

Backyard Poultry Flocks and Salmonellosis: A Recurring, Yet Preventable Public Health Challenge

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Poultry are well recognized as possible carriers of *Salmonella* species. As part of the local foods movement, backyard poultry flocks have increased in popularity in recent years. Between 1996 and 2012, 45 outbreaks of human *Salmonella* infections linked to live poultry from mail-order hatcheries were documented. This review examines the history of live poultry-associated salmonellosis in humans in the United States, the current status of the issue, and what can be done to help prevent these illnesses. An integrated One Health approach involving the mail-order hatchery industry, feed stores, healthcare providers, veterinarians, and backyard flock owners is needed to help prevent live poultry-associated salmonellosis.

Keywords. *Salmonella*; zoonoses; outbreak; backyard poultry; mail-order hatchery.

Nontyphoidal *Salmonella* bacteria cause an estimated 1.2 million illnesses, 19 000 hospitalizations, and 370 deaths in the United States annually [1]. Although the majority of infections are foodborne, zoonotic *Salmonella* infections are an important public health problem. *Salmonella* is found in the intestinal tract of many animals including reptiles, amphibians, and live poultry (eg, chicks, chickens, ducklings, ducks, geese, turkeys) [2–14]. An estimated 11% of *Salmonella* infections are attributed to animal exposure annually, making it important for healthcare providers to be aware of this zoonosis [15].

Both direct and indirect contact with infected animals can lead to human salmonellosis [4, 6, 7, 16]. Indirect transmission can occur through contact with anything in areas where animals live and roam or

consumption of food/drink prepared in contaminated environments [4, 7, 9, 17]. Live poultry infected with *Salmonella* typically appear healthy, but can intermittently shed bacteria.

In humans, *Salmonella* infection has an incubation period of 12–72 hours, and illness duration is typically 4–7 days. Acute uncomplicated gastroenteritis is typical; however, serious illness occurs. Occasionally, *Salmonella* invades normally sterile sites (eg, blood, cerebrospinal fluid, bone) [18]. Young children aged <5 years, immunocompromised persons, and seniors are at highest risk for serious illness. Fecal excretion of *Salmonella* usually persists for days or weeks after illness has resolved. Antibiotic treatment does not reduce symptom duration, can prolong shedding, and is usually not indicated unless an extraintestinal infection occurs [19].

Human salmonellosis is a reportable condition in the United States. Human isolates are identified through PulseNet, the national molecular subtyping network for foodborne disease surveillance [20]. Molecular subtyping techniques, which can link geographically dispersed cases in outbreaks to a common source, are valuable tools in epidemiologic investigations [21].

Public and animal health officials have investigated numerous outbreaks of human *Salmonella* infections

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linked to contact with live poultry in recent years, in both household and public settings [2, 3, 5, 7, 8, 11–14, 17, 22–27]. Despite awareness of the risk of salmonellosis from handling raw poultry, people are generally not aware that *Salmonella* can also spread between live poultry and humans (Centers for Disease Control and Prevention, unpublished data). Furthermore, backyard flock ownership, including by people inexperienced in animal husbandry, continues to increase in the United States and has likely contributed to the apparent increase in live poultry-associated salmonellosis.

RECENT OUTBREAKS OF LIVE POULTRY-ASSOCIATED *SALMONELLA* INFECTIONS

Poultry can be a reservoir of *Salmonella*, yet birds usually appear healthy despite shedding *Salmonella* serotypes that lead to human illness; additionally, shedding can be intermittent [10, 14, 16]. The risk of human salmonellosis after contact with live chicks and ducklings has been well documented through numerous large outbreaks [2, 3, 5, 7, 8, 11–14, 17, 22–26]. From 1996 to 2012, 45 outbreaks (range, 0–8 outbreaks per year) of human *Salmonella* infections linked to live poultry have been documented, resulting in >1581 illnesses, 221 hospitalizations, and 5 deaths (Figure 1). Because only a portion of *Salmonella* infections are diagnosed and reported, many more infections likely occurred in association with these outbreaks [1]. The median size of these outbreaks was 24 illnesses (range, 12–195 illnesses per outbreak). Multiple *Salmonella* serotypes were identified, and specific outbreak strains were

repeatedly linked to individual mail-order hatcheries over multiple years [2, 5, 13, 14, 22–24, 27, 28]. Case patients in 8 outbreaks in 2012 had a median time of 17 days (range, 3–106 days) between obtaining poultry and illness onset, suggesting that environmental contamination may play a role in transmission of *Salmonella* from live poultry to people and that birds may shed *Salmonella* for long periods.

