An Update on Salmonella in Louisiana

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INTRODUCTION

Over 2000 serotypes of Salmonella are pathogenic for both animals and humans. The primary habitat of these gram negative Enterobacteriaceae is the intestinal tract of mammals (cattle, swine, dogs, cats, and rodents), birds, reptiles, and amphibians. From the intestinal tract of animals, the bacteria are dispersed into soil, dust, sewage, rivers, seawater, and drinking water.[1] Although Salmonella are widely distributed throughout the environment, up to 95% of infections in the United States are food borne.[2] The most commonly implicated foods are poultry, eggs, meat, and dairy products; however, seafood, fruits, vegetables, and bakery goods have also been sources of infection.[3] Less frequent modes of transmission include person-to-person, direct contact with infected animals, and ingestion of contaminated water. Person-to-person transmission is most likely to occur in an institutionalized setting such as a hospital, nursery, or long-term care facility or in a home between infected parents and their infants. The clinical spectrum of *non-typhi Salmonella* infection includes asymptomatic carriage, gastroenteritis, enterocolitis, and bacteremia with or without focal infection.[1]

METHODS

1. Surveillance

In Louisiana, Salmonella is a Class B notifiable disease, and requires reporting to the Office of Public Health within one business day of diagnosis. Health care providers may communicate reports by way of phone, fax, mail-in-cards, or a web-based system (Reportable Disease Database). Probable and confirmed cases, as defined by the Centers for Disease Control and Prevention, are entered into surveillance systems at the state and national level.[4]

The following are the definitions used in the surveillance system:

Clinical description: An illness of variable severity commonly manifested by diarrhea, abdominal pain, nausea, and sometimes vomiting. Asymptomatic infections may occur, and the organism may cause extraintestinal infections.

Laboratory criteria for diagnosis: Isolation of Salmonella from a clinical specimen.

Case classification: A confirmed case is one that is laboratory confirmed. A probable case is a clinically compatible case that is epidemiologically linked to a confirmed case.

Case reports include basic demographic and epidemiologic information, which allows for routine follow up.

2. Case Control Study

The purpose of this retrospective case control study was to discover behaviors among Louisianians that are associated with sporadic Salmonella infection. Cases for this study were selected from the Reportable Disease Database and included any Louisiana resident with stool culture confirmed Salmonella infection, unrelated to an outbreak, during the time period from January 1, 2005, to June 30, 2005. Each case was matched with a control for the age categories of (0-1), (1-4), (5-17), (18-64), and 65-years-old or greater. Controls were obtained from the Louisiana State Office of Public Health immunization registry database. Controls were excluded if they had diarrhea with fever in the past week, had ever been diagnosed with Salmonella, or had a close contact diagnosed with Salmonella in the past four weeks.

A standard questionnaire designed for the study was administered to both cases and controls by telephone interview during August of 2005. The questionnaire focused on contact with animals, consumption of specific food items (including thoroughness of beef and egg cooking), food hygiene, and recreational water exposure. It also addressed usual source of drinking water and frequency of eating outside the home. The questionnaire was modified for the (0 to 1) age group to include questions related to source of infant milk (breast versus formula), hygiene involved in bottle preparation, and method of bottle washing. The infant survey excluded those questions related to consumption of specific food items, as most infants do not eat the items in question. Additional epidemiologic data were obtained from cases on type of primary care initially sought (family physician versus emergency room), treatment with antibiotics, hospitalization, ill close contacts, and international travel. All questionnaires included basic

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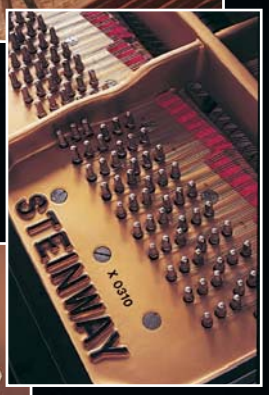

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demographic information such as age, gender, race, parish, and occupation. Because case infections occurred from one to seven months prior to the time of questionnaire administration, questions were phrased on the basis of *usual* habits, as recall during the specific time period immediate to the onset of illness would have been difficult.

Both case and control data were extracted to and stored in a Microsoft Access® database prior to analysis. Epi Info 2002 (Centers for Disease Control and Prevention, Atlanta, GA) was used to calculate univariate odds ratios with 95 percent confidence intervals (CIs) and to perform Mantel-Haenszel chi square analysis.

