8508	7834	5739	6977	5353	4873	4412	3110
Total # Pan Susc. (%)	65.8	51.9	55.7	52.9	48.4	52.3	48.7	48.1	51.9	50.6
Total # R = 1 (%)	9.4	8.1	8.8	9.8	7.5	8.0	8.2	7.7	7.5	12.4
Total # R $\geq$ 5 (%)	11.1	17.9	14.8	19.4	22.4	22.2	25.1	24.2	19.7	18.6
Total # R $\geq$ 10 (%)	0.8	2.0	1.3	5.5	5.4	7.3	7.0	3.2	2.8	3.6

Table 3. Percent Resistance- Top Serotypes Cattle Isolates, Slaughter, 2006

	Montevideo N=63	Muenster N=38	Newport N=30	Cerro N=24	Anatum N=23	Reading N=21	Dublin N=19	Typh N=15
Amox/Clav Acid	**0.0**	**0.0**	**76.7**	**0.0**	**4.3**	**76.2**	**31.6**	**26.7**
Ampicillin	**0.0**	**0.0**	**80.0**	**0.0**	**4.3**	**81.0**	**57.9**	**53.3**
Ceftiofur	**1.6**	**0.0**	**76.7**	**0.0**	**4.3**	**76.2**	**31.6**	**26.7**
Chloramphenicol	**0.0**	**0.0**	**66.7**	**0.0**	**4.3**	**76.2**	**57.9**	**53.3**
Gentamicin	**0.0**	**0.0**	**3.3**	**0.0**	**0.0**	**38.1**	**10.5**	**0.0**
Kanamycin	**0.0**	**0.0**	**13.3**	**0.0**	**0.0**	**42.9**	**47.4**	**6.7**
Streptomycin	**1.6**	**2.6**	**83.3**	**0.0**	**8.7**	**76.2**	**68.4**	**53.3**
Sulfizoxazole	**1.6**	**2.6**	**83.3**	**0.0**	**4.3**	**76.2**	**73.7**	**53.3**
Tetracycline	**4.8**	**2.6**	**83.3**	**4.2**	**26.1**	**100.0**	**68.4**	**53.3**

Table 4. Percent Resistance- Top Serotypes Swine Isolates, Slaughter, 2006

	Derby N=56	Anatum N=33	Johannesburg N=29	Anatum var. 15+ N=28	Typh var. 5- N=21	Infantis N=16	Saintpaul N=16	Heidelberg N=13
Amox/Clav Acid	**0.0**	**0.0**	**6.9**	**0.0**	**0.0**	**6.2**	**0.0**	**7.7**
Ampicillin	**1.8**	**0.0**	**10.3**	**0.0**	**81.0**	**6.2**	**6.2**	**7.7**
Cefoxitin	**0.0**	**0.0**	**6.9**	**0.0**	**0.0**	**6.2**	**0.0**	**7.7**
Ceftiofur	**0.0**	**0.0**	**6.9**	**0.0**	**0.0**	**6.2**	**0.0**	**7.7**
Chloramphenicol	**0.0**	**0.0**	**3.4**	**0.0**	**71.4**	**12.5**	**0.0**	**0.0**
Gentamicin	**1.8**	**0.0**	**0.0**	**0.0**	**9.5**	**6.2**	**0.0**	**0.0**
Kanamycin	**3.6**	**0.0**	**3.4**	**0.0**	**14.3**	**6.2**	**0.0**	**84.6**
Streptomycin	**55.4**	**0.0**	**0.0**	**0.0**	**66.7**	**12.5**	**0.0**	**69.2**
Sulfizoxazole	**48.2**	**0.0**	**3.4**	**3.6**	**95.2**	**18.8**	**6.2**	**0.0**
Tetracycline	**67.9**	**90.9**	**37.9**	**92.9**	**100.0**	**12.5**	**6.2**	**92.3**

