

Multijurisdictional Outbreak of *Salmonella* Typhimurium Infections Linked to Raw Milk, October 2023–May 2024

October 15, 2024

SUMMARY

From October 18, 2023 through May 4, 2024, the California Department of Public Health (CDPH), in collaboration with California local health jurisdictions (LHJs), the California Department of Food and Agriculture (CDFA), and state and federal public health partners, investigated a multijurisdictional outbreak of *Salmonella* Typhimurium associated with raw (unpasteurized) milk. Overall, this investigation identified 171 outbreak-associated cases; the majority of illnesses were among children.

Epidemiologic, laboratory, and traceback investigations identified Raw Farm brand raw milk as the source of the outbreak. Swift identification of the suspected outbreak source and close collaboration between local, state, and federal health agencies resulted in an expedited focused investigation and timely product recall. Consumption of raw milk, even from a certified dairy, remains a risk factor for many enteric diseases. Public health education should continue to raise awareness of the risks of unpasteurized dairy products, especially for those at risk of severe disease from enteric pathogens, including children.

BACKGROUND

Unpasteurized (raw) milk has been linked to many foodborne outbreaks from a variety of pathogens including *Campylobacter*, *Cryptosporidium*, *E. coli*, *Listeria*, *Brucella*, and *Salmonella*. From 2009—2021, there were 143 enteric disease outbreaks reported to CDC through the National Outbreak Reporting System (NORS) that were confirmed or suspected to be associated with consumption of raw milk [CDC NORS]. Of these, 16 were salmonellosis outbreaks with a median case count of 10 (range, 2-33) [CDC NORS]. Despite these risks, retail sale of raw milk was legal in 27 states as of 2019; and states that allow such intrastate sale account for 78% of outbreaks linked to raw milk [Koski L]. In California, CDFA permits and regulates the sale of raw milk and requires warning labels on raw dairy products. Since 2012, four confirmed and three

suspect enteric disease outbreaks linked to raw milk have been reported in California; there have been no pasteurized milk outbreaks during that same time period [CDPH unpublished data].

On October 18, 2023, the County of San Diego Health and Human Services Agency (CoSD HHSA) notified the CDPH of eight salmonellosis cases in persons reporting consumption of raw milk from Raw Farm, LLC of Fresno County, California. On the same day, CDPH identified a patient with *S. Typhimurium* infection who also reported Raw Farm raw milk consumption prior to illness onset. CDPH, in collaboration with affected LHJs and CDFA initiated an investigation to confirm and mitigate the source of infections.

INVESTIGATION

Epidemiologic Investigation

Case-Finding

A confirmed outbreak case was defined as laboratory-confirmed infection of *S. Typhimurium* with allele code SALM1.0 - 6745.4.2.1x that is closely related by whole-genome sequencing (WGS) in a person with symptom onset from September 15, 2023 through May 4, 2024. A probable case was defined as laboratory-confirmed *Salmonella* infection without serotype and WGS results in a person who reported consumption of Raw Farm raw milk and symptom onset from September 15, 2023 through May 4, 2024. Cases were identified by epidemiology surveillance by local and state epidemiologists and laboratory surveillance by the CDPH Microbial Diseases Laboratory (MDL), local and state public health laboratories (PHLs), and the U.S. Centers for Disease Control and Prevention (CDC).

Hypothesis Testing

Preliminary exposure and epidemiologic data from CoSD HHSA indicated Raw Farm raw milk as a likely vehicle. To aid the investigation, the CDPH Infectious Diseases Branch (IDB) reviewed data that was collected using the CDPH, Los Angeles County, and CoSD HHSA standardized salmonellosis case report forms to identify raw dairy

exposures and shared patient characteristics. The standardized salmonellosis case report forms include questions on a variety of food and animal exposures, including questions on exposures to raw milk and raw cheese. An IDB supplemental questionnaire was created to collect additional raw dairy product information, including lot numbers, purchase date, and other product information including brand, flavor, and size. The IDB supplemental questionnaire was finalized on October 19, 2023 and distributed to affected California LHJs and four other states with outbreak-associated cases. Patients who met the confirmed or probable case definition were contacted for an interview with the supplemental questionnaire, regardless of previously reported raw milk exposure. The questionnaire included questions on raw milk and raw dairy exposures including the brand, purchase location, purchase dates, receipts, credit/debit card statements, whether the patient had any leftover product, and other details of raw dairy exposures prior to illness onset.

Risk factors for illness and frequencies of exposure to raw dairy items were evaluated using the binomial probability model and compared to background frequencies in the general population of the catchment area in California included in the 2018–2019 Foodborne Disease Active Surveillance Network (FoodNet) Population Survey Atlas of Exposures [CDC FoodNet].

Environmental Investigation

On October 18, 2023, IDB notified the CDPH Food and Drug Branch (FDB) that preliminary epidemiologic data from CoSD HHSA identified Raw Farm brand raw milk as a likely source of *Salmonella* illnesses. During October 2023, FDB, CDFA, and LHJs collected Raw Farm product samples (raw milk, cream, kefir and cheese) from the Raw Farm dairy, retail stores, and patients' homes. Samples were tested for *Salmonella* and underwent WGS if positive.

