SHORT REPORT
Geographical information software and shopper card data, aided in the discovery of a *Salmonella* Enteritidis outbreak associated with Turkish pine nuts

B. BEDARD*, B. S. KENNEDY AND A. C. WEIMER

Monroe County Department of Public Health, Rochester, New York, USA

SUMMARY

In 2011, from August to November, the Monroe County Department of Public Health (MCDPH) investigated 47 salmonellosis cases. Geographical information software (GIS) was used to map the address locations of these cases. The resulting GIS analysis and culture information indicated that there were two distinct clusters of *Salmonella* that were geographically different. Pulsed-field gel electrophoresis (PFGE) testing was run at the New York State Department of Health Wadsworth Laboratory and identified *S.* Enteritidis (23 cases) and *S.* Typhimurium (10 cases). The epidemiological investigation identified Turkish pine nuts as the link between ill *S.* Enteritidis cases. Pine nut samples sent for laboratory testing were a PFGE match to human isolates with *S.* Enteritidis. A national recall of Turkish pine nuts ensued. A multistate outbreak was identified as a result of the initial investigation of MCDPH, in which 43 people were infected with the outbreak strain from five states. GIS software and shopper card data provided important tools in the epidemiological investigation.

Key words: Geographical information systems, infectious disease epidemiology, outbreaks.

Salmonella spp. is a leading cause of foodborne illness in the USA [1]. Transmission occurs by ingesting the bacteria through contaminated food or water or ingesting faeces from an infected person or animal [2]. People infected with *Salmonella* develop a gastrointestinal illness (diarrhoea, fever, abdominal cramps) from 6 to 72 h after infection [2]. This infection can spread into septicaemia and, in rare cases, to other body sites. Becoming infected with this bacterial illness can result in hospitalization and death [1].

Although poultry and eggs are the traditional vehicles for foodborne salmonellosis, there have been contaminated products other than poultry or eggs that have caused *Salmonella* outbreaks [3–6]. *Salmonella* contamination of low-moisture food products is one example. Low-moisture food products identified in the past with *Salmonella* are nuts, seeds, cereal, peanut butter, chocolate and powdered milk [7, 8].

Nuts and seeds have been identified as sources of *Salmonella* outbreaks. Examples of contaminated nuts and seeds are hazelnuts, peanuts, pistachios, pecans, sunflower and sesame seeds [8]. These foods may be contaminated with *Salmonella* due to the process of harvesting, mechanical processing, cross-contamination and storage [8, 9]. These products may pose an increased risk to consumers because they are often consumed raw. *Salmonella* is a reportable disease that all local health departments in New York State (NYS) are mandated to investigate under the NYS sanitary code. All suspected cases are contacted and interviewed with a standard

* Author for correspondence: B. Bedard, MPH, Monroe County Department of Public Health, Room 864, 111 Westfall Road, Rochester, NY 14692, USA.
(Email: bbedard@monroecounty.gov)

questionnaire that identifies symptom history, food and water sources of exposure, travel history, grocery store purchases, food eaten outside the home, occupation and living environment. The case interview is then entered into an electronic medical record that is submitted to the New York State Department of Health (NYSDOH).

In September 2011, an increase in salmonellosis cases above the Monroe County historical levels was observed. Monroe County, which has Rochester as its major city, has a population of about 745 000 and is located in western NYS with Lake Ontario along its northern border. Mapping software (ArcGIS® version 10; ESRI, USA) was used to geocode home residence address data. A new layer was developed based on these geocoded points and overlaid onto a map of Monroe County. The cases were initially stratified by serogroup because the serotypes were not identified from the local laboratory. A geographical pattern began to develop among the salmonellosis cases; the serogroup B residences tended to be on the western side of the county, while the serogroup D cases were frequently located on the eastern side of the county (see Fig. 1 for the final outbreak map).

