

***Salmonella* in the Caribbean**

A Classroom Case Study

STUDENT'S VERSION

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NOTE: This case study is based on real-life investigations undertaken in Trinidad and Tobago in 1998-1999 and published in Clinical Infectious Diseases and the West Indian Medical Journal. (See Appendix for abstracts.) Some aspects of these investigations (and the circumstances leading up to them) have been altered to assist in meeting the desired teaching objectives and some details have been fabricated to provide continuity to the storyline.

Target audience: public health practitioners with knowledge of basic epidemiologic concepts, especially non-epidemiologists (e.g., laboratorians, environmental health specialists, sanitarians, public health nurses, veterinarians, MPH students)

Level of case study: basic

Teaching materials required: graph paper, calculator

Time required: 3-4 hours

Language: English

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Learning objectives:

After completing this case study, the student should be able to:

- 1) describe the signs and symptoms, means of diagnosis, and control of salmonellosis
- 2) describe how *Salmonella* serotyping can be used in public health practice
- 3) given a disease, describe the desired characteristics of a surveillance system for that disease
- 4) discuss how the inclusion of the laboratory in the surveillance of a disease impacts the characteristics of the surveillance system and the usefulness of the data
- 5) calculate the incidence of a disease if given the number of cases and population size
- 6) characterize a health problem by time, place, and person (e.g., perform the descriptive epidemiology)
- 7) create and interpret a graph
- 8) interpret the measure of association for a case-control study

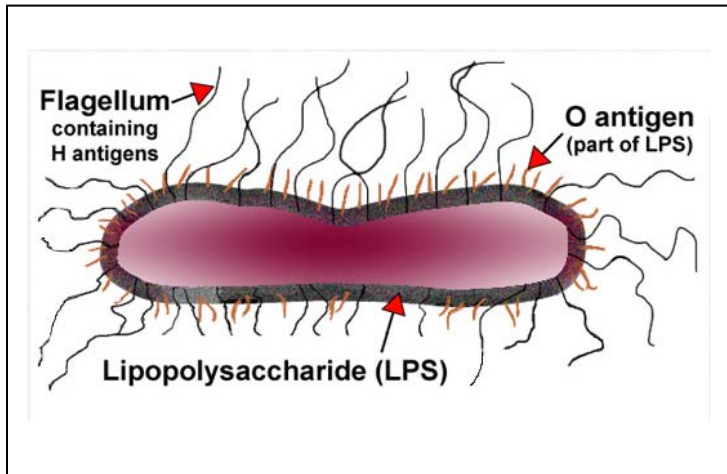
Part I – Background on *Salmonella*

Salmonellosis is a gastrointestinal illness caused by bacteria from the genus *Salmonella*. The illness is characterized by the sudden onset of headache, abdominal pain, diarrhea (which may be bloody), nausea, and sometimes vomiting. Fever is almost always present. The illness typically lasts for 5-7 days and usually does not require treatment unless the patient becomes severely dehydrated or the infection spreads from the intestines. In the immunocompromised host or an overwhelming infection in a normal host, *Salmonella* may spread to the blood stream and other body sites, and can cause death unless treated promptly with antibiotics.

Salmonella live in the intestinal tracts of humans and other animals, including mammals, birds, and reptiles. *Salmonella* are usually transmitted to humans by eating foods contaminated with animal feces. Implicated foods are typically those of animal origin, such as beef, poultry, milk, or eggs, but all foods, including vegetables, may become contaminated. The incubation period for salmonellosis is usually 12-36 hours, but can be as long as a week.

Question 1: How is salmonellosis diagnosed? How does the method of diagnosis impact our understanding of the occurrence of salmonellosis in the community (e.g., burden of disease, trends over time, high-risk populations)?

Figure 1. *Salmonella* surface antigens



The genus *Salmonella* consists of only two species: *S. enterica* and *S. bongori*. The latter species, however, is very rare.

Members of the species *Salmonella enterica* can be divided into smaller groups (i.e., serotypes) based on two structures on the cell surface: the O antigen and the H antigen. The O antigen is a carbohydrate antigen in the lipopolysaccharide of the bacterium's outer cell membrane. The H antigen is a protein antigen in the bacterium's flagella. (Figure 1)

O antigens and H antigens are detected using antisera that react with a single

antigen or group of related antigens. All *Salmonella* serotypes can be designated using a formula based on the O and H antigens they express. Many serotypes are also given a name (e.g., *Salmonella* Typhimurium, *Salmonella* Agona, *Salmonella* Muenchen). (NOTE: The serotype name is capitalized and not italicized.)

Although extensive serotyping of surface antigens can be used for identification of a *Salmonella* isolate, the reagents are costly, the process is time-consuming, and the results are not likely to affect treatment of the individual patient. As a result, in many countries clinical laboratories perform only a few O antigen reactions that allow them to group an isolate into broader, less specific categories called serogroups. The isolate is then forwarded to a state or national reference laboratory for complete serotyping.

