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Multistate outbreak of turtle-associated salmonellosis highlights ongoing challenges with the illegal sale and distribution of small turtles

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Summary

The sale and distribution of small turtles (shell length <4 inches) as pets has been banned in the United States since 1975 because of the risk of *Salmonella* transmission, especially to children. Despite this 48-year-old ban, salmonellosis outbreaks continue to be linked to contact with small turtles. During investigations of turtle-associated outbreaks, information regarding the turtle farm of origin is difficult to obtain because turtles are commonly sold by transient vendors. During 2020–2021, public health officials investigated a multistate illness outbreak caused by *Salmonella enterica* serotype Typhimurium linked to pet small turtles. Cases were defined as a laboratory-confirmed *Salmonella* Typhimurium infection highly related (within 0–6 allele differences) to the outbreak strain based on whole genome sequencing analysis by core genome multilocus sequence typing with illness onset occurring during August 27, 2020—May 14, 2021. Forty-three patients

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Ethics approval statement: This investigation was reviewed by the Centers for Disease Control and Prevention (CDC) and was conducted consistent with applicable federal law and CDC policy: 45 C.F.R. part 46, 21 C.F.R. part 56; 42 U.S.C. §241(d); 5 U.S.C. §552a; 44 U.S.C. §3501 et seq.

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were identified from 12 states; of these, 35% (15/43) were children <5 years old. Among patients with available information, 37% (14/38) were hospitalized, and one death was reported. Seventy-three percent (25/34) of patients reported turtle exposure in the week before illness onset, and 84% (16/19) specified exposure to small turtles. The outbreak strain was isolated from samples collected from a Pennsylvania patient's small turtle tank. Two patients reported purchasing their small turtles from pet stores. *Salmonella* Braenderup was isolated from samples collected from small turtles and their habitat at one of these stores; however, at that time this strain was not associated with any human illnesses. This investigation was notable because of the documented sale of small turtles from several pet stores combined with the identification of a single small turtle supplier to these pet stores. The high proportion of children involved in this outbreak highlights the continued need to educate the pet industry as well as parents and caregivers about the risk of turtle-associated salmonellosis especially in children. Understanding and addressing the persisting challenges related to the illegal sale and distribution of small turtles could reduce the burden of turtle-associated salmonellosis.

Keywords

outbreak; public health; *Salmonella* ; turtles; zoonotic disease

Introduction:

Non-typhoidal *Salmonella* is one of the most common enteric bacteria transmitted from animals to humans in the United States; animal contact is estimated to be responsible for approximately 11% (95% uncertainty interval: 3–24%) of human non-typhoidal salmonellosis in the United States [1]. Infections typically cause self-limiting diarrhea, abdominal pain, and fever. However, severe illnesses such as bacteremia and systemic infection might necessitate hospitalization and antimicrobial therapy [2]. Certain groups of people are at higher risk of severe infection, including children <5 years of age, people >65 years of age, people with weakened immune systems, and those who are pregnant [3].

Pet turtles are a long-known source of *Salmonella* transmission to humans. Turtles are commonly colonized with *Salmonella* and shed it intermittently in their feces, which contaminates their habitat even when they appear healthy [4, 5]. Turtle-associated salmonellosis was first documented in the early 1960s [6]. By the early 1970s, contact with pet turtles resulted in approximately 280,000 human *Salmonella* infections annually in the United States, representing 14% of all salmonellosis at the time [7]. Small turtles (shell length <4 inches) present an increased risk for disease transmission because they are often purchased for children who are more likely to put the small turtles in their mouths, kiss them, or not wash their hands after handling them [4]. As such, in 1975, the sale and distribution of small turtles and turtle eggs as pets was banned through regulation administered by the United States Food and Drug Administration (FDA). This regulation was estimated to reduce the burden of turtle-associated salmonellosis in children by approximately 100,000 infections each year [8]. However, illnesses and outbreaks linked to small turtles persist, and recent data suggest that the incidence of small turtle-associated salmonellosis is increasing [4, 9–17].