Based on the GIS map, the Monroe County Department of Public Health (MCDPH) looked for other differences in the two clusters. A grocery store chain and restaurants were identified as different variables between the two clusters. The MCDPH and NYSDOH have a good working relationship with this grocery chain. The serogroup D cases were interviewed and asked if they used a shopper card for grocery purchases. If they used the shopper card, then they were asked to give written permission for the release of their shopper card purchase records to the MCDPH. NYSDOH contacted the grocery chain, and provided written permission for the release of the shopper card records. The grocery chain sent the records to the NYSDOH in the form of a spreadsheet. Analysis of the shopper card summary count results identified three food items as common purchases among serogroup D cases. These items were tomatoes, Hass avocados and Turkish pine nuts.

A hypothesis-generating questionnaire was developed specifically to enquire about these common products among the serogroup D cases. These cases were re-interviewed to learn about consumption and to see if they had any leftover product that could be collected and sent to the NYSDOH laboratory. Three people were identified that had leftover Turkish pine nuts.

MCDPH coordinated with NYSDOH Western Region epidemiology staff to collect these products and submit for testing.

NYSDOH Wadsworth Center Laboratory confirms *Salmonella*-positive human cultures, identifies serotypes and conducts pulsed-field gel electrophoresis (PFGE) testing. Once PFGE results are identified, the pattern is uploaded to the PulseNet (the molecular subtyping network for foodborne disease surveillance) database [10]. If a pattern matches in the database, the NYSDOH notifies the local health department. Two separate serotypes and PFGE patterns were identified in the Monroe County clusters. *Salmonella* Enteritidis was identified as the serogroup D type and *Salmonella* Typhimurium was serogroup B. The leftover Turkish pine nuts cultured as *S*. Enteritidis and showed an indistinguishable PFGE pattern to the *S*. Enteritidis cases.

In the PFGE outbreak pattern of *S*. Enteritidis, a total of 23 cases matched. Illness onset dates were from 24 August to 19 November 2011 (Fig. 2). The median age of patients was 33 years (range 5–94 years); 68% of the cases were female. Twenty out of 23 people interviewed identified shopping at the same grocery store chain. Only one person was hospitalized, while two others visited the emergency department. Symptoms identified by the 23 cases included diarrhoea (100%), nausea (57%), vomiting (26%), headache (57%), fever (65%), and abdominal cramps (78%).

Once the PFGE pattern was identified, it was used to identify additional cases throughout the state and country. A total of 43 people from five states were identified with the outbreak strain of *S*. Enteritidis [11]. On 26 October 2011, the grocery chain issued a voluntary recall of Turkish pine nuts from their stores. Subsequent recalls also occurred from the distributor.