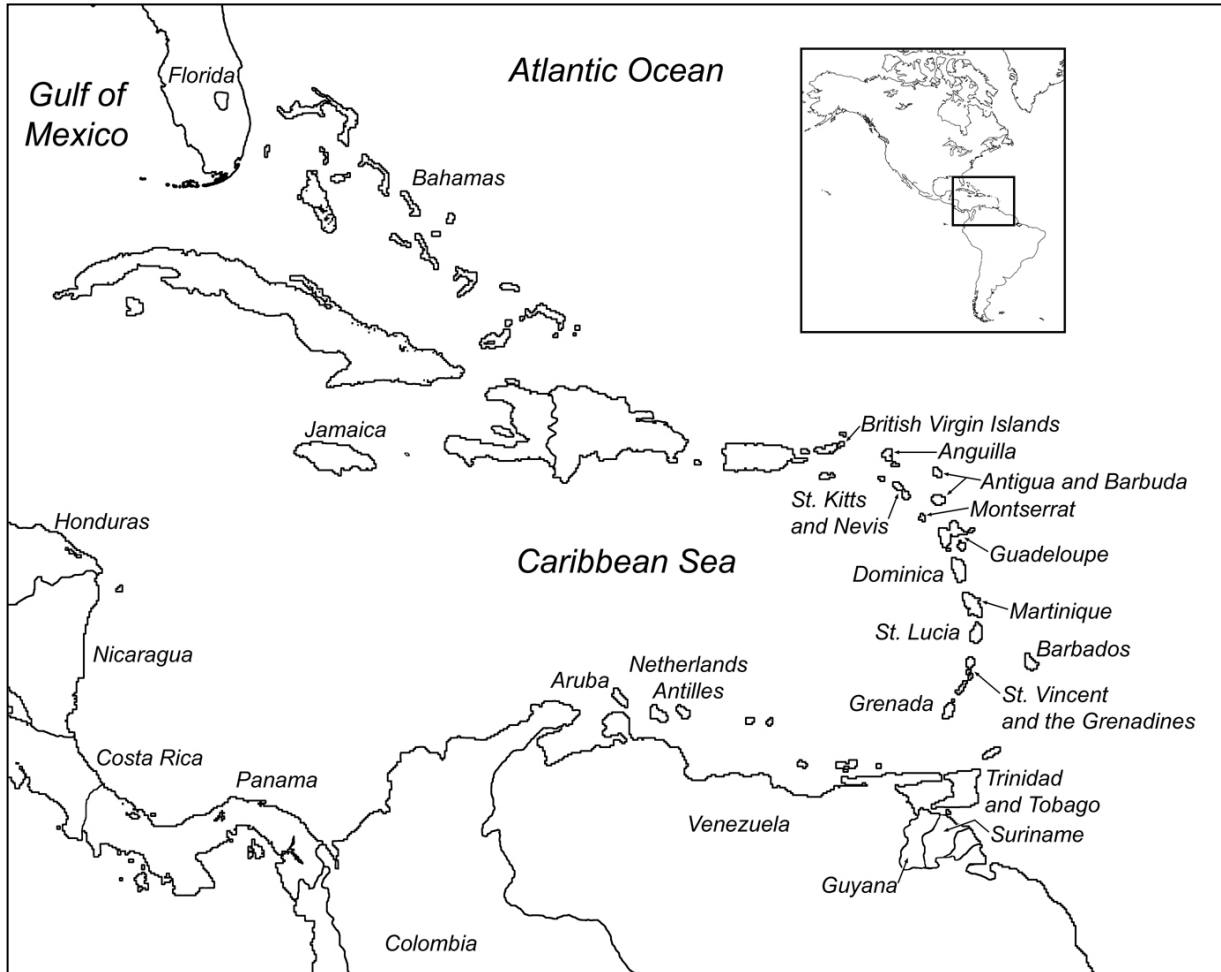
There are over 2,500 recognized *Salmonella* serotypes. In 1995, *Salmonella* Enteritidis, Typhimurium, and Typhi accounted for over three-quarters of the isolates reported in a global survey.

Question 2: Describe how serotype results can be used in public health practice.

Part II – Surveillance of *Salmonella* in the Caribbean

As early as the mid-1980s, *Salmonella* became a pathogen of public health concern in the Caribbean (Figure 2) when it caused an increasing number of cases and outbreaks of diarrhea involving local and tourist populations. The communicable disease surveillance system in place at the time, however, did not support the timely detection of these outbreaks or the investigation of risk factors associated with infection. As a result, the incidence of *Salmonella* continued to grow.

Figure 2. Countries of the Caribbean and surrounding land masses.