Historically, these outbreaks involved young children, occurred in the spring months around Easter, and were associated with birds obtained as pets [3, 5, 11–13, 16]. Baby poultry were dyed bright colors, making them more attractive to young children; this practice has been largely discontinued domestically, but continues internationally. At present, public health officials see outbreaks linked with poultry in backyard flocks (Figure 2) year-round with peaks in the spring; these illnesses occur in adult caretakers of flocks and children. The first multistate outbreak where the backyard flock trend was recognized occurred in 2007 [14]. The popularity of backyard flocks has increased tremendously since this time. Live poultry are starting to arise in urban areas where they were once rare [29]. A survey in 4 cities found that 1% of households owned chickens, and 4% planned to become first-time chicken owners within 5 years; the majority of respondents had owned chickens for <5 years [29].

Human behaviors can increase individuals' risk of *Salmonella* infection. Baby poultry need to be kept in warm conditions and are mistakenly brought inside homes; also, cleaning equipment (eg, feed/water dishes) in the kitchen leads to opportunities for cross-contamination. Many case patients reported kissing or snuggling with poultry, thus increasing their risk of infection.

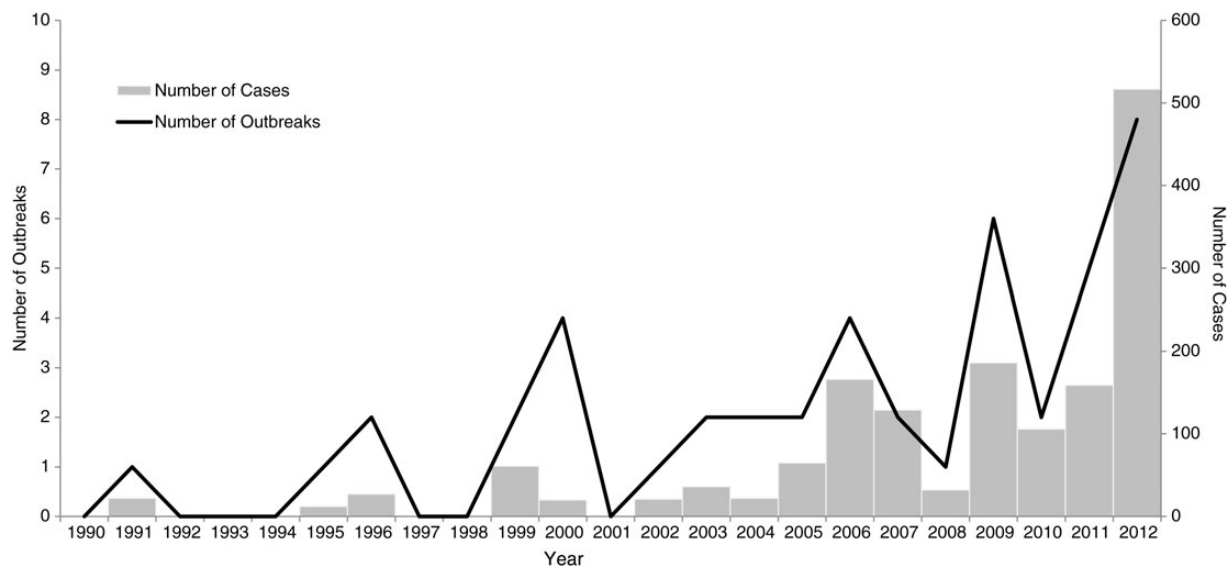


Figure 1. Number of outbreaks of human *Salmonella* infections linked to live poultry and number of outbreak-associated cases, United States, 1990–2012.