Despite the federal ban and some state prohibitions, small turtles are still available to purchase as pets.[18]. The illegal sale of small turtles often occurs in settings that are difficult to trace, such as roadside merchants, flea markets, unlicensed vendor markets, and by other transient vendors, making it challenging for authorities to identify and regulate these retailers [15, 16]. Some small turtles are sold through online retailers that ship turtles nationwide[19, 20]. Some retailers require consumers to agree to terms and conditions of purchase that state the risk of *Salmonella* transmission from small turtles and the illegality of selling them as pets [4, 19]. However, it has been demonstrated that consumers who purchase products online often do not read terms of use agreements [21], which suggests this action also has limited impact on preventing illness [4].

When small turtles are identified as the source in outbreaks of salmonellosis, investigators work to locate upstream turtle suppliers to implement public health action and prevent the sale of small turtles as pets. However, prompt identification of suppliers is not always possible. Patients might be unwilling or unable to provide information to public health officials regarding their small turtle purchases [9–17, 19, 22]. Patients might receive small turtles as gifts and not know where they were purchased, or they might not remember the location or name of the store they visited. Although uncommonly, brick-and-mortar pet stores have been reported as the source of patients' small turtles in prior outbreak investigations. Collection and testing of turtle and environmental (e.g., water, habitat surfaces) samples at these locations is often recommended to further support the association between small turtles as the source of the outbreak [17]. Enforcement of the federal ban to prevent further sale has been possible in some instances when physical locations of sales have been identified during investigations [9, 19].

During 2020–2021, federal, state, and local officials investigated a multistate illness outbreak of *Salmonella enterica* serotype Typhimurium linked to pet small turtles. We describe the epidemiologic, laboratory, and traceback evidence collected that linked the illness outbreak to small turtles, some of which were purchased from retail pet stores. We discuss the limitations of regulating established pet retailers and their small turtle suppliers and the ongoing need to increase consumer awareness about the risks of salmonellosis associated with small turtles.

Methods

This investigation was reviewed by the Centers for Disease Control and Prevention (CDC) and was conducted consistent with applicable federal law and CDC policy[§].

In December 2020, PulseNet, the national molecular subtyping network for foodborne disease surveillance within the United States, detected 12 *Salmonella* Typhimurium isolates from five states that were closely related by whole genome sequencing (WGS) within 0–3 allele differences. These isolates were also related genetically (within 0–3 allele differences) to isolates from a 2019 illness outbreak of *Salmonella* Typhimurium where small turtles were confirmed as the source of human illnesses. Cases were ultimately defined as a

[§]See e.g., 45 C.F.R. part 46, 21 C.F.R. part 56; 42 U.S.C. §241(d); 5 U.S.C. §552a; 44 U.S.C. §3501 et seq.

laboratory-confirmed *Salmonella* Typhimurium infection highly related (within 0–6 allele differences) to the outbreak strain based on WGS analysis by core genome multilocus sequence typing (cgMLST) with illness onset occurring between August 27, 2020—May 14, 2021.

In the United States, *Salmonella* illnesses are reportable to public health officials [23]; once a laboratory-confirmed *Salmonella* infection is detected, state or local public health officials routinely interview patients to collect demographic and clinical information and exposure histories consisting of various food, animal, and other exposures in the week preceding illness onset. Based on the history and genetic relatedness of this *Salmonella* strain linked to a prior small turtle outbreak, CDC deployed a turtle-focused supplemental questionnaire to obtain additional details about reptile contact in the week before illness onset, including type of contact with turtles, description of the turtles (e.g., shell length, breed), locations of turtle contact or purchase, and at-home husbandry practices. Data obtained from questionnaires were analyzed using SAS 9.4 (SAS Institute Inc., Cary, NC, USA). Descriptive analyses were performed for all questions, with frequencies reported based on the total number of responses for each question. Using a binomial probability analysis, we compared the proportion of patients reporting contact with turtles within seven days of illness onset to the proportion of healthy individuals that reported contacting turtles in the seven days before interview as part of the 2018–2019 Foodborne Diseases Active Surveillance Network (FoodNet) population survey [24].