Question 3: To detect outbreaks of infectious diseases (e.g., salmonellosis) and investigate risk factors for infection, what characteristics should a communicable disease surveillance system have?

The communicable disease surveillance system in the Caribbean was based on notifiable disease reports from physicians and other health care providers in the community (i.e., clinician-based reporting). Surveillance of most communicable diseases included both laboratory-confirmed cases and cases diagnosed based on clinician suspicion. The laboratory did not report cases of communicable disease to the surveillance system or submit isolates for confirmation or further testing (e.g., serotyping).

To report a communicable disease in the Caribbean, the health care provider completed a disease report card (Figure 3) and mailed it to the local health department within 7 days of diagnosis of the patient.

Figure 3. Communicable Disease Case Report Card

CARIBBEAN EPIDEMIOLOGY CENTRE Clinician-based Reporting COMMUNICABLE DISEASE CASE REPORT CARD	
Case identification Last name, First name, Middle initial:	
Address:	
City/Country:	
Disease information Diagnosis: Lab-confirmed: <input type="checkbox"/> Yes <input type="checkbox"/> No Date of onset:	Case information Sex: <input type="checkbox"/> Male <input type="checkbox"/> Female Age: Current status: <input type="checkbox"/> Alive <input type="checkbox"/> Dead
Attending physician Name: Address: Telephone number:	Person reporting case (if not attending physician) Name: Telephone number:

A clerk at the local health department reviewed the report cards for completeness (requesting additional information from the health care provider, where needed), batched the reports, and mailed them to the country's Ministry of Health where they were sorted by disease. The Ministry of Health forwarded the reports to the Caribbean Epidemiology Centre (CAREC).

An epidemiologist from CAREC reviewed and summarized the reports from the individual countries. If necessary, the epidemiologist contacted the Ministry of Health if an unusual disease pattern was noted. CAREC distributed weekly, quarterly, and annual communicable disease reports for the region and each country to all Ministries of Health. In addition, CAREC reported occurrences of selected diseases (e.g., cholera, plague, yellow fever) to the Pan American Health Organization/World Health Organization as required by International Health Regulations.

Question 4: Diagram the flow of information in the Caribbean communicable disease surveillance system.

In an evaluation of the Caribbean communicable disease surveillance system, it was determined that less than 40% of notifiable disease cases were actually reported by health care providers. The average reporting delay (i.e., from diagnosis to receipt of the report by CAREC) was 56 days.

Question 5: Evaluate the Caribbean communicable disease surveillance system with respect to the desired goals of outbreak detection and investigation of risk factors for infection. What changes would you make to the surveillance system? Why?

After extensive consultation with the Ministries of Health from the individual Caribbean countries, health care providers, professional medical organizations, and clinical laboratories, CAREC proposed a modification of communicable disease reporting in the region.

In addition to health care providers (i.e., clinician-based surveillance), clinical laboratories were enlisted to report the detection of notifiable diseases that were laboratory confirmed (i.e., laboratory-based surveillance). Clinical laboratories were also asked to forward all isolates of *Salmonella* to the national reference laboratory in Trinidad (i.e., the Public Health Laboratory). Staff at the Public Health Laboratory, who had specialized training in *Salmonella* serotyping and access to specialized reagents, were to perform serotyping and antimicrobial susceptibility testing on forwarded *Salmonella* isolates.

To further improve the timeliness of reporting, health care providers and clinical laboratories were to submit reports directly to newly designated surveillance officers in each country's Ministry of Health. Diseases that potentially could be spread through food or water or readily from person-to-person were to be reported within 24 hours of diagnosis. The remainder were to be reported within 3 days of diagnosis. Health care providers and clinical laboratories were encouraged to submit reports by telephone or FAX.

Initial acceptance and implementation of the new communicable disease reporting procedures were slow. Member countries had limited public health resources to initiate the changes and there was resistance among health care providers and clinical laboratories.

Question 6: What might be done to encourage acceptance of the surveillance system and improve reporting?

Staff from CAREC visited member countries and, with the assistance of staff from the local Ministry of Health, provided training to both health care providers and staff from clinical laboratories. Training focused on the mechanics of reporting and how surveillance data would be used to monitor disease trends, detect outbreaks, and initiate controls measures. Many of the presentations were made at professional meetings, allowing for an open discussion of the reporting procedures and surveillance in general.

CAREC staff toured the larger clinical laboratories in the various countries and identified problems associated with testing, reporting, and the forwarding of *Salmonella* isolates to the national Public Health Laboratory in Trinidad. A resource person was identified at the Public Health Laboratory to provide ongoing support to all clinical laboratories.

A close working relationship developed between the Public Health Laboratory in Trinidad and CAREC. Laboratory staff forwarded laboratory results to epidemiologists at CAREC on a weekly basis and notified them by phone if an unusual case was noted or an increase in the isolation rate of a particular disease occurred.