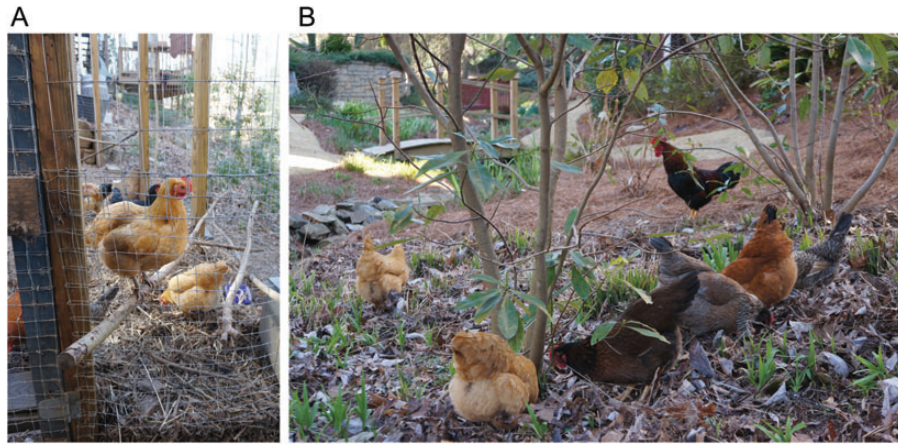


Figure 2. Typical backyard flock; chickens are shown in coop (A) and free-range (B) in backyard. Photo reprinted with permission from Rebecca Myers, Centers for Disease Control and Prevention, March 2013.

Additionally, most patients are not aware that healthy poultry can carry zoonotic diseases. Poultry are sometimes kept in day-care centers or other facilities that house individuals at higher risk for serious illness with *Salmonella* [7, 13].

In 1999, an outbreak of *Salmonella enterica* serovar Infantis infections was linked to contact with live poultry from hatchery A [26]. Subsequent public health interventions reduced, but did not eliminate, transmission of salmonellosis from this hatchery. Additional cases with the outbreak strain were identified in spring 2000, and the state imposed a quarantine of the hatchery for depopulation, cleaning, and disinfection. Depopulation of birds helped eliminate the outbreak strain of *Salmonella* Infantis; however, in 2001 an outbreak of *Salmonella* I 4,5,12:i- infections was linked to hatchery A. Depopulation of poultry at this hatchery did not prevent another outbreak from occurring.

Success stories have been documented about how mail-order hatchery interventions can help reduce the number of human *Salmonella* infections linked to live poultry contact [5]. For example, between 2005 and 2011, 316 case patients with *Salmonella enterica* serovar Montevideo strain A were reported (range, 12–84 illnesses per year). These illnesses primarily involved young children (median age, 4 years) and began in the spring. Infections with strain A were repeatedly traced to hatchery B; strain A was found in the hatchery environment multiple times. Starting in 2007, this hatchery began working with a poultry consultant who specialized in *Salmonella* control and implemented interventions to reduce *Salmonella* transmission in their flocks, including enhanced sanitation, better biosecurity measures, regular environmental *Salmonella* testing, and use of an autogenous vaccine specific to strain A and other *Salmonella* strains found in the hatchery's environment. Cases declined after interventions began, and only 1 human illness with strain A was reported by early 2012 [5]. Therefore, implementing and

maintaining interventions addressing sanitation and *Salmonella* control at the mail-order hatchery level have successfully prevented additional outbreaks. A working group of poultry experts should be formed to develop Best Management Practices to provide basic guidance for mail-order hatcheries to target variables involved with *Salmonella* transmission in the hatchery and in their breeding flocks.

Additionally, hatchery C has been a recurring source of poultry associated with annual outbreaks during 2009–2012, but with different *Salmonella* serotypes [7, 22, 27, 28, 30]. This is most likely because hatchery C has multiple source flocks for both eggs and breeder birds. Hatchery C also trans-shipped day-old hatchlings through its hatchery; this is a high-risk practice that can introduce *Salmonella* from outside sources into the hatchery. Hatchery C was linked to the largest documented *Salmonella* outbreak linked to live poultry contact as of 2012 (195 illnesses, 36 hospitalizations, and 2 deaths) [28].