RESULTS

1. Surveillance

In Louisiana, 954 cases (21/ 100,000) were reported in 2004, which is an 11% increase when compared to the average incidence from 2000 to 2003. Overall, incidence rates have been relatively stable since the late 1980's (Figure 1). Attack rates in Louisiana were highest among infants and children less than five years of age. Rates were similar across gender and race, with the exception of substantially higher rates occurring in white infants (71/100,000) when compared to African American infants (8/100,000) for 2000-2004 data (Figures 2, 3). While Salmonella is usually a mild, self-limiting illness, hospitalization ranged from 9 to 16% of cases annually, generally with higher rates occurring among older age groups (Figure 4). Additionally, Salmonella has caused an average of two deaths per year since 1987 in Louisiana, the majority of which occurred in adults 55 years of age and older (Figure 5). In recent years, the five most common serotypes to cause human infection in Louisiana

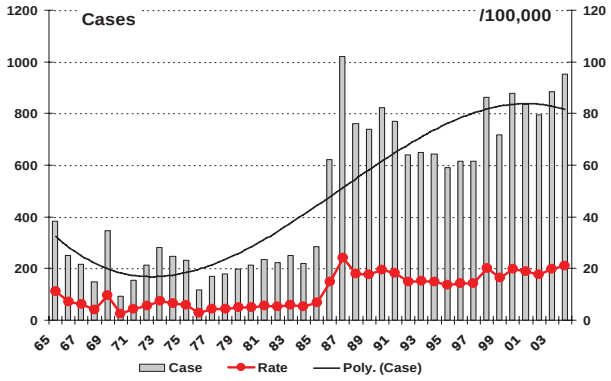

Figure 1. Salmonella cases and rates /100,000 per year, 1965-2004.

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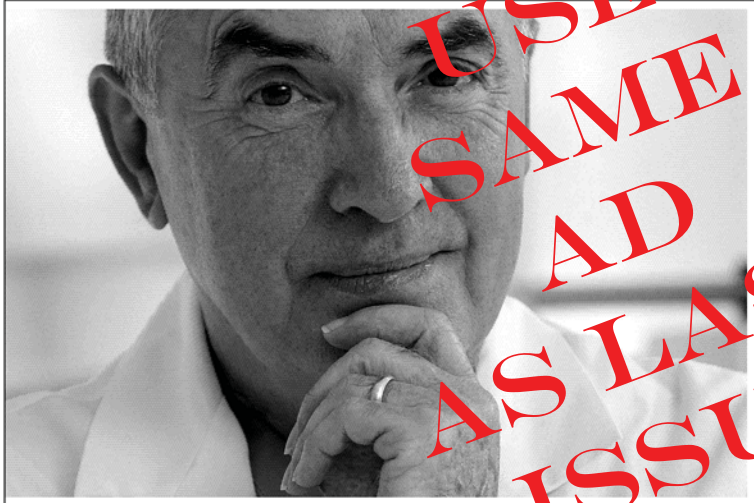

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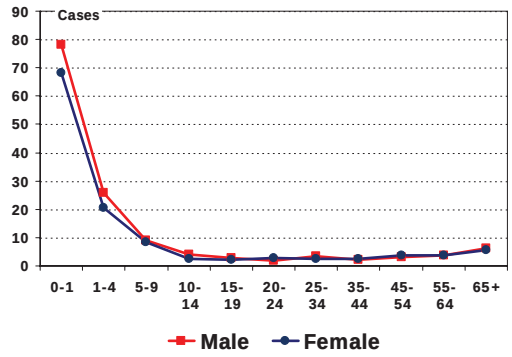

Figure 2. Number of Salmonella cases by age & gender, 2000-2004.

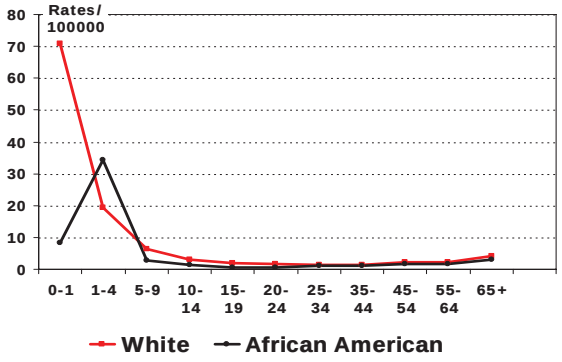

Figure 3. Number of Salmonella cases by race & age, 2000-2004.