Some patients voluntarily permitted state and local health officials in California, Pennsylvania, and Texas to sample their pet turtles and habitats. CDC, state, and local public health officials conducted traceback investigations to determine if there was a single source of turtles linked to illness. Traceback activities focused on patients who provided detailed information about their turtle purchases. Investigators contacted retailers reported by patients to obtain information on turtle suppliers and distributors. State officials in Delaware, Florida, Texas, and Washington conducted on-site investigations at retailers and a single wholesaler based on traceback findings, which included sampling and testing of turtles and habitats.

Salmonella culture of samples collected from turtles and their habitats was performed by state public health laboratories using standard techniques [25]. Human, turtle, and environmental isolates were processed using the Nextera XT library preparation kit (Illumina, San Diego, CA) followed by sequencing on the Illumina MiSeq according to PulseNet standard protocol [26]. Sequences were shared with CDC for cgMLST analysis which compared genetic relatedness across human, turtle, and environmental *Salmonella* isolates [27].

Results

Forty-three cases were reported from 12 states (Figure 1). Patients ranged in age from <1 to 59 years (median: 9 years); 35% (15/43) were children <5 years old. Overall, 44% (19/43) of patients were female. Among 38 patients with available information, 14 (37%) were hospitalized. One death was reported in a 32-year-old with *Salmonella* being a contributing factor. All human isolates were highly related within 0–6 allele differences by WGS; these

isolates were also highly related genetically (within 0–3 allele differences) to isolates from a 2019 illness outbreak linked to small turtles (Figure 2).

Among patients with information available, 74% (25/34) reported exposure to turtles in the week prior to illness onset, which was significantly higher than the 2.9% of healthy people reporting contact with turtles in the seven days prior to being surveyed in the 2018–2019 FoodNet Population Survey ($p<0.01$). Among 19 patients who specified turtle shell length, 16 (84%) reported contact with a small turtle. The deceased patient was among the patients who had contact with a small turtle. Of the 18 patients interviewed with the supplemental questionnaire, 14 (78%) reported touching or holding their turtle, 13 (72%) reported hand-feeding their turtle, nine (50%) reported touching the cage or habitat where the turtle lived or roamed, and eight (44%) reported changing turtle tank water.

Of the 13 patients with available purchase location information, two (one from Maryland and one from Texas) reported obtaining turtles from independently owned pet stores. One Washington patient reported exposure to turtle (shell length >4 inches) tank water in a pet store. Two patients that resided in the same household in California owned two small painted turtles (*Chrysemys picta*) which were suspected to have been acquired from a pet store, but the source could not be confirmed. One Nevada patient reported purchasing a small turtle from an open-air marketplace; one Illinois patient purchased three small Mississippi Map turtles (*Graptemys pseudogeographica kohnii*) from a website; and one Pennsylvania patient purchased two small red-eared slider turtles (*Trachemys scripta elegans*) from a mobile vendor selling small turtles at a gas station.

Water samples collected from the Pennsylvania patient's turtle habitat yielded the outbreak strain of *Salmonella* Typhimurium and was highly related (within 0–6 allele differences) by WGS to human isolates (Figure 2). The outbreak strain was not detected in samples collected from turtles in patients' homes in Texas and California nor from samples collected from two turtle (shell length >4 inches) tanks in the Washington pet store.

Traceback was initiated from purchase or exposure locations associated with four patients from four states (Figure 3). A common supplier (Supplier T) was identified as the source of turtles for two pet store purchase locations. State and local officials conducted on-site investigations at three small turtle purchase locations and one small turtle supplier identified by the traceback investigation. At a pet store in Delaware, investigators noted that a tank housing small red-eared slider turtles indicated that these turtles were "for scientific and educational purposes" along with the statement that "all turtles can carry *Salmonella*." A single water sample collected from this tank did not yield the outbreak strain. Following this investigation, the pet store owner voluntarily agreed to stop further sale of small turtles. Texas local health department epidemiology and environmental health staff investigated a pet store in Texas that was selling Texas-native non-game species of turtles without a non-game dealers permit. Five of the ten environmental samples obtained from two small turtle tanks yielded *Salmonella* Braenderup, a strain which was not linked to this outbreak. Following the investigation, the pet store owner applied for the Texas non-game species permit but refused to stop selling small turtles even after being informed of the federal ban.