CAREC staff summarized communicable disease surveillance results (including serotype and antimicrobial susceptibility test results) and distributed a weekly summary to the Ministries of Health and monthly updates to health care providers and clinical laboratories. They worked closely with staff from the respective Ministries of Health if an unusual disease pattern was noted or some reporting problem became evident.

Part III – Descriptive Epidemiology of *Salmonella* in Trinidad

Due to the close proximity of both CAREC and the national Public Health Laboratory, Trinidad and Tobago moved most quickly on the implementation of the new reporting procedures. As a result, several large outbreaks of salmonellosis were detected allowing local public health practitioners to initiate investigations and implement appropriate control measures. However, salmonellosis continued to occur at a high rate in the country.

In 1998, CAREC summarized the following data for laboratory-confirmed cases of salmonellosis reported in Trinidad and Tobago.

Table 1. Laboratory isolates of *Salmonella* by serotype and year of diagnosis, Trinidad and Tobago, 1988-1997.

Serotype	Year of Diagnosis									
	88	89	90	91	92	93	94	95	96	97
Enteritidis	0	0	0	0	1	0	18	47	107	73
Typhimurium	4	6	9	17	84	45	37	13	11	5
Other	27	18	27	48	21	37	44	49	57	31
TOTAL	31	24	36	65	106	82	99	109	175	109

Question 7A: Calculate the incidence of laboratory-confirmed salmonellosis (all serotypes combined) for Trinidad and Tobago in 1997. (Assume that only one isolate was received for each patient. The population of Trinidad and Tobago was estimated to be 1,265,000 in July of 1997.)

Question 7B: The annual incidence of laboratory-confirmed *Salmonella* infections in Trinidad and Tobago is approximately 9 per 100,000 population. Assume that: 1) approximately one in every 10 people with diarrhea go to the doctor, 2) doctors request submission of a stool specimen from approximately one in every 10 patients with diarrhea that they see, and 3) approximately two in every three stool specimens are properly tested for *Salmonella* and are reported through the surveillance system.

Given these assumptions, what is the true burden of *Salmonella* in Trinidad and Tobago?

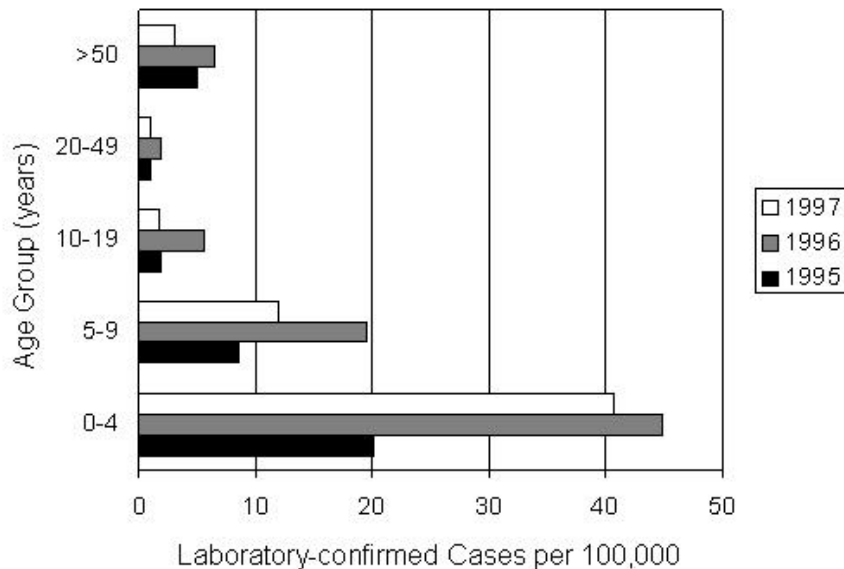
Question 8: Create a line graph of the number of *Salmonella* isolates by serotype by year of diagnosis for Trinidad and Tobago from 1988 to 1997. Interpret the graph.

Due to the increase in *S. Enteritidis* in Trinidad and Tobago, CAREC focused their analyses on this serotype. The following data are for *S. Enteritidis* only.

From 1995-97, 227 laboratory-confirmed cases of *S. Enteritidis* infection were reported in Trinidad and Tobago. Approximately, 76 cases were reported each year for an annual incidence of 6 per 100,000 population. In general, the geographic distribution of patients with *S. Enteritidis* infection reflected population distributions on the two islands. The largest numbers of cases were reported from the most populous counties of St. George and Victoria.