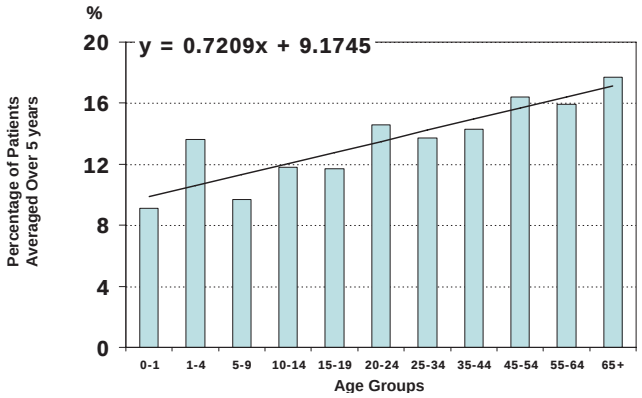

Figure 4. Percentage of patients with Salmonella infection who were hospitalized, 2000-2004, by age group. The percentage increases with age according to the formula y=0.7209x + 9.1745 (solid line), where x represents age groups 1 to 11.

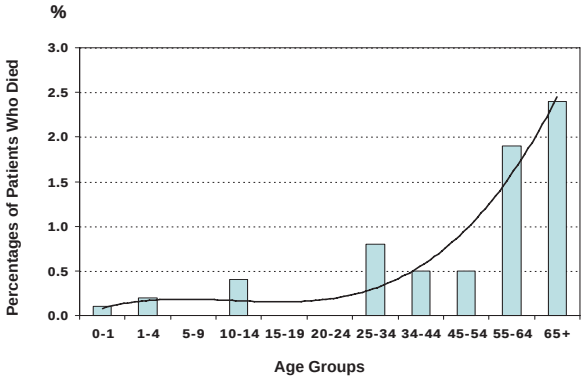

Figure 5. Percentage of patients with Salmonella infection who died 1987-2004, by age group.

have been *S. newport*, *S. typhimurium*, *S. javiana*, *S. mississippi*, and *S. enteritidis*. Isolates *S. newport*, *S. typhimurium*, and *S. javiana*, along with *S. montevideo*, have been increasing, while *S. mississippi* and *S. enteritidis* are stable (Figure 6).[5] The Cochran-Armitage trend test shows significantly increasing rates of *S. newport* (Z=12.28, p<0.0001).

2. Case Control Study

Of the 250 cases identified during the study time period, 76 (30%) participated. One hundred thirty-three were unable to be contacted due to a missing or wrong telephone number, and another 35 were unreachable after multiple (five or more) attempts. Additionally there were two refusals, two nosocomial infections, one deceased (cause of death was unrelated to Salmonella infection), and one unable to participate due to poor English skills. Of the

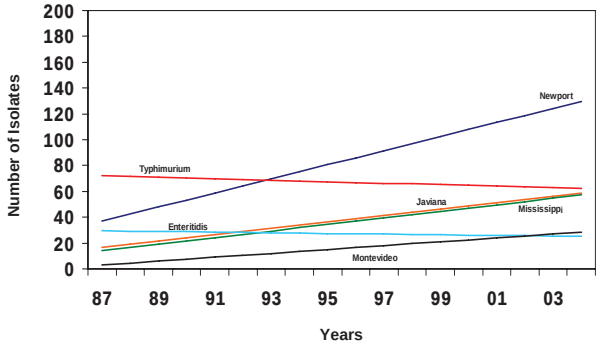

Figure 6. Salmonella trends per year by serotype.

Marc W. Judice

Marc W. Judice has been actively engaged in litigation since 1977, with emphasis in the areas of medical, dental, healthcare and professional liability defense. He is certified in Civil Trial Advocacy by the National Board of Trial Advocacy.

Marc has been asked to give numerous presentations in the fields of law and healthcare to a wide array of organizations including: Lafayette Parish Medical Society, Louisiana Society of Orthopedic Surgeons, Louisiana Society of Neurosurgeons, Acadiana Pediatric Society, Acadiana Dental Association, Louisiana Medical Mutual Insurance Company, The Medical Protective Company, Louisiana Association of Defense Counsel, National Business Institute, LSU School of Dentistry, Medical Risk Management and LSU School of Law.

Marc served as Chairman of the Board of Directors at University Medical Center in Lafayette; Chairman of the Board of Trustees at Medical Center of Southwest Louisiana; and on the Board of Trustees for Women's & Children's Hospital.