Table 5a. Percent Resistance- Top Serotypes Chicken Isolates, Slaughter, 2006

	Kentucky N=674	Enteritidis N=188	Heidelberg N=164	Typh var 5- N=62	4,[5],12,:i:- n=62	Typh n=56	Montevideo N=21	Schwarzengrund N=18
Amox/Clav Acid	**15.4**	**0.0**	**15.9**	**33.9**	**8.9**	**25.6**	**0.0**	**0.0**
Ampicillin	**16.2**	**1.6**	**16.5**	**50.0**	**10.7**	**32.6**	**0.0**	**5.6**
Cefoxitin	**15.1**	**0.0**	**15.2**	**33.9**	**8.9**	**23.3**	**4.8**	**0.0**
Ceftiofur	**15.3**	**0.0**	**15.9**	**33.9**	**8.9**	**25.6**	**0.0**	**0.0**
Chloramphenicol	**1.8**	**0.0**	**2.4**	**9.7**	**0.0**	**4.7**	**0.0**	**0.0**
Gentamicin	**5.5**	**0.0**	**9.8**	**4.8**	**16.1**	**9.3**	**9.5**	**0.0**
Kanamycin	**2.1**	**0.0**	**7.3**	**16.1**	**0.0**	**20.9**	**4.8**	**0.0**
Streptomycin	**34.9**	**0.0**	**10.4**	**21.0**	**8.9**	**11.6**	**9.5**	**11.1**
Sulfizoxazole	**6.2**	**0.0**	**7.9**	**71.0**	**17.9**	**58.1**	**14.3**	**0.0**
Tetracycline	**47.2**	**1.6**	**12.2**	**66.1**	**3.6**	**53.5**	**9.5**	**11.1**

Table 5b. Percent Resistance- Top Serotypes Chicken Isolates, Slaughter, 2006

	Hadar N=98	Heidelberg N=43	Saintpaul N=18	Schwarzen-grund N=15	Reading N=14	Agona N=13	Senftenberg N=12	Kentucky N=8
Amox/Clav Acid	**2.0**	**9.3**	**5.6**	**6.7**	**0.0**	**38.5**	**8.3**	**0.0**
Ampicillin	**19.4**	**37.2**	**55.6**	**6.7**	**21.4**	**38.5**	**25.0**	**12.5**
Cefoxitin	**1.0**	**9.3**	**5.6**	**6.7**	**0.0**	**38.5**	**8.3**	**0.0**
Ceftiofur	**1.0**	**9.3**	**5.6**	**6.7**	**0.0**	**38.5**	**8.3**	**0.0**
Chloramphenicol	**1.0**	**4.7**	**0.0**	**0.0**	**0.0**	**23.1**	**8.3**	**0.0**
Gentamicin	**12.2**	**32.6**	**27.8**	**0.0**	**0.0**	**0.0**	**25.0**	**37.5**
Kanamycin	**2.0**	**27.9**	**27.8**	**0.0**	**0.0**	**7.7**	**0.0**	**12.5**
Streptomycin	**40.8**	**34.9**	**38.9**	**6.7**	**7.1**	**23.1**	**16.7**	**25.0**
Sulfizoxazole	**15.3**	**30.2**	**61.1**	**6.7**	**7.1**	**61.5**	**8.3**	**87.5**
Tetracycline	**89.8**	**62.8**	**55.6**	**20.0**	**21.4**	**84.6**	**8.3**	**87.5**

Table 6. Animal versus Human *Salmonella newport* 1997-2006

		1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
ANIMAL	Total No. of Newport	18	42	134	282	455	574	483	299	161	109
	Total No. of *Salmonella*	2391	3318	8508	7834	5739	6977	5353	4873	4412	3110
	% Newport for year/AmpC	0.8/ 0	1.3/ 5	1.6/ 27	3.6/ 190	7.9/ 309	8.2/ 393	9.0/ 287	6.1/ 200	3.6/ 98	3.5/ 56
HUMAN	Total No. of Newport	46	77	99	121	124	239	221	190	ND	ND
	Total No. of *Salmonella*	1301	1460	1498	1377	1419	2008	1865	1793	ND	ND
	% Newport for year/AmpC	3.5/ 0	5.3/ 1	6.6/ 18	8.8/ 27	8.7/ 31	11.9/ 53	11.9/ 46	10.6/ 28	ND	ND

Multi-Drug Resistant *Salmonella Dublin* in New York State Cattle Populations

Belinda Thompson
College of Veterinary Medicine, Cornell University

http://www.diaglab.vet.cornell.edu/pdf/*Salmonella*dublin.pdf
Animal Health Advisory

Multi-drug Resistant *Salmonella dublin* in Cattle

The Animal Health Diagnostic Center at Cornell University has isolated *Salmonella dublin* (Group D) from diagnostic samples submitted from multiple animals of four different cattle premises in either New York or Pennsylvania in the last two months. They have all shown the same antimicrobial susceptibility profile, being resistant to most antibiotics.

