Salmonella enteritidis...

When a Good Egg Goes Bad

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We’ve all heard the news recently that over one half billion eggs have been recalled in 17 states. This article discusses how and why outbreaks occur and what can be done to prevent them.

The Outbreak

Over 1,500 cases of salmonella food poisoning due to egg consumption have been confirmed. The real number may be much higher, as many people don’t bother to report a minor illness. It has been estimated that 130,000 people become ill from infected eggs every year. Although these numbers may seem high, contaminated eggs account for only about 1% of all food-borne illness in the United States. The Food Safety Inspection Service (FSIS) recently reported a four-fold increase in Salmonella poisoning since May of 2010 due to the consumption of shell eggs.

The Salmonella strain implicated in the outbreak has been recently identified in egg farm environmental samples, the CDC said. Currently the source is thought to be the chicken’s feed, where genetically similar bacteria have been isolated that match strains found in sick patients. These epidemiological studies use diagnostic testing, DNA fingerprint analysis and pulsed field gel electrophoresis (PFGE) to identify strains.

The Food and Drug Administration has collected nearly 600 samples from Wright County Egg and Hillandale Farms of Iowa as part of its investigation. Six samples collected from manure, traffic areas and the feed tested positive for a particular strain whose PFGE patterns are indistinguishable from the outbreak strain.

The Disease

The main culprit when it comes to contaminated eggs is usually Salmonella enteritidis.
This infection can cause fever, abdominal cramps, and diarrhea beginning 12 to 72 hours after ingesting tainted eggs or other foods like tainted meat, poultry, and milk. The illness usually disappears after 4 to 7 days of infection and most people do not require antibiotic therapy.

People who are at high risk for severe complications are elderly people, infants, and those with compromised immunity, such as cancer patients and organ recipients. In serious cases, the bacterium can spread to the intestines, to the blood stream, and then to other body parts, causing death unless the patient is treated promptly with antibiotics.

**How Eggs Become Contaminated**

Eggs may become contaminated from the inside out or the outside in.

Eggs can become infected from the outside because eggshells are porous and whatever the eggshell comes into contact with can cross over this semi-permeable membrane and end up inside the egg, including *Salmonella*. This happens when hens sit on their eggs. It is estimated that each egg has over 9,000 pores in its shell large enough for bacteria to pass through.

Oddly enough, washing eggs, which is required by federal and most state laws, can remove one of the barriers that normally protects eggs from becoming contaminated.

But eggs can also become contaminated while they are being formed if salmonella exist inside a chicken’s ovaries. Hens can become infected by eating rodent droppings or contaminated feed, and then pass the salmonella on to their eggs. Salmonella can be transmitted by rodents, other birds, and flies.

It has been estimated that one in every 20,000 hens has ovaries infected with salmonella. Infected hens show no symptoms of disease and, thus, cannot be culled from the flock.

Although only small numbers of bacteria are shed from the ovaries, under ideal conditions a Salmonella bacterium divides every 20 minutes. Consequently, after two hours there could be as many as 1,000 bacterial cells. Numbers over 100 cells are usually required upon ingestion in order for symptoms to occur.

The bacteria tend to proliferate in the membrane surrounding the yolk. This is why “sunny-side up” eggs might be potentially more dangerous than “over easy”.

**How to Control and Prevent Contamination**

Stringent eggshell cleaning and inspecting procedures were implemented in the 1970s and then strengthened in 2009 to decrease this form of contamination, according to the U.S. Department of Agriculture’s Food Safety and Inspection Service (FSIS).
In July of 2009, the FDA and FSIS released a new set of tougher regulations that apply to all egg producers having over 3,000 laying hens. The regulations provide guidelines for rodent and pest control, testing of young chicks and the chicken litter for Salmonella, cleaning and disinfecting procedures, and refrigeration.

One strategy to control infections is to get eggs refrigerated as quickly as possible. A hen has an internal temperature of 39 degrees C (102 degrees F). With bacteria multiplying at a rate of one division every 20 minutes, it becomes imperative to get eggs refrigerated as soon as possible. Current FDA regulations require that egg farms refrigerate eggs at or below 7 degrees C (45 degrees F) no more than 36 hours after they are laid.

Another strategy is to vaccinate all hens for salmonella. This is routinely done in Europe.

Is Agribusiness at Fault?

Salmonella tend to proliferate in the crowded conditions lacking in sunlight and adequate ventilation found in large poultry operations. Chickens raised in unsanitary conditions are far more likely to be contaminated, and lay contaminated eggs. In fact, one study by the British government found that 23 percent of farms with caged hens tested positive for salmonella, compared to just over 4 percent in organic flocks and 6.5 percent in free-range flocks.

As studies show, contamination occurs most often on farms that contain the most birds, typically 30,000 or more. These large farming operations have flocks that contain over four times the average levels of salmonella compared to smaller flock sizes allowed under British organic standards.

One of the Iowa egg farms that is implicated in the latest outbreak produces over two million eggs every week.

The Envirobootie for Sampling

Recently Hardy Diagnostics has released a product to assist in the monitoring and control of Salmonella in chicken flocks. It facilitates the sampling of chicken litter in the poultry barn, and consists of a skim milk soaked bootie (or sock) that the worker wears over their shoes.

Figure 1: Hardy’s Envirobootie is used to sample chicken litter on the floor of the poultry barn.

As the worker walks through the poultry barn they sample a large area of litter for salmonella. The bootie is then removed and cultured in Tetrathionate or similar broth specific for Salmonella.

The Envirobootie II is moistened with Skim Milk prior to donning over the worker’s shoes.

Hardy offers a full line of culture media products for the isolation and detection of
Salmonella from food. The liquid culture media typically used is Tetrathionate Broth, Rappaport Vasilliadis Broth, and Selenite Cystine Broth.

Solid media would include Bismuth Sulfite Agar, Hektoen Enteric Agar (HE), and XLD Agar.

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The information contained in this article is for educational purposes only and is not intended nor recommended as a substitute for medical advice, diagnosis, or treatment.

Tips for Safe Egg Handling

To prevent infection with *Salmonella enteritidis*, follow these rules when buying, storing, preparing, serving, and eating eggs:

1. **Don't eat raw eggs.** This includes so-called "health-food" beverages made with raw eggs, and foods traditionally made with raw eggs, such as Caesar salad, hollandaise sauce, homemade mayonnaise, ice cream, eggnog, and cookie dough, unless the dish was made with a pasteurized liquid egg product or pasteurized in-shell eggs. Egg mixtures made with an egg-milk base cooked to an internal temperature of 160 degrees Fahrenheit (71 degrees Celsius) are safe, too. Use a thermometer to make sure the mixtures reach the correct temperature.

2. **Buy eggs only if sold in the grocer's refrigerated case.**

3. **Open the carton and check that the eggs are clean and uncracked.**

4. **Store eggs in their carton in the coldest part of the refrigerator**, not in the door, and use within three to five weeks. The refrigerator should be set at 40 F (5 C) or slightly below.

Keep hard-cooked eggs, including dyed Easter eggs, in the refrigerator, not at room temperature. Use within one week.

5. **Eggs should not be frozen in their shells.** To freeze whole eggs, beat yolks and whites together. Egg whites can also be frozen by themselves. Use frozen eggs within one year.

6. **Wash hands, utensils, equipment, and work areas with warm, soapy water before and after contact with eggs and egg-rich foods.**

7. **Don't leave cooked eggs out of the refrigerator for more than two hours.** When baking or cooking, take out the eggs you need, and then return the carton to the refrigerator.

8. **Cook eggs until yolks are firm.**