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76 cases, 49 (65%) initially sought care from their primary physician, while 26 (34%) used the emergency room as the first point of care. Forty-seven cases (62%) recalled being treated with antibiotics, and 28 (37%) reported being hospitalized. Only two cases were linked to foreign travel.

Three hundred and thirty households were called to enroll 77 controls. There were 132 wrong numbers, 66 unreachable after multiple attempts, and 48 refusals. Five were no longer residents of Louisiana and therefore ineligible. Additionally, one potential control was excluded due to a history of prior Salmonella infection, and another was ineligible because of diarrhea with fever in the preceding week.

Gender and age distributions were similar for cases and controls. A statistically significant (p=0.0002) racial difference existed between cases and controls. Whites and African Americans made up 79% and 13% of the case group, respectively, and 48% and 37% of the control group (Table 1).

There were no behaviors identified in this study as being associated with an increased risk of Salmonella infection. Specific professions, including those involving health care, child care, and food service, were not associated with an increased risk of illness. No statistical difference was found between cases and controls having contact with selected animals, including farm animals, dogs, cats, rabbits, rodents, ferrets, birds, reptiles, and amphibians, although odds ratios (ORs) were increased for contact with rabbits (OR=2.5), reptiles (OR=2.3), and amphibians (OR=2.0). Cases were no more likely than controls to eat specific food items such as uncooked cookie dough or cake batter, raw oysters, sushi, or beef or eggs cooked to varying degrees. If participants ate beef or eggs, they were also asked how these usually were prepared. Choices for beef included rare, medium rare, medium, and well-cooked. For those who ate eggs, choices included runny, medium, or well. Odds ratios were increased for individuals eating raw oysters (OR=2.2), sushi (OR=1.8), and runny eggs (OR=1.9), but were not statistically significant. Neither usual source of drinking water (city, filtered, bottled, or well) nor recreational activity in freshwater (lake, river, or bayou) was linked to illness. In terms of food habits, cases and controls equally washed hands before meals and immediately after handling uncooked meat. Cases were more likely to eat out often (OR=1.6) and less likely to wash or peel fresh produce (OR=2.1) than controls, but no statistical difference was demonstrated for either behavior (Table 2).

An attempt was made to identify risk factors specific to the infant population. Being breastfed at least some of the time (OR=0.5) as opposed to formula fed only, and sterilizing bottles (OR=0.3) as opposed to washing by hand or dishwasher, appeared to be protective but not to a statistically significant degree. Cases reported more often than controls using a powder formula preparation (OR=4.2) as opposed to a liquid type, and not cleaning the surface

Table 1. Demographic profile, salmonella case-control study.

Characteristics	Cases Number	%	Controls Number	%	Odds Ratio	95% C.I.†	P value
Gender	(N=76)		(N=77)				
Male	42	55.3	36	46.8	Reference Group		
Female	34	44.7	41	53.2	0.7	0.4-1.4	0.29
Age (Years)	(N=76)		(N=77)				
0-1	14	18.4	17	22.1	Reference Group		
1-4	21	27.6	21	27.3	1.2	0.4-3.4	0.68
5-17	15	19.7	15	19.5	1.2	0.4-3.7	0.71
18-64	19	25	19	24.7	1.2	0.4-3.5	0.69
≥ 65	7	9.2	5	6.5	1.7	0.4-8.1	0.44
Race	(N=76)		(N=77)				
White	60	78.9	37	48.1	Reference Group		
African American	10	13.2	28	36.4	0.2	0.1-0.5	0.0002
Other	6	7.9	12	15.6	0.3	0.1-1.0	0.025

† Confidence interval

Table 2. Analysis of selected risk factors, salmonella case-control study.

Risk Factor	Cases Number*	%	Controls Number*	%	Odds Ratio	95% C.I.†	P value
Animal Contact							
Rabbit	13/75	17	6/76	8	2.5	0.8-7.7	0.08
Reptile	10/73	14	5/77	6	2.3	0.7-8.2	0.14
Amphibian	12/71	17	7/70	10	2.0	0.7-6.2	0.16
Food Consumption							
Raw oysters	14/62	23	7/60	12	2.2	0.8-6.7	0.11
Sushi	10/61	16	6/60	10	1.8	0.5-6.0	0.30
Eggs, runny	7/52	13	4/48	8	1.9	0.5-8.6	.31
Food habits							
Eat out often‡	35/62	56	27/60	50	1.6	0.7-3.5	0.21
Don't wash/peel produce	4/58	7	2/58	3	2.1	0.3-17.1	0.40

* "Unknown" responses excluded and households with infants (N=14 for case group, N-17 for control group) did not provide responses regarding specific food items or food habits; † Confidence interval; ‡Defined as 3 times per week or more.