Some features from outbreak investigations linked to live poultry contact include indirect contact from infected food handlers or contamination in food preparation areas. These include an unlicensed caterer that recently purchased chicks and caused a foodborne outbreak at several catered events with the same *Salmonella* strain linked to the mail-order hatchery where the chicks originated [8]. Another example of an outbreak being caused by indirect contact with live poultry is a foodborne outbreak originating from infected delicatessen workers who had contact with chickens from a mail-order hatchery associated with the same outbreak strain [17]. Both of these outbreaks were caused by *Salmonella* Montevideo, strain B, and were ultimately linked to hatchery D despite being transmitted through the foodborne route.

Outbreaks and illnesses have occurred in facilities that house individuals at highest risk for severe salmonellosis, including

day-care centers and nursing homes [13, 25]. In 2009, an outbreak of *Salmonella enterica* serovar Johannesburg infections was traced back to a flock at a day-care facility; birds originated from hatchery C, and the outbreak strain was found in chicken and turkey droppings at the day-care center [7]. In a 2012 outbreak of *Salmonella* involving multiple serotypes, 2 deaths were reported. One death was in a nursing home resident who contacted chicks sourced from hatchery C; chicks were taken into the nursing home as a way to improve morale. Other noteworthy case patients in past live poultry-associated outbreaks include feed store employees [7] and 1 sick postal worker who only handled chicks while delivering them in the mail.

THE MAIL-ORDER HATCHERY INDUSTRY IN THE UNITED STATES

Approximately 20 mail-order hatcheries provide the majority of live poultry sold to the public in the United States—an estimated 50 million live poultry are sold annually, generating \$50–\$70 million in sales [5]. These 20 core hatcheries that produce hatchlings may supply birds to many other “hatcheries” that are resellers but do not actually hatch poultry. Hatchlings are distributed nationally to agricultural feed stores and other retail outlets or directly to homes, and are typically purchased for <\$5.00.

Previously, the sale of live poultry to agricultural feed stores or directly to consumers via mail order has been largely seasonal, with a peak occurring during the Easter holiday. In the past few years, purchases of live poultry for backyard flocks raised for eggs or meat have resulted in increased adult cases and a lessened seasonal sales trend, and have contributed to record sales by mail-order hatcheries. Within 24 hours after hatching, baby poultry are shipped across the country in cardboard boxes containing up to 100 birds through the US Postal Service, which ships day-old poultry if it can be delivered to the addressee within 72 hours of hatching [31]. National distribution of birds through the mail-order system is possible, offering potential for widespread dispersal of *Salmonella* contamination from a single hatchery to travel across state boundaries, to be distributed through other mail-order hatcheries, or to be spread through poultry sold in feed stores.

AGRICULTURAL FEED STORES

In recent outbreaks, birds are often purchased from agricultural feed stores, also known as farm stores; thus, it is critical for these venues to play a key role in prevention and control of salmonellosis. Many mail-order hatcheries have requirements to order a minimum number of hatchlings, often 25–35 birds per shipment. This makes it harder for customers to purchase birds directly from these hatcheries, as backyard flocks typically have

Table 1. Summary of 2 Surveys of Agricultural Feed Store Staff on Knowledge of Zoonotic Salmonellosis Transmitted by Live Poultry

Knowledge Assessed	New Mexico (2006) ^a	Pennsylvania (2009) ^b
Awareness that poultry can cause <i>Salmonella</i> infection in people	85% (46/54)	76% (38/50)
Warn customers that poultry can cause <i>Salmonella</i> in people	56% (26/54)	28% (14/50)

^a From Gaffga et al [5].

^b From Loharikar et al [8].

fewer birds. Some feed stores offer “chick days” and sell chicks, ducklings, and other baby poultry to customers at select times (eg, spring, fall) based on their geographic location.

Feed store surveys were conducted in New Mexico and Pennsylvania to determine whether staff were aware that contact with poultry can cause human *Salmonella* infections and whether these stores provided information to customers about *Salmonella* prevention when selling poultry [5, 8]. Surprisingly, although a relatively high percentage of staff reported knowledge of risks, few provided customer education (Table 1).