To the authors' knowledge, this is the first reported *Salmonella* outbreak associated with pine nuts in the literature. During this outbreak, the Turkish pine nuts were consumed raw or as an ingredient in prepared foods such as pesto sauce. These pine nuts were sold in bulk bins at the grocery store and were imported from Turkey. Although low-moisture food products do not have the proper sustenance to support bacterial growth, low numbers of salmonella can still cause illness. The problem with pine nuts, and nuts in general, is that they have a long shelf-life. This is depicted in the epi-curve in Figure 2. Moreover, pine nuts may be used as an ingredient in prepared foods and then frozen for consumption later, which occurred
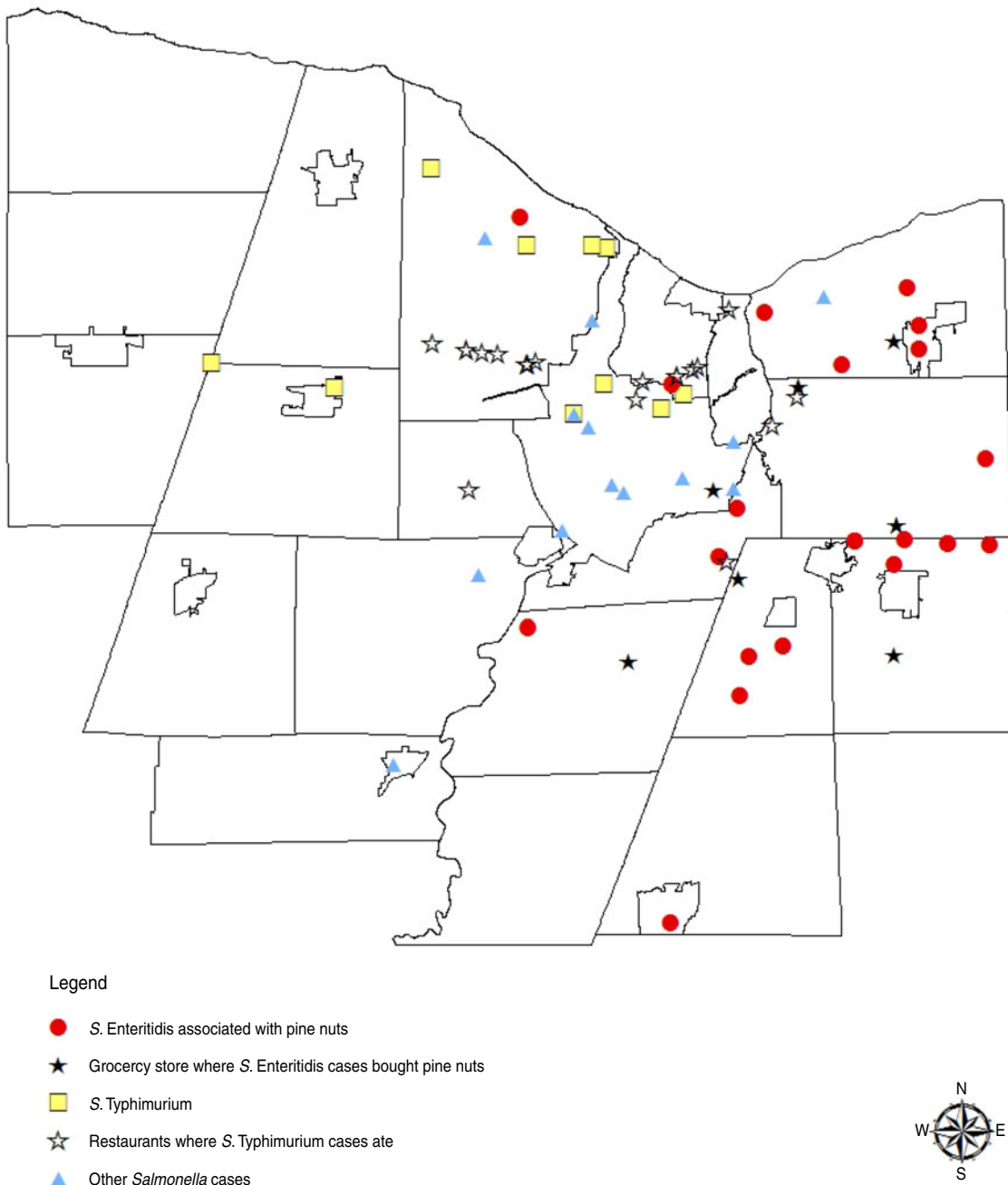
Fig. 1 [*colour online*]. Map of *Salmonella* cases based on home address in Monroe County, New York from August to November, 2011.

in some cases. The increasing number of significant *Salmonella* outbreaks associated with low-moisture foods emphasizes the need for proper environmental monitoring in processing areas and establishing procedures for controls and corrective actions [12].

