

## Bad Eggs: On the Trail of Salmonellosis

10/26/2010

Two groups attending separate events in Santa Clara, CA soon became central characters in a salmonellosis outbreak investigation that eventually led to the largest egg recall in history. The two groups, high school prom-goers and newly minted college graduates, had topped off dinner with egg-containing desserts brought in from a local bakery.

Both groups became infected with *Salmonella* Enteritidis, and suddenly, public health officials began spotting more egg-related outbreaks in other parts of the country. Within months, more than 1,800 people in 23 states would be associated with this outbreak of *Salmonella* infections. People had fever, abdominal cramps and diarrhea beginning 12 to 72 hours after eating the contaminated food. The elderly, infants, and those with impaired immune systems were at risk for more serious illness.

Investigators ultimately linked the outbreaks to both Hillandale Farms and Iowa mega-egg producer Wright County Egg, currently under investigation by the FDA. Eventually, more than half a billion eggs would be recalled as a result of this outbreak.

### Role of PulseNet in DNA Fingerprinting *Salmonella* Strains

CDC has chronicled through a [timeline](#) the investigation that relied on teamwork across federal, state, and local government agencies and used data from PulseNet. PulseNet, a CDC-managed, national network of public health and food regulatory agency laboratories, helps public health officials detect foodborne disease case clusters early on. It works by using molecular subtyping (or "fingerprinting") of foodborne disease-causing bacteria with a technique known as pulsed-field gel electrophoresis (PFGE).

The PulseNet team includes about 20 CDC staff, half of whom are database managers. Six staff members serve as epidemiologist liaisons with the Outbreak Response and Prevention Branch, where investigators are working on as many as 30 to 40 clusters a week. PulseNet has grown dramatically over the last decade, with all 50 states now participating in the laboratory network. The PulseNet database currently houses *Salmonella* patterns from more than 290,000 samples – including 44,400 for *Salmonella* Enteritidis, the second most common form of the *Salmonella* bacteria," says Kelley Hise, MPH, unit chief of the PulseNet Database in CDC's Enteric Diseases Laboratory Branch.

"PulseNet maintains databases of the DNA fingerprints of the bacteria. You can't think of these like human fingerprints because human fingerprints are only going to match with identical twins. You have to think of bacteria as having a lot of identical twins, and it's our job to match them up. Our ultimate goal is if we find a



The SE outbreak team meets to discuss the latest data from the epi curve. (l-r: Latoya Simmons, Kelley Hise, Thai-An Nguyen, and Ian Williams). *Photo by Jim Gathany*



Conditions inside the hen houses of Wright County Egg of Galt, Iowa, contributed to a large-scale national outbreak of *Salmonella* Enteritidis. *Photo by Ian Williams*



San Diego county environmental health workers photographed these egg boxes at a restaurant that had sick customers. The eggs were traced back to Wright County Egg. *Photo by Brad Richardson, San Diego County Department of Environmental Health*

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cluster or a group of DNA fingerprints that match, we look to see if the numbers we are seeing are above baseline of what you would expect.”



Jessica Halpin, research biologist, in CDC’s Enteric Diseases Laboratory Branch tests *Salmonella* Enteritidis samples to see if they match existing patterns in the database. *Photo by Jim Gathany*

CDC’s PulseNet team noticed the numbers of this type of *Salmonella* infection doubling in late June. “Normally, we’d see about 300 of these monthly around summer every year, but around the third week in June, we saw that number double. At the end of June, San Diego posted several isolates to PulseNet with the outbreak pattern.”

Hise says what made this outbreak difficult to identify was the fact that *Salmonella* Enteritidis infection is so “clonal.” “What that means is in the whole scheme of patterns, almost 50 percent are this one pattern that was involved in the outbreak.”