Additionally, the feed store environment may lead to *Salmonella* propagation. If infected birds are displayed in the feed store and displays are not properly cleaned and disinfected between adding new birds, infection can spread. Mixing birds from different source hatcheries may also increase the risk of *Salmonella* transmission. Public and animal health officials should distribute notifications to feed stores annually about the safe display of poultry and distribution of educational materials.

US DEPARTMENT OF AGRICULTURE NATIONAL POULTRY IMPROVEMENT PLAN

Although the mail-order hatchery industry is much smaller than the commercial poultry and egg industry, both are encouraged to maintain the same standards of environmental hygiene based on guidance provided through the US Department of Agriculture–National Poultry Improvement Plan (USDA-NPIP). The USDA-NPIP is a voluntary partnership between industry and state and federal government with the goal of eliminating poultry diseases from breeder flocks to prevent egg-transmitted and hatchery-disseminated diseases [32]. This program currently includes testing and monitoring for *Salmonella enterica* serotypes Pullorum, Gallinarium, and Enteritidis, *Mycoplasma species gallisepticum*, *synoviae*, and *meleagridis*, and avian influenza. The USDA-NPIP currently does not certify freedom from other strains of *Salmonella* in poultry, including those that cause human illness. Additionally, when poultry

from nonparticipant hatcheries are commingled with those from participant hatcheries, NPIP certifications for the participant hatchery are lost [33].

Hatcheries may voluntarily choose to follow USDA-NPIP recommendations for achieving these standards, which include monthly environmental sampling of the hatchery, enhanced rodent control, feed decontamination, increased biosecurity, and vaccine usage. Wide variation among hatchery operations exists, making it important to customize interventions.

A new US voluntary *Salmonella* Monitoring Program for mail-order hatcheries, which proposes monthly environmental sampling of the hatchery for *Salmonella*, was ratified by NPIP in 2010 [8]. Once this NPIP classification becomes official, which likely occurs within a year, mail-order hatcheries may voluntarily choose to participate and enhance control of *Salmonella* serotypes that cause human illness. Several mail-order hatcheries are already following the proposed guidance, and some feed stores are requiring that their hatchery suppliers participate. This program will allow mail-order hatcheries to practice a defined program for *Salmonella* prevention and control, which will ultimately help reduce the number of live poultry-associated human *Salmonella* infections. It is important for hatcheries to submit *Salmonella*-positive samples for further subtyping (eg, serotyping and pulsed-field gel electrophoresis); doing so will allow them to identify recurring strains and direct control efforts before identified strains get to the point of causing an outbreak in humans. Ideally, mail-order hatcheries that receive birds from outside sources should only do so from other hatcheries that also participate in this program.

CHALLENGES OF TRACING POULTRY TO THEIR SOURCE

Traceback investigations must be conducted to determine the ultimate source of poultry linked to outbreaks of human salmonellosis in order for improvements to be made at the mail-order hatchery to prevent future outbreaks. However, investigations are complicated by common industry practices. First is dropshipping, when one hatchery is not able to fill a customer's order and a second hatchery is called upon to ship birds directly to the customer under the first hatchery's name. In these situations, the shipping label does not indicate the name of the second hatchery that actually supplied the birds. Second, multiplying occurs when a hatchery obtains eggs or birds from other hatcheries that are then incorporated into their breeding stock. Third is transshipping, when hatchlings from other hatcheries come through one hatchery, allowing for birds from multiple hatcheries to be mixed before distribution to customers. Multiplying and transshipping practices can introduce *Salmonella* from other source flocks into the hatchery. Feed stores may purchase from one source hatchery but

unknowingly receive birds from multiple mail-order hatcheries who drop-ship, trans-ship, or use multiplier birds from outside sources. Because of record live poultry sales in recent years, some hatcheries have had trouble meeting customer demands and have outsourced to other flocks ranging in size from small-scale backyard flocks to commercial hatcheries. Adequate record keeping at all points in the distribution chain is important for traceback investigations so the ultimate source of birds can be determined quickly. This includes mail-order hatcheries maintaining detailed records of egg and bird sources, and dropshipping and feed stores maintaining detailed records of bird purchases including breeds.