The United States Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), Veterinary Services (VS), National Veterinary Services Laboratories (NVSL), Ames, Iowa have confirmed that there have been over 287 cases of *S. dublin* disease reported in the United States from September of 2005 until September of 2006. Of those, 39 occurred in cattle in Ohio, New York, and Pennsylvania. It is unknown how and when multi-drug resistant *Salmonella dublin* strains emerged in the northeastern bovine industry, or how widespread they are. Selective pressure applied through non-therapeutic use of antibiotics is one factor suggested for the emergence of resistance in bacteria. Resistance attributes may also be shared between bacteria. At this point, the recent positive isolations at this laboratory have all been from sick calves with a clinical history of pneumonia. The age range of clinical illnesses reported with sample submissions has been from seven days of age to about four months of age, in dairy or veal calves.

It is advised that cattle operations take steps to prevent the introduction and transmission of *Salmonella dublin* and other enteric pathogens. Illness associated with *Salmonella dublin* can be difficult to treat, may be fatal, and the environment, once contaminated, may be difficult to clean up. People, other livestock and companion animal species are also susceptible to infection and could suffer serious illness. Carrier animals can maintain the infection within a herd and may continue to shed organisms contributing to repeat exposure of healthy and sick animals. Cattle owners and caretakers should be especially alert to cattle illnesses involving fever, diarrhea, abortions, and respiratory signs (especially in calves) including coughing and labored breathing. While pneumonia is not considered to be an unusual illness in cattle populations, all pneumonia associated with a high incidence or mortality rate should be investigated promptly by a veterinarian. Blood cultures, nasal swabs, transtracheal washes, fecal cultures and other samples from sick animals can be submitted to the Animal Health Diagnostic Center at Cornell for *Salmonella* diagnostic testing and other infectious diseases.

Finally, *Salmonella spp.* have the potential to infect people and can cause illness and death. Notify a physician or the local Health Department if any animal caretakers show signs of serious illness, such as fever, delirium, vomiting, diarrhea with or without blood, and abdominal cramping. Individuals with weakened or suppressed immune systems, pregnant women, and the very young and very old are most susceptible to infection and illness with *Salmonella spp.* Consumption of raw milk is a high risk practice, especially from herds experiencing a suspected or confirmed outbreak of *Salmonella*.

The Animal Health Diagnostic Center at Cornell's College of Veterinary Medicine is currently monitoring New York *Salmonella dublin* outbreaks. Veterinarians may consult with our microbiology and extension staff for diagnostic and surveillance advice. Physicians involved with bovine-associated human cases of salmonellosis are also encouraged to speak with our bacteriologists.

Background Information

Salmonellosis is generally a disorder of the gastrointestinal tract. *Salmonella dublin* however, is a cattle host-adapted strain that usually presents as a respiratory illness, primarily in

young stock less than 2 months of age (range 1 week to 6 months), although any age animal can be infected. Alternate clinical presentations include septicemia, abortions in pregnant mature cows, and/or diarrhea, especially terminally. As a host-adapted strain, infected, subclinical carriers are important in maintaining infection in a herd with shedding into feces and milk. Some animals may remain lifetime carriers of this infection. Stress resulting from overcrowding, poor air quality, co infections with other pathogens, poor hygiene, transportation, or dietary inadequacies can result in clinical signs in infected carrier animals or recrudescence of shedding in latently infected animals. Recent introduction of *Salmonella dublin* into a population with no prior exposure might, under the right conditions, result in an explosive outbreak. In the face of an outbreak of *Salmonella dublin* infection, exceptional calf management procedures must be instituted. These practices include maintaining clean maternity pens, prompt removal of calves from dams, fastidious colostrum management, milk and feed utensil sanitation, promotion of good air quality, and reduction of stress by providing clean, comfortable housing and proper nutrition. Feeding of raw milk should be avoided. Outbreaks of clinical illness in calves, in herds where the infection is apparently endemic, are reported to occur when there are breakdowns in management. Adult cattle susceptibility to clinical salmonellosis may be reduced by maximizing health and immune status. Excellent nutrition and management, especially surrounding the dry cow/fresh cow transition period, are essential to minimize the occurrence of all periparturient health proble.

Disinfection and other biosecurity practices must be utilized in order to prevent the introduction or the spread of this disease. Isolation of all introduced cattle, whether newly purchased or returning to the farm from other premises, allows for the detection of clinical illness prior to commingling with other cattle. In addition, co-mingling into a limited group may detect illness in the newly exposed animals if there is a carrier in the new arrivals, but may also limit the magnitude of spread on the farm. Cattle trailers should be thoroughly cleaned, disinfected and re-bedded prior to transport of healthy animals from different herds. Avoid contact with manure when visiting other facilities, and do not wear the same clothing and shoes while visiting other facilities that you wear when caring for animals at your home facility. More information regarding salmonellosis and best management practices are outlined in the New York State Cattle Health Assurance Program (NYSCHAP), a program designed to promote herd health, care, and welfare. For more information regarding this program see the contact information listed at the end of this article.