This common genetic fingerprint also posed a unique challenge for epidemiologists on the case. It made it “hard to sort out which cases were outbreak-related and which were background,” says CDC’s lead investigator Ian Williams, PhD, acting chief of the Outbreak Response and Prevention Branch in the Division of Foodborne, Waterborne and Environmental Diseases. “The big break came when California found six of these clusters

spread out across the state.”

### California Investigators Find Outbreak Source

Jeffrey Higa, MPH, epidemiologist with the California Department of Public Health (CDPH) Infectious Diseases Branch, said it was mid-June when the state lab first informed his office of a cluster of *Salmonella* Enteritidis infections with the outbreak pattern.

Higa and his colleagues started collecting case histories from the county health departments. Looking for clusters of people eating at the same restaurant in a defined period of time, Higa and his colleagues were able to look at what foods they had in common that tied them together. Eventually, CDPH interviewed 81 of the high school students who attended the prom.

“We had suspected eggs early on,” he says, recalling a previous North Carolina outbreak in a restaurant that had implicated meringue, which was made with a commercial egg product. That was confirmed through the case-control study of the high school students, which implicated a dessert called profiterole, a custard-filled pastry. “We also learned that at the graduation dinner, they served a mini-fruit tartlet. Both of these desserts came from an offsite bakery,” he says.

Higa says while Santa Clara County was experiencing a spike in cases, there were also increases in ill persons with the outbreak strain of salmonellosis in San Diego, Los Angeles, and Orange County. Public health officials started collecting more data to determine if there were other clusters of people getting sick with the same *Salmonella* strain.

With some of the San Diego restaurant customers reporting that they had consumed eggs, county environmental health workers photographed egg boxes that had labels with plant numbers. Higa called the California Department of Food & Agriculture and learned that the eggs came from Wright County Egg in Iowa. Traceback efforts at the bakery also pointed to the same egg producer.

It turns out that California is an “egg-deficit” state, with 35 percent of the shell eggs consumed by the state

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Ashley Sabol, a CDC guest researcher and fellow, uses an advanced subtyping methodology to further characterize this strain of *Salmonella* Enteritidis. *Photo by Jim Gathany*



EIS Officer Joanna Gaines reviews a state map of surplus incidence of *Salmonella* Enteritidis cases. *Photo by Stacey Hoffman*

coming in from other states (20 percent of which come from Iowa).

The California outbreak findings were just the beginning, Williams says, as CDC asked all other states to try to identify clusters of cases that might be associated with shell eggs, and where those eggs came from.

“Very quickly we found there was another cluster of cases with the outbreak strain in Colorado associated with eating a ‘rattlesnake cake,’ which is like a crab cake, but made with rattlesnake meat and served with a sauce that contains raw shell eggs. Then we heard of a cluster in Minnesota – and the source again was Wright County Egg. Quickly we were able to say it’s not just in California; it’s in Colorado, Minnesota and Wisconsin.” In total, CDC and its state partners identified 29 different clusters of cases, 15 for which Wright County Egg was the likely source.

#### Partnering with FDA

These findings led the FDA to inspect Wright County Egg. Williams was part of the FDA investigation team that was on site at the Iowa farm. FDA worked with CDC and the states to find the best clusters in the outbreak to identify the source of the contamination. As a regulatory agency, FDA has to document evidence before it can take certain actions. Throughout the investigation, FDA participated in conference calls with CDC, USDA, and state partners to give updates and share information on the investigation status.

“We continue to have a close collaboration with CDC from an epidemiological standpoint,” says Sherri A. McGarry, MS, emergency coordinator for the FDA’s Center for Food Safety and Applied Nutrition. FDA permanently bases one of its staff, Susan Lance, in CDC’s Food Safety Office, she adds, noting that this is another indication of the two agencies’ close collaboration.

McGarry says as a result of the new Food Safety Egg Rule, which went into effect in early July, FDA investigators now have the “standards to compare against what might be food safety violations. With that standard, we will be conducting egg-producing inspections during the next 14 months or so, throughout the country. We’ll be prioritizing the inspections based on our system of the risk posed by specific facilities. So it’s the facilities we think have been potentially at greatest risk of problems that will be inspected first as we go through this inspection plan.”

