



# Multistate outbreak of human *Salmonella* Typhimurium infections linked to live poultry from agricultural feed stores and mail-order hatcheries, United States 2013



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## ABSTRACT

Live poultry-associated salmonellosis is an emerging public health issue in the United States. Public and animal health officials collaborated to investigate one of the largest (356 cases, 39 states) of these outbreaks reported to date. A case was defined as illness in a person infected with the outbreak strain of *Salmonella* Typhimurium with illness onset between 1 March and 22 October 2013. The median patient age was seven years (range: <1–87 years); 58% of ill persons were children ≤10 years, 51% were female, 25% were hospitalized; 189 (76%) of 250 patients reported live poultry exposure in the week before illness; and 149 (95%) of 157 reported purchasing live poultry from agricultural feed stores. Traceback investigations identified 18 live poultry sources, including 16 mail-order hatcheries. Environmental sampling was conducted at two mail-order hatcheries. One (2.5%) of 40 duplicate samples collected at one hatchery yielded the outbreak strain. Live poultry are an important source of human salmonellosis, particularly among children, highlighting the need for educational campaigns and comprehensive interventions at the mail-order hatchery and agricultural feed store levels. Prevention and control efforts depend on a One Health approach, involving cooperation between public and animal health officials, industry, health professionals, and consumers.

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## 1. Introduction

Non-typhoidal salmonellosis is the most common enteric bacterial illness in the United States, resulting in an estimated 1.2 million illnesses, 19,000 hospitalizations, and 370 deaths annually [1]. Although the majority of *Salmonella* spp. infections are foodborne, an estimated 11% are attributed to animal contact, or are zoonotic [2]. *Salmonella* is naturally found in the intestinal tract of many animals. Based on reported outbreak investigations, reptiles, amphibians, live poultry, and small non-traditional pets present a high risk for zoonotic salmonellosis [3–6]. Importantly, infected animals often appear healthy, but can intermittently shed bacteria [5]. Zoonotic *Salmonella* infections can occur through

direct contact with infected animals; or through indirect contact with anything in the areas where animals live and roam, or consumption of food or drink prepared in contaminated environments [2,6,7].

Backyard flocks are increasing in popularity in the United States as a result of the local foods movement and the desire to raise live poultry for fun or hobby [8]; concurrently, live poultry-associated salmonellosis is an emerging public health issue [6]. The mail-order hatchery industry is the primary producer of baby poultry for sale to private individuals, with approximately 20 core mail-order hatcheries across the nation [6,9–11]. Mail-order hatcheries produce and sell more than fifty million chicks annually, and may distribute a variety of live poultry nationwide. Baby poultry is typically distributed through the U.S. Postal Service to agricultural feed stores, and is also sold directly to customers through catalog and internet orders.

Mail-order hatcheries are voluntarily regulated through the United States Department of Agriculture National Poultry Improvement Plan

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(USDA-NPIP). USDA-NPIP is a voluntary partnership between industry and state and federal government, with the goal of eliminating or controlling certain poultry diseases in breeder flocks to prevent egg-transmitted and hatchery-disseminated diseases [12]. The NPIP's original purpose was to serve as an avenue for the commercial poultry industry to officially test birds and demonstrate degrees of freedom from economically devastating vertically-transmitted diseases of poultry, such as Pullorum and Typhoid. The program has since expanded to include important diseases that impact trade, by including surveillance programs for Low Pathogenic Avian Influenza. Through constant evolution, the NPIP has expanded with the impetus to add voluntary programs to the NPIP provisions through periodic amendments as a means to ultimately protect the U.S. poultry industry and continue trade through diagnostic testing. One of these amendments to the NPIP provisions includes the addition of a new certification program that was proposed and accepted in 2010 and officially adopted as a program within the NPIP on 8 August 2014 [13]. The US voluntary *Salmonella* Monitoring Program is a program in which mail-order hatcheries have the opportunity to voluntarily participate. Participation in this program will certify their flocks are monitored for *Salmonella* organisms that may cause illness in humans. By participating, mail-order hatcheries should be able to track trends in *Salmonella* over time through diagnostic testing. The intent of this program is to reduce the incidence of *Salmonella* in day-old poultry in the hatchery and give the poultry industry a better opportunity to reduce the incidence of *Salmonella* in their products.