For the *S.* Typhimurium cluster, which occurred during the same time-frame, a total of ten cases showed an indistinguishable PFGE pattern but did not result in a product being identified through the

epidemiological investigation. Illness onset dates were from 28 August to 1 October 2011. The median age of patients was 31 years (range of 9–60 years); 50% of the cases were male. Four people were hospitalized. The GIS map (Fig. 1) details a clustering of restaurants where cases ate during the incubation period along a major traffic route in the county. A hypothesis based on the GIS map might indicate a common ingredient that was used and distributed to these
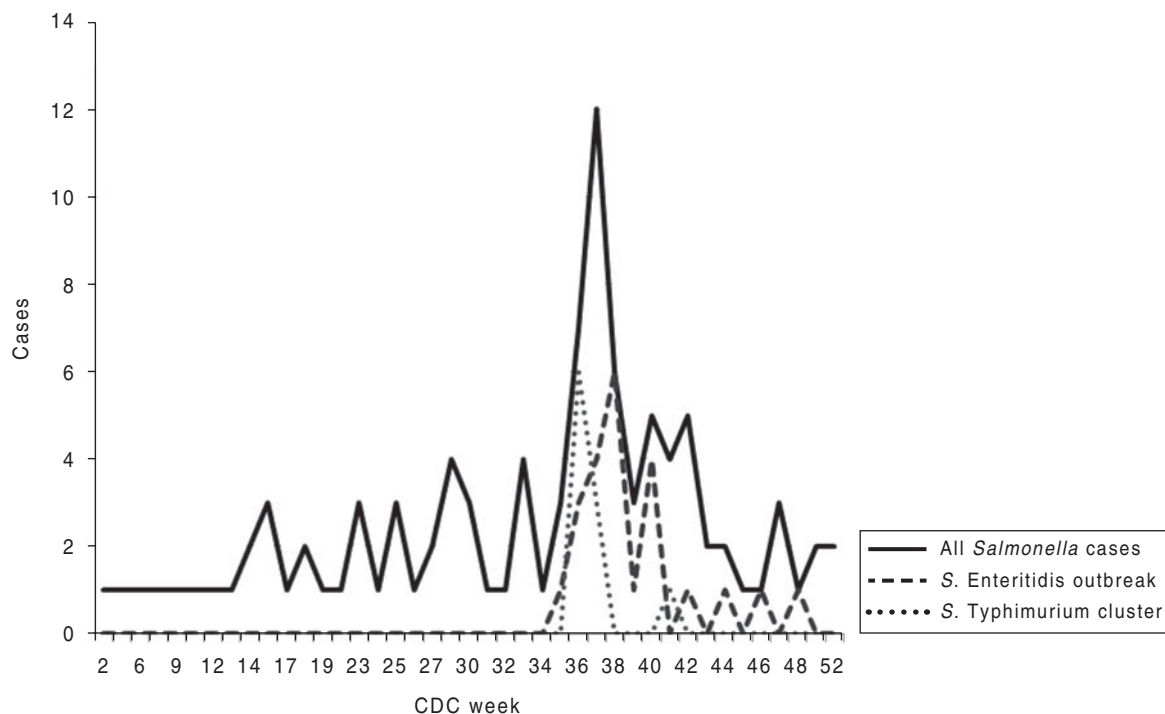
Fig. 2. Epi-curve for all *Salmonella* cases investigated in Monroe County in 2011 based on CDC reporting week.

restaurants. However, follow-up interviews with the restaurants did not identify a common distributor. A common food worker was also excluded in the investigation based on the number of restaurants identified. This cluster might have been due to a convenience food consumed by the cases at home that was not identified by case interviews. Whole genome sequencing might have been useful in determining more complete genetic polymorphisms for the cluster since the PFGE pattern identified was relatively common [13].

Field epidemiology, GIS mapping, shopper card data, PFGE confirmation and product testing identified the cause of the *S*. Enteritidis outbreak. The use of GIS mapping in a communicable disease investigation should be considered routinely as a tool for epidemiologists. The authors did not use spatial scan statistics such as SatScan software, but this could have also provided an additional quantitative approach in conducting disease surveillance for detecting clusters of illness [14]. Most cases of *Salmonella* that are investigated tend to be singly isolated and the source of infection is never confirmed. The cluster of *S*. Typhimurium that occurred during the same time-frame points to the difficult challenges for public health epidemiologists in identifying a source of exposure.

DECLARATION OF INTEREST

None.

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