Environmental cleanup involves the removal of all organic material (bedding, contaminated feed, manure), complete washing down of all surfaces including feed troughs, water buckets/tanks, and equipment with water and a detergent cleaner to remove remaining organic residues, and the application of an appropriate disinfectant for the proper contact time. Disinfectants used to combat *Salmonella* include halogens like dilute chlorine bleach, phenols, quaternary ammonium compounds, and oxidizing agents like Virkon-S. Scrapers,brooms, shovels and manure forks can spread the organism from contaminated areas to previously uncontaminated ones. Cleaned areas should be dried quickly by using fans and exposing the area to sunlight. Pressure washers should be avoided, unless all animals have been removed and the operator wears OSHA-approved respirator protection, as *Salmonella* organisms can be aerosolized and transmitted in this manner. Environmental sampling may be employed to determine the effectiveness of cleaning a contaminated environment.

Few well designed vaccine studies have been published evaluating *Salmonella* vaccines in adult cattle or calves. Published studies involving vaccines on the market in the United States are equivocal. Some inactivated *Salmonella dublin* vaccines are available, as well as a newer vaccine which uses a technology that involves the incorporation of purified *Salmonella newport* siderophore receptor and porin proteins. Clinical and field trials have not been performed to evaluate the efficacy of protection in commercial cattle herds with endemic infection or recent introduction of *Salmonella dublin*.

For further information about the (NYSCHAP) administered by the New York State Department of Agriculture and Markets/ Division of Animal Industry, visit the website:

http://nyschap.vet.cornell.edu/ or contact program coordinator Kathy Finnerty: KDF2@CORNELL.EDU or 607-253-3910.

NVSL National *Salmonella* serotype Report July 2006- June 2007 –

Brenda R. Morningstar
National Veterinary Services Laboratories (NVSL)

Concerning *Salmonella* nomenclature and standardization, we changed our nomenclature so it is in agreement with World Health Organization and the Centers for Disease Control and Prevention. Subspecies I *Salmonella* will be the only named serotypes. Other subspecies are reported with the antigenic formula preceded by the subspecies designation. We are not using the IIIa or IIIb designation for subspecies III- rather we are reporting all with just a III. The Group E2 and E3 isolates are now all reported by the E1 name followed by variant 15+ or 15+, 34+. You will note a difference between the number of listed isolates. National Veterinary Services Laboratory (NVSL) received 1157 isolates that had clinical roles that were left blank, and were therefore not included in the presented data. Submitting laboratories are urged to provide this information when submitting isolates in the future. Laboratories submitted 18,246 isolates, which resulted in 253 serotypes from 42 States and the District of Columbia. The 10 most common serotyped accounted for 54 percent of the total, and there were, 10114 monitor isolates (62 percent), and 6975 clinical isolates (38 percent). The 5 most frequent serotypes isolated at the NVSL from monitor and clinical cases are: typhimurium, kentucky, heidelberg, enteritidis. and senftenberg. The top 5 serotypes were broken down into clinical versus monitor cases (Table 1). Also, the numbers of isolates from different species (monitor isolates versus clinical) were described; the majority of isolates from chickens and turkeys are monitor samples, while the majority of those from cattle, swine, and horses are of clinical origin. The 3 most common serotypes over the last 5 years were *S. typhimurium, S. heidelberg, and S. kentucky; S. kentucky* was identified more times this year than in the past decade. It should be noted that although *S. typhimurium* is still the most common serotype isolated, the serotypes in the top ten group make up for 54 percent of all isolated this year, a decrease of approximately 7 percent from last year. The majority of *S. newport* are isolated from cattle and horses. For the past few years, we had been reporting the increase in *S. typhimurium* var. Copenhagen isolates in relation to those identified as *S. typhimurium*. This year 48 percent were *S. typhimurium*, compared to 43 percent last year, and an overall decrease in Typhimurium was noted. An untypable *Salmonella* that has increased both in numbers and significance, is 4,5,12:i:monophasic; this is probably a Typhimurium, however, NVSL will continue to report out only the phases that we are able to obtain.