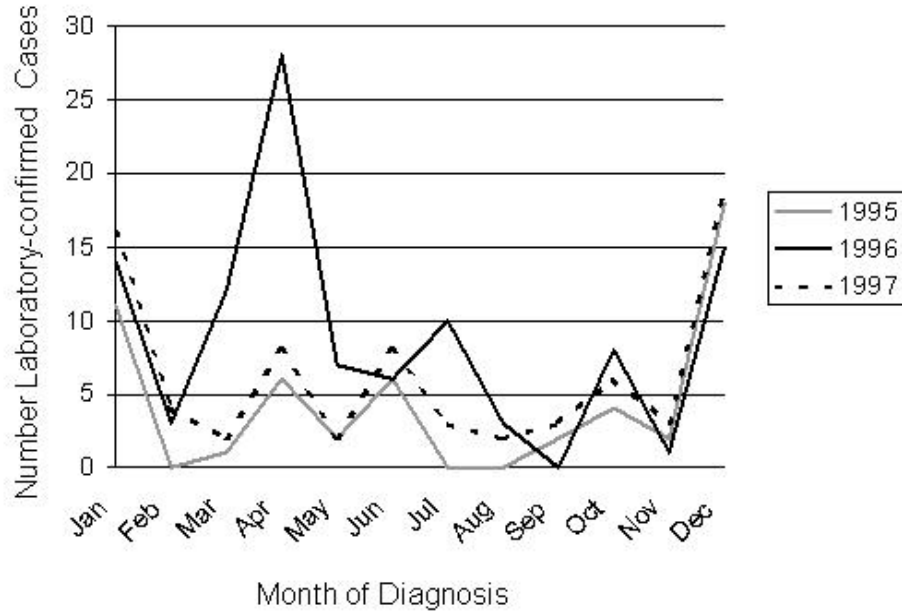
A similar proportion of *S. Enteritidis* infections occurred among males (48%) and females (52%). However, the distribution of cases varied by age group (Figure 4) and month of diagnosis (Figure 5).

Figure 4. Laboratory-confirmed cases of *Salmonella* Enteritidis (per 100,000 population) by age group and year of diagnosis, Trinidad and Tobago, 1995-1997.



Question 9: Interpret the grouped bar chart of laboratory-confirmed *S. Enteritidis* cases by age group. What age group(s) is at highest risk for infection?

Figure 5. Laboratory-confirmed cases of *Salmonella* Enteritidis by month and year of diagnosis, Trinidad and Tobago, 1995-1997.



Question 10: Describe the occurrence of *S. Enteritidis* infection in Trinidad and Tobago by month of diagnosis?

Part IV – Case-Control Study of *S. Enteritidis* in Trinidad and Tobago

To explore risk factors for *S. Enteritidis* infection in Trinidad and Tobago, a matched case-control study was undertaken from March 1998 - May 1999. A case-control study design was used because the cases did not arise from a well-defined group of people and were distributed across the entire country.

Cases were patients with laboratory-confirmed *S. Enteritidis* infection who were reported through the communicable disease surveillance system. Cases were enrolled prospectively, shortly after diagnosis. Controls were persons with no diarrheal illness in the previous 4 weeks who lived in the same neighborhood as cases and were similar in age. Investigators attempted to enroll two controls for each case.

Using a standardized questionnaire, investigators collected information from cases about foods and beverages consumed, recent travel, and food handling practices in the 3 days before they became ill. Controls were asked about these exposures during the same 3-day period as the matched case. The questionnaire was administered to both cases and controls by one of the investigators in face-to-face interviews.

Forty-five patients and 92 controls were enrolled in the case-control study. The investigators analyzed the results of the case-control study.

Question 11: What is the measure of association in a case-control study? How is it interpreted?

In the Trinidad and Tobago case-control study, cases and controls were similar to each other in terms of age, sex, ethnic distribution, and place of residence. Exposure to potential sources of *Salmonella*, however, differed between cases and controls (Table 2).

Table 2. Potential sources of exposure to *Salmonella*, Trinidad and Tobago Case-Control Study, March 1998 – May 1999.

Exposure*	Matched Odds Ratio	p-value
Ate chicken	0.5	0.4
Ate shell eggs	8.8	<0.001
Ate dishes that contained raw or undercooked eggs	18.9	0.001
Ate ground beef	1.3	0.6
Ingested powdered milk	1.5	0.2
Exposed to live chickens	1.3	0.4
Bought refrigerated eggs	0.1	<0.001
Refrigerated eggs at home	0.03	<0.001

*in the 3 days before onset of illness in the associated case

Question 12: Interpret the odds ratios for the above exposures. What exposures appear to be risk factors for *S. Enteritidis* infection in Trinidad and Tobago?

The specific raw egg-containing foods that were implicated by the case patients' food histories included homemade eggnog, cake batter, homemade ice cream, punch a crème (i.e., a drink similar to eggnog), and stout and eggs. The implicated food items correlated with the predominance of cases in December and January as many of these foods are consumed more frequently in the holiday season.

Samples of the implicated foods were collected from patients, from the places where patients had originally purchased the foods, or both and were cultured for *Salmonella*. *S. Enteritidis* isolates from patients and food were phage-typed at the U.S. Centers for Disease Control and Prevention (CDC) in Atlanta, Georgia.