At the time of a visit by health officials to an open-air flea market reported by a Nevada patient, no vendors were selling small turtles. However, one vendor indicated that they had sold small turtles recently and had purchased more from a supplier in Florida. State officials informed the vendor of the federal ban and requested they voluntarily discontinue small turtle sales. Officials also educated the flea market managers on the federal ban, and the managers agreed to monitor the vendor to ensure adherence.

Supplier T reported purchasing red-eared sliders directly from a licensed turtle farm in Louisiana. Documents provided by the farm indicated an agreement to supply small turtles to Supplier T for export purposes only; however, no records of international exports from Supplier T were identified in records provided to CDC by United States Fish and Wildlife Services. These findings suggest that turtles from Supplier T were not exported and might have been sold domestically. On June 17, 2021, three months after initial contact with Supplier T, public health officials in Florida collected 28 water samples from various small turtle tanks at Supplier T; *Salmonella* was not isolated from these samples.

On June 17, 2021, CDC notified Supplier T that small turtles they sold were linked to human illness in this outbreak. That same day, CDC posted an Investigation Notice to notify pet owners of the outbreak and to advise not to purchase turtles from Supplier T [28]. CDC recommendations to pet owners during this outbreak focused on ways to prevent *Salmonella* transmission from turtles and advised consumers not to purchase small turtles. Recommendations to pet stores and suppliers advised against selling small turtles as pets.

Discussion

Despite the long-standing federal ban and some state prohibitions, retailers continue to sell small turtles to the public; this report documents the continued public health issue of multistate salmonellosis outbreaks linked to pet turtles and the resulting preventable illnesses. From 2009–2018, 16 outbreaks of *Salmonella* were linked to small turtles, resulting in 914 illnesses and 200 hospitalizations [29]. To our knowledge, we describe the first reported patient death in a small turtle-associated salmonellosis outbreak in the United States since 2007 [15, 29]. It was determined that this individual's *Salmonella* infection was one contributing factor to their death. Risks for severe health outcomes that can result in hospitalization and death exemplify the need for people to demonstrate caution when handling animals known to carry *Salmonella*. Certain groups of people, such as people >65 years of age or those who are pregnant or have weakened immune systems, are at higher risk for severe outcomes from salmonellosis and should consider avoiding handling reptiles or keeping them as pets [30, 31].

Though people of all age groups were affected by this outbreak, children <5 years of age were overrepresented among outbreak patients; this is consistent with previous turtle-associated outbreaks [4, 13, 14, 16]. In comparison to other reptiles, turtles are often incorrectly perceived by the public to be safe pets for children [4], which might contribute to their sustained popularity as pets. Children infected with *Salmonella* are at increased risk of hospitalization and death [3], which demonstrates the ongoing need to educate parents or caregivers about the risks of turtle-associated salmonellosis [31]. Public health officials

should continue to collaborate with the pet industry and human and animal health agencies to ensure consistent prevention messaging is disseminated to these groups.

Identifying and preventing the sale of small turtles as pets during outbreak investigations can be difficult, particularly if patients report purchasing small turtles from roadside merchants, flea markets, or other transient vendors [15, 16]. Investigators often have more success identifying small turtle supply chains if patients report purchasing from brick-and-mortar pet stores because these locations typically keep invoices or purchase receipts [17]. Once small turtle vendors and suppliers are identified, public health, agriculture, and wildlife officials can work with these merchants to prevent further illness by providing education about existing federal and state regulations (if applicable). Several previous reports of *Salmonella* illness outbreaks linked to small turtles have highlighted the challenges associated with enforcement of the existing federal ban. Given the sustained difficulties with enforcement, many have suggested examining the effectiveness of the ban or considering alternative approaches to decrease the sales of pet small turtles to consumers [4, 16, 17, 19, 20]. In some instances—such as the Delaware pet store in this investigation—stores or suppliers might voluntarily agree to stop selling small turtles once informed of the federal ban due to an outbreak investigation. However, not all retailers voluntarily comply with the applicable regulation. In this outbreak, the Texas pet store refused to stop selling small turtles to the public, and Supplier T refused to stop supplying small turtles to domestic pet stores. The federal ban continues to be crucial in reducing the incidence of small turtle-associated salmonellosis [8, 19]. Nevertheless, this outbreak suggests that conducting outbreak investigations will remain important for identifying locations or retailers in need of education about the ban.