PREVENTION MEASURES

Although interactions with animals are beneficial, risks associated with animal contact, including live poultry or their environments, exist [25]. Outbreak investigations show that consumers are often unaware of *Salmonella* risks from exposure to live poultry and are not adequately informed about the risks at the time of purchase. Venues that sell poultry refer to them as farm animals, but flock owners often refer to them as pets. Treating poultry like a pet may inadvertently increase the risk of disease transmission. These outbreaks highlight the need to address this issue through a collaborative multilevel and multidisciplinary "One Health" approach. This approach includes developing and implementing interventions at the mail-order

Table 2. Recommendations to Prevent Transmission of *Salmonella* From Contact With Live Poultry^a

- Persons should wash hands thoroughly with soap and water immediately after touching live poultry or anything in the area where poultry live and roam. Adults should supervise hand washing for young children. If soap and water are not readily available, hand sanitizer should be used until a person is able to wash his/her hands thoroughly with soap and water.
- Children younger than 5 years of age, elderly, or immunocompromised persons should not handle or touch chicks, ducklings, or other live poultry.
- Live poultry should not be kept in the house, in bathrooms, or especially in areas where food or drink is prepared, served, or stored, such as kitchens and outdoor patios.
- Any equipment or materials associated with raising or caring for live poultry, such as cages or feed or water containers, should not be cleaned inside the house. All surfaces, including tables, sinks, floors, and rugs, that come in contact with live poultry have the potential to be contaminated with *Salmonella* and need to be properly cleaned and disinfected.
- Persons, especially young children, should not snuggle or kiss live poultry, touch their mouths, or eat or drink around live poultry.

^a Additional recommendations on reducing the risk of illness associated with live poultry are available [34, 36]. More information and consumer guidance is available on websites such as the Centers for Disease Control and Prevention's Keeping Backyard Poultry feature (<http://www.cdc.gov/Features/SalmonellaPoultry/>).

hatchery, feed store, healthcare provider, veterinarian, and backyard flock owner levels to prevent *Salmonella* transmission from poultry to humans. For example, recommendations for consumers (Table 2), feed stores, and mail-order hatcheries are available [34–36]. Because of the increasing number of households with backyard flocks, educational messaging about health risks associated with live poultry is especially important now, particularly in homes and settings with high-risk individuals and inexperienced flock owners [34, 36].

Healthcare providers should consider contact with live poultry and other animals to be a possible source of salmonellosis and should collect patient stool specimens for culture testing when appropriate. Providers, particularly pediatricians and veterinarians, can play a key role in educating patients and families about the risks of human salmonellosis from contact with live poultry. Pediatricians have a unique opportunity during well-child visits to inquire about child exposure to animals and offer parents guidance about associated risks [9, 37]. More small-animal veterinarians will see poultry from backyard flocks in their clinics, making it important for veterinarians to receive training on poultry medicine in veterinary school, including information on zoonoses. Organizations that address health issues for high-risk groups, such as the American Academy of Pediatricians and the American Veterinary Medical Association, should collaborate with public and animal health partners to distribute educational materials about zoonotic salmonellosis. Other groups with tremendous outreach potential are educational programs targeting youth (eg, parent-teacher associations and the Cooperative Extension Service, eg, 4-H).

CONCLUSIONS

Raising backyard poultry can be a rewarding experience, but zoonotic disease risks exist. Human salmonellosis from contact with live poultry is a challenging, yet largely preventable, public health problem. Prevention requires an integrated One Health approach including public and animal health officials collaborating with the mail-order hatchery industry, feed store industry, healthcare providers, veterinarians, and backyard flock owners. Outbreaks of human *Salmonella* infections linked to live poultry have been reported since the 1950s and are increasing in frequency in recent years in part due to the increasing popularity of backyard flock ownership; the continued occurrence of these preventable outbreaks highlights the need for enhanced prevention efforts to protect the public's health.

Notes

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