S. Enteritidis samples from 34 patients were selected for phage typing. Of these, 30 (88%) were found to be phage type 4 and 4 (12%) were found to be phage type 1. *S. Enteritidis* was isolated from 15 (45%) of the 33 food samples implicated by the patients' food histories. Nine of the 15 food isolates were phage typed; all nine were phage type 4.

Question 13: Discuss possible interpretations of the same phage type among *Salmonella* isolated from patients with salmonellosis and suspect food samples.

Question 14: What control measures would you consider at this point?

Part V – Study of Eggs in Trinidad

To further investigate the role that eggs may play as a source of *Salmonella* infections in Trinidad, a microbiologic survey of shell eggs was undertaken. Ten egg-producing farms across the country were selected, nine of which were the largest and most popular commercial table egg farms in Trinidad. Their total production accounted for approximately 75% of the country's egg supply.

Twenty-five freshly laid eggs were collected from each farm on three different occasions for a total of 750 eggs. Each set of 25 eggs was cultured for *Salmonella* in pooled batches.

Eggshells were cultured separately from egg contents. The eggshell samples were prepared by swabbing the shell surface of each of the 25 eggs with cotton wool tips moistened with lactose pre-enrichment broth. The eggs were not washed prior to swabbing. The eggs were then sanitized using U.S. Food and Drug Administration eggshell disinfection procedures: each egg was cleaned with a stiff wire brush, hand washed under running water with antibacterial soap, and patted dry with a paper towel. The eggs were then placed in a wire basket and immersed in 70% alcohol for 30 minutes followed by distilled water for 10 minutes. The eggs were then allowed to air dry. The contents were removed aseptically, pooled together, and homogenized in a blender.

Question 15: Why were the eggshells cultured separately from the egg contents? Why were the eggs sanitized before the contents were cultured?

Salmonella was detected more often in shell cultures (4.6% of samples) than in content cultures (1.2% of samples). *S. Typhimurium* was the most prevalent serotype found on the eggshells and *S. Enteritidis* was the most prevalent serotype isolated from the egg contents (Table 3).

Table 3. *Salmonella* serotypes isolated from the 750 pooled eggshells and egg contents from 10 egg-producing farms, Trinidad, 1998-1999.

<i>Salmonella</i> serotype isolated	Percent positive for serotype*	
	Pooled eggshells	Pooled egg contents
<i>S. Typhimurium</i>	3.06	0.4
<i>S. Enteritidis</i>	0.67	0.8
<i>S. Ohio</i>	0.27	-
<i>S. Cerro</i>	0.27	-
<i>S. Infantis</i>	0.27	-
<i>S. Heidelberg</i>	0.13	-
Total	4.6	1.2

*Because *Salmonella* isolates are generally present in very low numbers in eggs, it was assumed that each isolate came from one positive egg and the percentage was based on a denominator of 750.

The isolation rates of *Salmonella* on shell surfaces and in egg contents varied among the 10 egg-producing farms. At least one serotype of *Salmonella* was isolated from eggshells at all 10 of the farms. *Salmonella* was isolated from egg contents at only three of the farms.

An environmental health assessment was undertaken at each of the farms by a food safety officer from the Trinidad and Tobago Ministry of Agriculture to identify factors that could have contributed to the contamination of eggshells and contents with *Salmonella*.

Question 16: What specific activities would you undertake as part of an environmental health assessment of the egg-producing farms?

The food safety officer inspected the farms and collected information about the system of chicken rearing, quality control measures, feed and litter type, egg cleanliness, and other management practices.

At four of the farms, the environment and immediate surroundings were generally clean with dry litter surfaces and clean drinking water, poultry houses, nesting boxes, and equipment. Proper egg-handling techniques and good farm practices were also employed. The eggs collected from these farms appeared clean with little or no fecal matter on their surfaces.

In contrast, the surroundings of the other six egg-producing farms generally appeared unsanitary: litter surfaces were wet on most occasions. Egg belts, poultry houses, and nesting boxes were dirty and there were rodents and flies. These farms were also characterized by odor build-up, such as ammonia, and the eggs collected from them frequently had feces and sometimes blood on the shells. In general, these farms had higher *Salmonella* isolation rates from pooled eggshells and egg contents than the other farms.

None of the 10 farms had routine microbial monitoring of their flocks or eggs.

Question 17: What food safety practices at the egg-producing farms might help prevent or reduce the risk of salmonellosis from the consumption of eggs from these farms?

Part VI - Prevention and Control

Following release of the results from the *S. Enteritidis* case-control study, the microbiologic survey of shell eggs, and environmental health assessments of egg-producing farms, the Trinidad and Tobago Ministries of Health and of Agriculture initiated a farm-to-table approach to *Salmonella* prevention and control strategies. These strategies combined public health education of consumers, food service establishments, and food workers (on the risks associated with eating raw and undercooked eggs and using unrefrigerated eggs) and strategies for reduction of *Salmonella* infections among egg-laying flocks and breeder flocks.