To prevent illnesses linked to sale of small turtles, states and localities can seek alternative prevention approaches, which might include state or local regulation. Several states have passed their own small turtle bans, some of which have more stringent restrictions than the federal ban [18]. For example, some regulations require all turtle retailers to provide education to customers about *Salmonella* risks, in addition to regulating the sale of small turtles [18]. Some jurisdictional regulations even expand restrictions to potential turtle owners by limiting childcare businesses, healthcare facilities, or food establishments from displaying turtles [18]. State and local regulatory strategies might limit or prevent sales of small turtles and thereby prevent illnesses, but further evidence is needed to determine the impact of these localized regulations on the number of turtle-associated outbreaks and illnesses.

The findings in this report are subject to limitations. First, not all patients in the outbreak could be contacted or interviewed, limiting the extent of epidemiologic information that could be gathered. Second, among patients that provided exposure information, some did not report ownership of or contact with turtles. It is not known how these individuals were exposed to the outbreak strain. Third, though sampling and testing was conducted at multiple locations selling or supplying small turtles, not all sampling efforts yielded the outbreak strain. Turtles are known to shed *Salmonella* intermittently, and it is possible that sampled turtles were not shedding at the time sampling occurred.

Small turtles will continue to be a source of human illnesses and disease outbreaks for as long as they continue to be sold as pets. As a result, small turtle-associated salmonellosis will continue to demand public health resources and represent a burden of preventable illness among healthcare systems, particularly for children. A multi-faceted approach to disease prevention is needed, and the existing federal regulation should be viewed as a last-line defense rather than the only available means of preventing small turtle-associated illness. Furthermore, public health professionals should continue to collaborate with the pet industry and human and animal health agencies using a One Health approach to disseminate prevention messaging about the risks of small turtle-associated salmonellosis [31]. Messaging to parents and caregivers should emphasize the recommendation to avoid purchasing small turtles as pets for children, and messaging to the pet industry should emphasize not selling small turtles and not marketing them as good pets for children [31].

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Data availability statement:

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Impacts

- The illegal sale and distribution of small turtles (shell length <4 inches) continues to cause significant illness, especially among children, in the United States despite a federal ban and some state prohibitions.
- Although traceback investigations are often difficult to conduct during turtle-associated salmonellosis outbreaks, this investigation identified a common supplier among two pet store locations where patients purchased small turtles.
- Evidence-based public health prevention messages are essential to reduce the risk of turtle-associated salmonellosis among pet owners and the pet industry, especially to prevent illness in children, the elderly, and people with weakened immune systems.