Table 3. Analysis of selected infant-specific risk factors, salmonella case-control study.

	Cases		Controls				
Risk Factor	Number	%	Number*	%	Odds Ratio	95% C.I.†	P value
Breast milk‡ vs. formula only	3/14	21	6/17	35	0.5	0.07-3.2	0.41
Powder formula vs. liquid preparation.	11/14	79	7/15	47	4.2	0.7-30.1	0.08
Bottles sterilized vs. hand-washed or dishwasher.	2/14	14	5/15	33	0.3	0.03-2.7	0.24
Surface not cleaned prior to formula preparation.	6/14	43	2/15	13	4.9	0.6-46.8	0.08

* Households with infants exclusively breastfed (N=2) did not give responses related to formula or bottles; †Confidence interval; ‡Includes breast milk only and breast milk supplemented with formula.

prior to formula mixing (OR=4.9). However, no statistical difference between the two groups was achieved (Table 3). Source of water used to prepare the formula (city, filtered, or bottled), method of surface cleaning (commercial product, soap and water, or other), and parental hand-washing prior to formula mixing were not associated with infant illness.

DISCUSSION

As a result of industrialization and modernization of agricultural practices, Salmonella incidence has been on the rise worldwide.[1] Following behind Campylobacter, Salmonella is the second most common cause of laboratory confirmed enteric disease in the United States with 43,657 cases (15/100,000) reported in 2003.[2,3] At both the national level and in Louisiana, approximately one third of reported cases occur in children aged 0 to 4.[2] However, over-sampling may be contributing to the relatively high proportion of cases in this age group as medical evaluation of diarrheal illness is more likely to be sought for infants and small children than for older children and adults.

In 1988 the rates of Salmonella increased at the same time that a MS Access® system for electronically reporting of disease was installed in hospitals. In 1998, a less drastic increase was observed at the same time the MS Access® system was replaced with a web-based system.

More puzzling is the difference in attack rates between whites and blacks in Louisiana in the Salmonella surveillance. Substantially higher rates occurred among white infants when compared to African American infants. Perhaps it represents a disparity in access to care or the type of care accessed. If blacks have more barriers to care, the opportunity to diagnose infection is lacking, leading to fewer reportable cases. A similar result could occur if as a result of decreased access to care, African Americans sought treatment in emergency rooms more frequently than whites. In emergency rooms the goal may be to restore the patient to health, such as by giving IV fluids for diarrhea-induced dehydration, rather than to seek an etiology of disease. This may be especially true if the diagnostic test involved is relatively expensive, time-delayed, and won't impact the immediate management of the patient, as is the case with a stool culture. Furthermore, most cases of diarrhea in infants aren't bacterial in origin.

In other studies several of the risk factors we considered showed significant associations with Salmonella. For example Kohl et al[5] showed that inconsistent hand-washing between preparation of food items with and without meat was associated with illness. In this study the odds ratios for the usual risk factors were all in the range of 1.6 to 2.6 (see Table 2) but these associations did not reach the level of significance. The power of our study may have been too low to detect a difference between cases and controls, especially for items that only applied to a subset of the study population, ie, infants or individuals eating raw oysters.

Also, if low detection rates and under-reporting are taken into account, the true incidence of Salmonella infection within the general population is estimated to be as high as 1.5 % (1,500 per 100,000) annually.[6] A large gap exists between the estimated true incidence and the actual reported incidence (15 per 100,000), meaning many cases are likely asymptomatic or undiagnosed. Although controls with a known history of Salmonella were excluded from participation, it is possible that some controls, unaware of prior infection, were actually cases. This misclassification bias would have effectively weakened any potential associations between risk factors and disease.

Identifying unrecognized sources of Salmonella remains a challenge. While most reported cases of Salmonella are sporadic in nature, much of the information about risk factors for infection comes from outbreak investigations.[7] While such information is useful, larger more in-depth studies need to be conducted to uncover possible behaviors linked specifically to sporadic Salmonella infections. Once risk factors have been identified, prevention strategies targeting those behaviors can then be devised and implemented.

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