Regional workshops were held in November 2002 for egg producers on production and food safety. “Good Agricultural Practices” for hatchery sanitation and egg production were developed from the proceedings. Drafts were widely distributed for review and comment. Final copies were distributed to all egg-producing farms under the coordination of the Inter-American Institute for Cooperation on Agriculture. The Ministry of Agriculture, responsible for the regulation of food safety in Trinidad and Tobago, made staff available on an ongoing basis to answer questions from producers on the “Good Agricultural Practices” and help them to explore and solve problems.

Through public and private partnerships and networking, Ministry of Agriculture officials developed a protocol to identify and remove infected flocks from the egg supply and increase quality assurance and sanitation measures at egg-producing farms. The procedures included the following steps:

- Both eggs and chickens from commercial egg-producing farms will be tested for *Salmonella* on a quarterly basis.
- Any flocks that test positive for *Salmonella* on routine exam will be re-tested.
- If a second sample is positive, traceback investigations will be undertaken to identify breeder flocks.
- Infected breeder flocks (those that produced the egg-laying chickens) will be slaughtered.
- Eggs from infected egg-laying chickens will be pasteurized instead of being sold as shell eggs.
- Non-infected flocks from farms at which infected flocks have been detected will be tested more frequently (i.e., every 4 weeks).

The Ministry of Agriculture implemented the above procedures in Trinidad and Tobago in 2003.

Question 18: In addition to the testing of eggs and flocks for *Salmonella*, how might you monitor the impact of *Salmonella* control measures in Trinidad and Tobago?

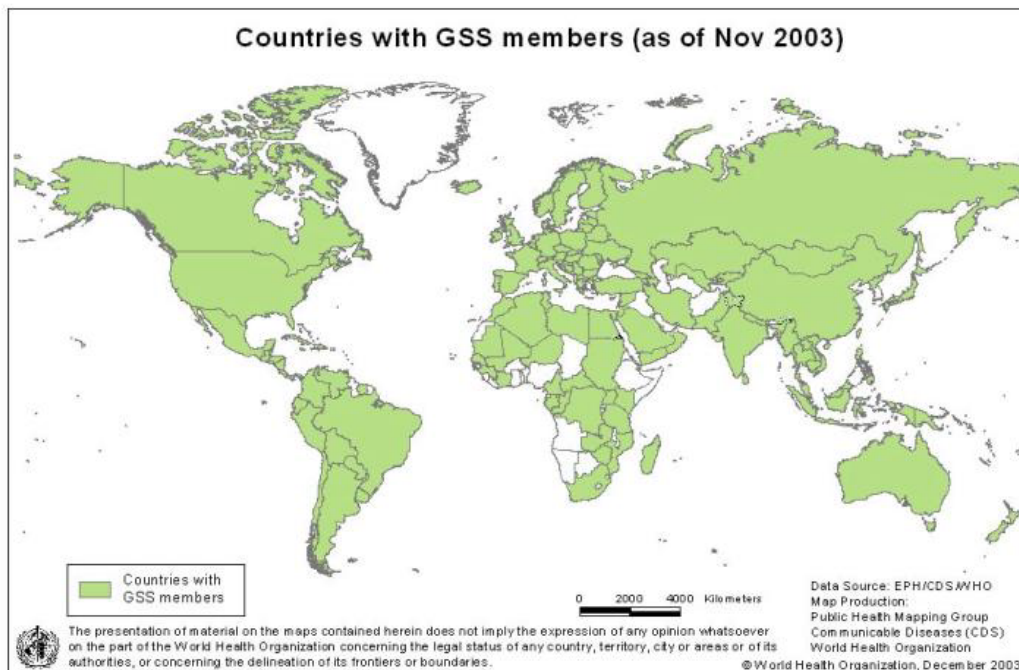
Epilogue

Serotyping of *Salmonella*, as used in the investigation of *Salmonella* Enteritidis in the Caribbean, is a common subtyping procedure used throughout the world. In a 1997 survey of World Health Organization (WHO) member states, 69 of the responding 104 countries conducted *Salmonella* serotyping as part of public health surveillance for salmonellosis. Serotyping was performed in all six WHO regions; however, surveillance was limited in time or scope for some countries. Access to serotyping reagents varied by country and some countries reported only serogroup results.