FDA has jurisdiction over the safety of foods in general, including shell eggs. FDA has primary responsibility for the parts of the continuum that involve the production and processing of shell eggs. The USDA has responsibility for implementing the Egg Products Inspection Act (EPIA), which it carries out through programs administrated by the Food Safety and Inspection Service (FSIS) and the Agricultural Marketing Service (AMS). FSIS has primary responsibility for the inspection of processed eggs, while AMS conducts a surveillance program to ensure proper disposition of restricted shell eggs. Additionally, AMS provides grading and certification services on a voluntary basis.

“This year, we are initiating over 600 inspections of large egg-producing facilities. That’s 80 percent of the egg producers in this country we’ll be covering over the next 14 months,” McGarry says.

#### Teamwork was Key in Outbreak Investigation

All the parties involved in the outbreak investigation agree that teamwork within their own organization and across various local, state, and federal partners was critical.

“CDC depends on the states doing this work,” says Hise, noting that CDC only pulses isolates when the states cannot or when they are having problems. Commenting on the collaboration he witnessed in California, Higa says, “I’m most proud of the teamwork by the epidemiologists, public health nurses, the microbiologists in the lab, and the environmental health investigators – all the pieces really needed to be there. We got clues from all different places and once we put them together, everything kind of fell into place.”

#### Global Collaboration Key to Safeguard Food

CDC's Williams reiterates that while the US. has the safest food supply in the world, the changing nature of the global food supply chain — among them, reliance on non-locally grown food (and often international crops) as well as mass production — has created new challenges for regulatory as well as public health agencies. Ten or 20 years ago, these challenges did not exist. "When things go right, we have lots of cheap, very safe food. But when things go wrong, because supply chains are so long and we have mass production, a problem can be rapidly amplified through the system. This is what occurred at Wright County Egg, which produces more than a billion eggs a year," he says.

"Whether smaller farms are safer than the large food production facilities remains a point of debate," says Williams, noting that some of the larger producers have better quality control. He adds that one thing is clear. "Finding where the problems are *quickly* is critical."

"With the growth of PulseNet, CDC is able to more easily find and flag increases in bacteria clusters," says Hise. "At the same time, Williams' notes, we're getting better and more aggressive about investigating clusters and engaging states and local partners in collecting the data to find sources of the clusters."

He adds that because long food supply chains are "a fact of life," driven by the public's demand for fresh fruit and vegetables year-round, "we are relying on food safety systems around the world, so it's making this international collaboration even more critical." This effort includes inspecting raw ingredients to ensure that those coming into the United States are safe.

PulseNet is certainly responding to this new reality by going global. "We have PulseNet Canada, Latin America, Europe, Asia Pacific, and Middle East. And soon we'll have PulseNet Africa. We have a direct link to Canada, and I think Latin America and Asia Pacific want to eventually get there," says Hise.

This ***Inside Story*** by Anne Wainscott-Sargent.

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## How to Handle Eggs Safely

CDC's Ian Williams emphasizes that "eggs in general are safe, but they are not completely risk free." Follow these egg-handling tips to stay healthy:

- Keep eggs refrigerated at = 45° F (=7° C) at all times.
- Discard cracked or dirty eggs.
- Wash hands and all food contact surface areas (counter tops, utensils, and cutting boards) with soap and water after contact with raw eggs. Then, disinfect the food contact surfaces using a sanitizing agent, such as bleach, following label instructions.
- Eggs should be cooked until both the white and the yolk are firm and eaten promptly after cooking.
- Do not keep eggs warm or at room temperature for more than 2 hours.
- Refrigerate unused or leftover egg-containing foods promptly.
- Avoid eating raw eggs.
- Avoid restaurant dishes made with raw or undercooked, unpasteurized eggs