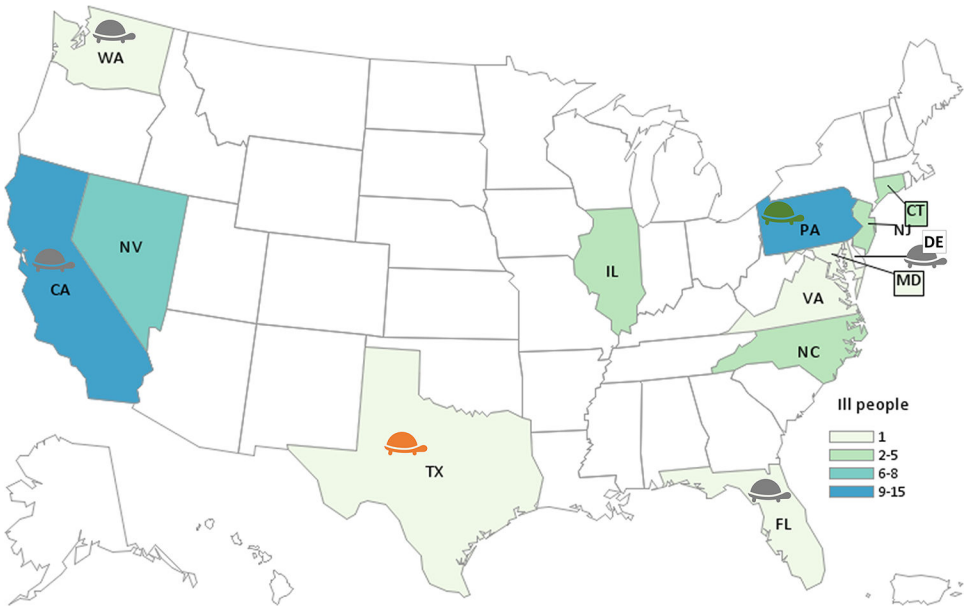

Figure 1: People infected with the outbreak strain of *Salmonella* Typhimurium, by state of residence.

Cases were identified in 12 states with the most occurring in California (28%, 12/43), Pennsylvania (23%, 10/43), and Nevada (14%, 6/43). The *Salmonella* Typhimurium outbreak strain was isolated from pet small turtles at a patient's home in Pennsylvania (green turtle icon). *Salmonella* Braenderup was isolated from sampling of small turtles that occurred at a Texas pet store (orange turtle icon); however, this strain was not genetically related to other isolates reported to the PulseNet database at the time of the investigation and was therefore not considered linked to this outbreak. States in which testing of turtles and their environments did not yield *Salmonella* are indicated by the gray turtle icon.

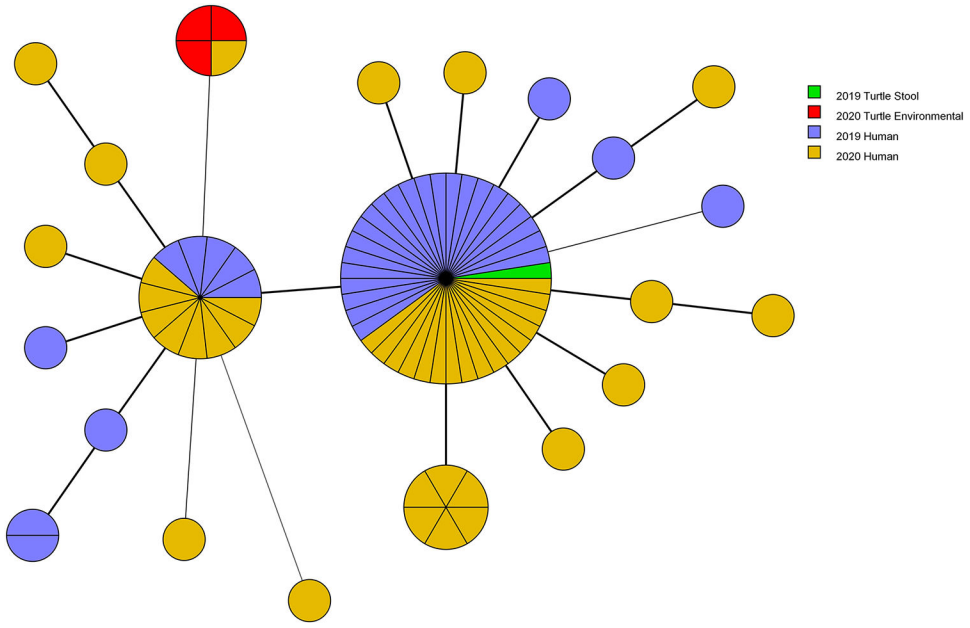

Figure 2: Genetic relatedness of human, animal, and environmental *Salmonella* Typhimurium isolates determined by analysis of whole genome sequencing data by core genome multi-locus sequence typing.

Indistinguishable isolates (0 alleles different) are demonstrated on this minimum spanning tree as slices of a single circle. Human isolates in the 2020–2021 outbreak (designated in orange) were indistinguishable from human isolates (designated in purple) and a single small turtle (shell length <4 inches, designated in green) isolate obtained from a 2019 salmonellosis illness outbreak investigation. Human isolates were genetically related to environmental isolates obtained from the habitat of two small turtles (designated in red) during the 2020–2021 outbreak.