WHO Global Salm-Surv, an international, foodborne disease surveillance network, was created by WHO in partnership with the Danish Institute for Food and Veterinary Research, the Centers for Disease Control and Prevention, Institut Pasteur International Network, Health Canada, and the Animal Sciences Group (ID-Lelystad) in the Netherlands. The goal of WHO Global Salm-Surv is to reduce foodborne diseases through enhancement of laboratory-based surveillance (including serotyping and antimicrobial resistance testing) and outbreak detection and response techniques. Components of the network that help promote this goal include international training courses, an external quality assurance system, and country and region-specific projects. The network also offers a moderated list serv, web-based annual *Salmonella* summary data from member institutions, and a website, and provides services such as reference testing and identification of reliable sources of antisera for countries.

As of November 2003, WHO Global Salm-Surv had members from 138 countries including the Bahamas, Barbados, Belize, Dominican Republic, Jamaica, Saint Lucia, Suriname, and Trinidad and Tobago in the Caribbean. Participation in WHO Global Salm-Surv has provided critical information to investigate outbreaks such as the one described in this case study and has led to local interventions that have reduced the human health burden of *Salmonella* and other foodborne diseases globally.

Figure 6. WHO Global Salm-Surv Country Membership



References

- Herikstad H, Motarjemi Y, Tauxe RV. *Salmonella* surveillance: a global survey of public health serotyping. Epidemiol. Infect 2002;129:1-8.
- Indar-Harrinauth L, Daniels N, Prabhakar P, Brown C, Baccus-Taylor G, Commissiong E, Hospedales J. Emergence of *Salmonella enteritidis* phage type 4 in the Caribbean: Case-control study in Trinidad and Tobago, West Indies. Clinical Infectious Diseases 2001;32:890-6. (See Appendix for abstract.)
- Indar L, Baccus-Taylor G, Commissiong E, Prabhakar P, Reid H. Salmonellosis in Trinidad: evidence for transovarian transmission of *Salmonella* in farm eggs. West Indian Med J 1998;47:50-3. (See Appendix for abstract.)
- Orrett FA and Shurland SM. Susceptibility patterns and serotypes of non-typhoidal *Salmonella* in Trinidad. Saudi Med J 2001;22:852-5.

Appendix: Abstracts from Original Investigations

Indar-Harrinauth L, Daniels N, Prabhakar P, Brown C, Baccus-Taylor G, Comissiong E, Hospedales J. Emergence of *Salmonella enteritidis* phage type 4 in the Caribbean: Case-control study in Trinidad and Tobago, West Indies. Clin Infect Dis 2001;32(6):890-6.

A prospective case-control study involving 46 case patients and 92 age- and neighborhood-matched control subjects was conducted in Trinidad and Tobago (T&T) between March 1998 and May 1999 to determine the etiology, sources, and risk factors for *Salmonella enteritidis* (SE) infection. SE infection in T&T was found to be associated with the consumption of shell eggs, and in particular raw or undercooked eggs. SE isolates from 30 (88%) of 34 patients and from 9 implicated egg or egg-containing food samples were phage type 4. Homemade eggnog and ice cream, cake batter, and egg-containing beverages were the main raw egg-containing foods, reflecting the cultural practices of the people of T&T. Public health education on the risks of eating raw or undercooked eggs, thorough cooking of all egg dishes, and refrigeration of shell eggs and egg dishes; studies tracing infected eggs to their sources; and testing of flocks of layer chickens for SE are needed to reduce the incidence of this infection.

Indar L, Baccus-Taylor G, Commissiong E, Prabhakar P, Reid H. Salmonellosis in Trinidad: Evidence for transovarian transmission of *Salmonella* in farm eggs. West Indian Med J 1998;47(2):50-3.

The aim of this study was to determine whether the contents of farm eggs in Trinidad are contaminated with *Salmonella* and if transovarian transmission occurs. 750 fresh eggs from 10 farms supplying 75% of the country's eggs were cultured for *Salmonella*. *Salmonella* was found on the egg shells' surfaces from all farms, and in the egg contents from three farms. Isolates were obtained from the cultures of the contents and shells of nine (1.2%) and 35 (4.66%) eggs, respectively ($p < 0.005$). Serotypes found in the contents were *S. enteritidis* (0.8%; deduced to be contaminated by transovarian transmission) and *S. typhimurium* (0.4%); those isolated from the shells (contaminated by faecal transmission) were *S. typhimurium* (3.06%), *S. enteritidis* (0.67%), *S. ohio* (0.27%), *S. cerro* (0.27%), *S. infantis* (0.27%) and *S. heidelberg* (0.13%). This study provides the first evidence for *Salmonella* and, more importantly, *S. enteritidis*, in eggs in Trinidad. This is of major public health significance because *S. enteritidis* infected eggs appear normal and the organism is difficult to detect and control. The consumption of these eggs may increase the risk of *Salmonella* infection. Food safety practices, particularly the thorough cooking ($> \text{or} = 70 \text{ degrees C}$) of all egg dishes and the refrigeration ($< 10 \text{ degrees C}$) of shell eggs and egg dishes, are recommended.