PulseNet, the national molecular subtyping network for foodborne disease surveillance, routinely performs pulsed-field gel electrophoresis (PFGE) on isolates from clinical cases of *Salmonella* and other reportable enteric diseases to identify clusters of human infections that may represent outbreaks [14]. From 1990 to 2012, 45 live poultry-associated salmonellosis outbreaks were identified, resulting in 1581 illnesses, 221 hospitalizations, and 5 deaths [6]. Since this time, additional live poultry-associated salmonellosis outbreaks have been investigated [15,16]. Additionally, a recent study of live poultry hatchling shipment boxes to multiple locations of a national farm store chain was published, further highlighting the link between mail-order hatcheries and human illness for particular non-typhoidal salmonella genotypes and antimicrobial susceptibility patterns [17]. Although many individuals recognize the risk of salmonellosis from handling raw poultry meat products, people are generally not aware that *Salmonella* can also be acquired through live poultry contact [6,18].

The Centers for Disease Control and Prevention (CDC) collaborated with public health and agriculture officials in many states and the U.S. Department of Agriculture Animal and Plant Health Inspection Service (USDA-APHIS) to investigate a multistate outbreak of human *Salmonella* Typhimurium infections. The objectives of the investigation were to identify the source of the outbreak through epidemiologic, traceback, and laboratory investigations; implement strategies to control the outbreak and prevent future illnesses; and provide recommendations to appropriate stakeholders to prevent future outbreaks.

## 2. Material and methods

### 2.1. Outbreak detection, case definition, and case finding

On 8 April 2013, a cluster of *Salmonella enterica* serotype Typhimurium isolates with an identical PFGE pattern (i.e., outbreak strain) was detected by PulseNet. CDC contacted state and local health departments to further investigate this cluster. Cases were defined as ill persons with laboratory-confirmed *Salmonella* Typhimurium infections with a PFGE pattern indistinguishable from the outbreak strain and illness onset (or isolation date if illness onset date unknown) between 1 March and 22 October 2013. Throughout the investigation, PulseNet notified CDC epidemiologists of isolates matching the outbreak strain that were newly uploaded to the database. CDC contacted epidemiologists in states with matching isolates.

### 2.2. Hypothesis generation

Health department personnel conducted hypothesis-generating interviews with patients using state or local enteric disease questionnaires, which typically address shopping locations, the foods patients ate at home and outside the home, travel, and animal contact during the week before illness onset. When patients reported live poultry exposure, personnel were asked to interview patients with a live poultry supplemental questionnaire. This questionnaire addresses specific baby and adult live poultry exposures and collects purchase, behavior, and backyard flock information. Interview results were compared by binomial probability to the Foodborne Diseases Active Surveillance Network (FoodNet) Population Survey Atlas of Exposures, 2006–2007, a national survey of healthy people regarding foods consumed in the 7 days before interview [19].

### 2.3. Traceback investigation

When patients reported a live poultry purchase from an agricultural feed store, epidemiologists contacted the store to complete the feed store information section of the live poultry supplemental questionnaire. This section addresses species of live poultry sold, months and numbers sold, as well as the sources of live poultry sold at the store. When possible, CDC confirmed live poultry sources with agricultural feed store chain corporate headquarters. CDC also worked with state public health and agriculture partners to confirm feed store shipments with identified mail-order hatcheries.

### 2.4. Laboratory investigation

Live poultry and environmental samples were collected from ill persons' homes. Environmental sampling was conducted at two mail-order hatcheries, using drag swabs according to standard protocol [13]. Samples were cultured for *Salmonella*, serotyped, and subtyped by PFGE [20] using enzyme *Xba*I at state public health laboratories, the National Veterinary Services Laboratories, and the CDC laboratory. Multiple-Locus Variable-number tandem repeat Analysis (MLVA) pattern typing [21] was performed on multiple isolates matching the outbreak strain by certified state public health laboratories and the CDC laboratory. Select human and environmental isolates were tested for antimicrobial susceptibility [22] by the CDC National Antimicrobial Resistance Monitoring System laboratory.

## 3. Results

### 3.1. Case finding and patient characteristics

The outbreak strain (*Salmonella* Typhimurium, PFGE pattern *Xba*I JPXX01.0286) had been seen in PulseNet before, with an average of 33 (range = 20–51) uploads per year during 2008–2012. By 22 October 2013, 356 persons infected with the outbreak strain were reported from 39 states (Fig. 1). Estimated and reported illness onset dates were between 4 March and 6 October 2013 (Fig. 2). Ill persons ranged in age from <1 to 87 years, with a median age of 7 years (Table 1). 58% of ill persons were children ≤10 years of age. 51% of ill persons were female. Among ill persons with available information, 25% were hospitalized. No deaths were reported.

### 3.2. Hypothesis generation

Early epidemiologic information suggested an association between patient illness and baby poultry exposure. During interviews, 189 (76%) of 250 patients reported exposure to any live poultry in the 7 days before illness onset (Table 2). Of 177 patients with specific exposure information, 84% reported live poultry exposure including chicks or chickens and 56% reported exposure to only chicks or chickens. 42% of

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