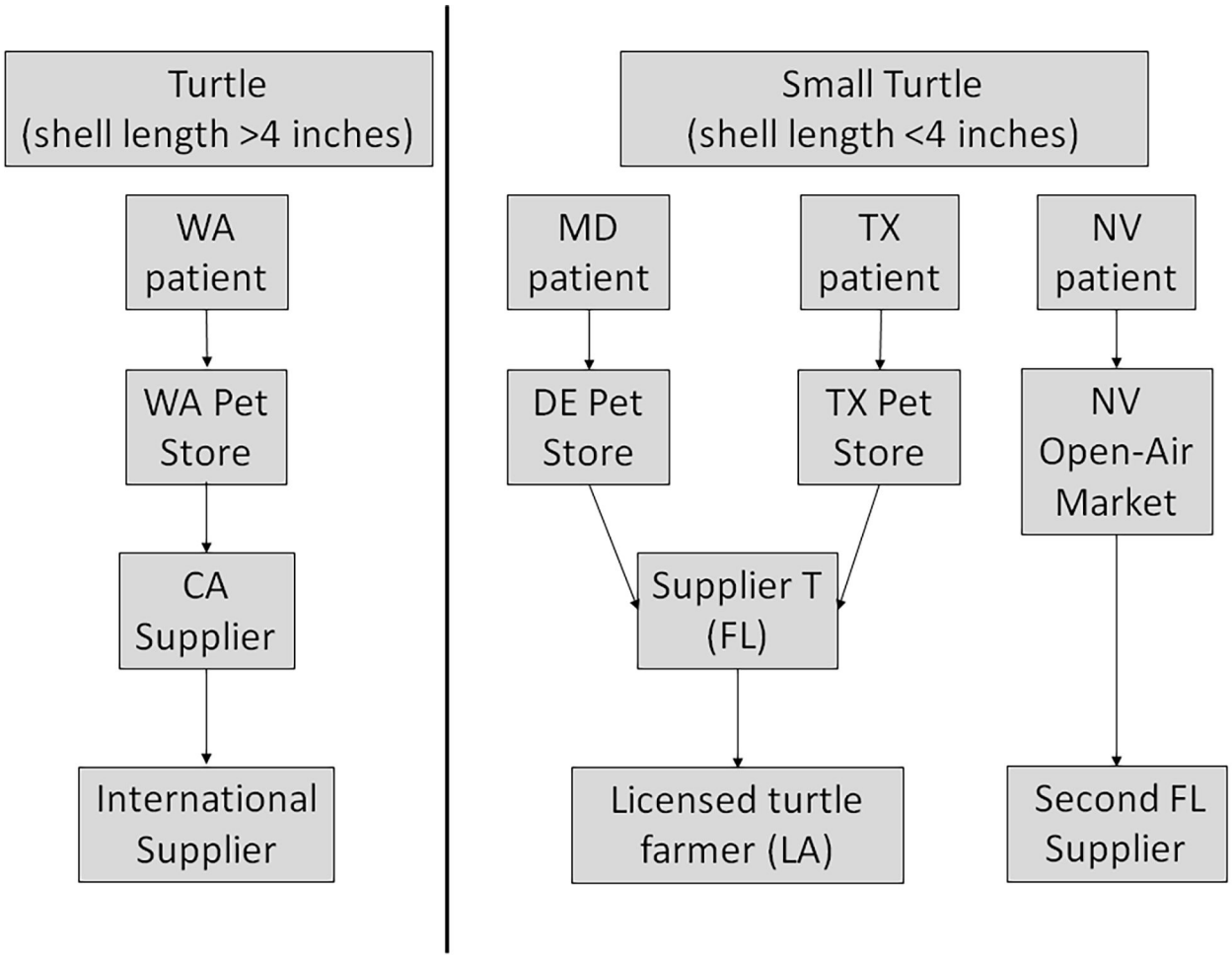

Figure 3: Traceback of turtles associated with human salmonellosis from patient to turtle source.
Traceback of turtles was conducted by state and local health departments throughout this investigation. Supplier T was identified as the sole supplier of small turtles to two pet stores.