The most common serotypes for chickens, turkeys, cattle, swine, horses, dog/cats are listed in the appendix. *Salmonella enteritidis* Phage Typing of 520 isolates resulted in the detection of 13 phage types, Phage type 8 most common (55 percent), and Phage type 13 (25 percent). *S. typhimurium* Phage Typing results were 124 isolates were phage typed, 25 phage types were identified, with DT104 (46 percent), U302 (11 percent), and Untypable (10 percent), that is there was no lysis by any of the 35 phages tested.

TABLE 1

Most Common Serotypes

Clinical

- Typhimurium
- Newport
- Dublin
- Agona
- Derby

Monitor

- Kentucky
- Heidelberg

- Typhimurium
- Enteritidis
- Senftenberg

Most Common Serotypes Chickens
Clinical
Enteritidis
Kentucky
Typhimurium
Heidelberg
Senftenberg

Monitor
Kentucky
Heidelberg
Enteritidis
Senftenberg
Typhimurium

Most Common Serotypes Turkeys
Clinical
Senftenberg
Anatum
Hadar
Montevideo
Agona

Monitor
Hadar
Schwarzengrund
London
Heidelberg
Saintpaul

Most Common Serotypes Cattle
Clinical
Typhimurium
Dublin
Newport
Cerro
Montevideo

Monitor
Anatum
Kentucky
Senftenberg
Cerro
Orion var 15+34+

Most Common Serotypes Swine
Clinical
Typhimurium
Derby
Choleraesuis (kunzendorf)
Heidelberg

Agona

Monitor
Typhimurium
Derby
Agona
Anatum
Johannesburg/ Worthington

Most Common Serotypes Horses
Clinical
Typhimurium
Newport
Javiana
Anatum
4,5,12:i:-

Most Common Serotypes Dog/Cat
All sources
Newport
Typhimurium
Montevideo
Enteriditis

Update from the National Poultry Improvement Plan (NPIP)

C. Stephen Roney
Andrew R. Rhorer
National Poultry Improvement Plan

The *Salmonella pullorum* and *Salmonella gallinarum* eradication program began in 1935; there has been no isolation of *Salmonella gallinarum* in the United States since 1987, and no isolation of *Salmonella pullorum* in 2006 and 2007 in backyard poultry in the US. *Salmonella enteritidis* isolations in Egg-Type chickens were outlined for the time period 1989-2007 and have shown a decline in prevalence with 4 reports of positive flocks in 2007. *Salmonella enteritidis* positive Egg-Type Breeding Flocks for the time period 1990-2007 were presented by state location. Also, the *S. enteritidis* Phage types were detailed from Egg-Type Breeding Positive Flocks for 1990-2006 with the most common types being 8, 13, 13A, and 28. The same lists were provided for Phage types from Egg-Type chickens with the most common types 8, 13, 13A, Untypable, and 28.

Salmonella related services provided through NPIP include an Annual Hands-on *Salmonella* Isolation and Identification Workshop for authorized laboratories sponsored by the Georgia Poultry Improvement Association (1994-2007), a series of three videos sponsored by the U.S. Poultry and Egg Assoc on *Salmonella*: Isolation and Identification, Sampling and Collection, and Serology. The National Veterinary Services Laboratories (NVSL) issues a group D *Salmonella* check test annually for authorized laboratories of the NPIP. NVSL issues a avian influenza check test for the Agar Gel Immunodiffusion Test annually for the authorized laboratories of the NPIP.

Participating Breeding flocks and birds in NPIP (Table 1) include Egg-Type Chickens (225 flocks with 3,906,189 birds), Meat-Type Chickens (5928 flocks with 93,334,497 birds), Turkeys (559 flocks with 4,817,104 birds), Waterfowl, Exhibition Poultry and Game Birds (3,631 Flocks with 1,470,287 birds). Moreover, 49 Official State Agencies and 135 Authorized Laboratories participate under the Provisions found in the Code of Federal Regulations 9CFR 145, 9 CFR 146, 9 CFR 147 and 9 CFR 56. The General Conference Committee of NPIP is composed of the Secretary of Agriculture's Official Advisory Committee on Poultry Health-Steering Committee. There are participating Egg and Meat Type Hatcheries (284), Turkey Hatcheries (50), and Waterfowl, Exhibition Poultry and Game Birds Hatcheries (784).

TABLE 1
Hatchery Participation in the National Poultry Improvement Plan Testing Year 2006

Egg and Meat-Type Chickens: Participating	**283**
Capacity	**698,974,826**
Turkeys Participating	**49**
Capacity	**33,285,723**
Waterfowl, Exhibition Poultry and Game Birds	**721**
Capacity	**26,321,162**