Laboratory Investigation

The CDPH MDL and local PulseNet PHLs (in Los Angeles, Santa Clara, and Orange Counties) performed WGS on clinical *Salmonella* isolates and uploaded results to the national PulseNet network. WGS results for the isolates were compared with results from human and dairy product isolates from other state and local PulseNet laboratories and CDFA. Data was also uploaded to the National Center for Biotechnology Information (NCBI) Pathogen Detection system to identify related pathogen genome sequences using single nucleotide polymorphism (SNP) trees.

RESULTS

Epidemiologic Investigation

Case-Finding

As of May 4, 2024, 171 cases (159 confirmed and 12 probable) were identified from five states: CA (167), NM (1), PA (1), TX (1), and WA (1). The California cases were from 35 LHJs throughout California: Los Angeles (27), San Diego (25), Orange (19), Placer (7), Riverside (7), Sacramento (7), Alameda (6), Ventura (6), Contra Costa (5), Kern (5), San Bernardino (5), Santa Clara (5), Solano (5), Santa Barbara (4), Stanislaus (4), Long Beach (4), Fresno (3), Kings (2), Madera (2), Nevada (2), San Joaquin (2), Yolo (2), Butte, El Dorado, Mariposa, Mendocino, Merced, Mono, Pasadena, San Francisco, San Luis Obispo, Shasta, Sonoma, Tehama, and Tuolumne. Illness onset dates ranged from September 21, 2023 through March 11, 2024 (Figure 1). The majority (65%) of cases occurred in October. Specimen collection dates ranged from September 23, 2023 through March 12, 2024. The median age of patients was seven years (range, <1 - 87 years) and nearly 40% of the patients were under five years old. Sixty-four percent were male. Twenty-two (14%) of 162 patients with available information required hospitalization; no deaths were reported.

Hypothesis Generation and Testing

Of the 159 confirmed cases, 79 (50%) were interviewed with the supplemental questionnaire or had available information regarding exposure to raw dairy products. The remaining 80 patients could not recall exposure history or were lost to follow-up. Seventy-seven percent (61/79) of patients interviewed with the supplemental

questionnaire reported consuming raw milk. Of those, 93% (57/61) consumed Raw Farm brand raw milk. Overall, 72% (57/79) of patients with available information reported consuming Raw Farm brand raw milk during the 7 days prior to illness onset.

The proportion of patients reporting exposure to Raw Farm brand raw milk was significantly higher than the expected background rate of raw milk consumption in the general California population (1.9%, $p < 0.000001$), based on the 2018-2019 FoodNet Population Survey. Five patients who reported consuming or likely consumed other types of Raw Farm raw dairy products (including various cheeses, cream and butter) also confirmed drinking Raw Farm raw milk. Of the four non-California residents, only the Washington patient was lost to follow up. The New Mexico patient reported purchasing Raw Farm raw milk and cheese in Bosque Farms, New Mexico, but declined to provide further details; the Pennsylvania patient did not recall consuming raw milk; and the Texas patient consumed Raw Farm raw cheese only.

Environmental Investigation

FDB initiated traceback of raw milk purchased by four patients in different counties to help identify product lot numbers. Approximately 40 samples were collected at the Raw Farm dairy, retail stores, and patients' homes. Four were found to be positive for *S. Typhimurium* matching the outbreak strain; this included two raw milk samples collected by CDFA at the Raw Farm dairy bulk tank on October 19 and 25, 2023, and one retail sample of raw milk in a 64 oz. container with a best by date of 10/27/2023. Additionally, one raw cheese sample made from the contaminated milk (not for retail) collected in January 2024 tested positive for the outbreak strain of *S. Typhimurium*. The remaining samples from retail stores and patients' homes were negative for *Salmonella*. In response to the epidemiologic evidence and a milk sample from the dairy farm testing positive for *Salmonella*, a voluntary recall of all Raw Farm raw milk and cream was issued on October 24, 2023. Fluid milk and heavy cream with best by dates 10/11/23-11/6/23 were recalled, the contaminated lots were destroyed, and production was

halted. Mitigation efforts carried out by the producer met requirements to restart production on 10/31/2023.

Laboratory Investigation

State and local PHLs identified 159 isolates of *S. Typhimurium* with allele code SALM1.0 - 6745.4.2.1x that were highly related by WGS, from patients with illness onset or specimen collection dates from September 2023 through March 2024. The four positive samples collected by CDFA and CDPH in October 2023 and January 2024 from the dairy farm and retail were found to be *S. Typhimurium* with allele code SALM1.0 - 6745.4.2.1x and were indistinguishable by single nucleotide polymorphism (SNP) analysis to the clinical isolates collected from patients in the outbreak.

Communications

Public messaging regarding this outbreak investigation was issued by LHJs as well as CDPH. This included:

- Two press releases from CoSD HHSA on [October 20](#), 2023 and [October 25](#), 2023
- One press from Orange County Health Care Agency on [October 25](#), 2023
- FDB recall list posting (web link no longer available)
- CDPH social media posts including on X and twitter:
 - <https://x.com/CAPublicHealth/status/1717631849558913229>;
 - <https://twitter.com/CAPublicHealth/status/1732807204430921907>;
 - <https://twitter.com/CAPublicHealth/status/1730300684849795213>

DISCUSSION

From October 2023 through May 2024, a multijurisdictional outbreak of 171 cases of *S. Typhimurium* occurred, primarily impacting residents in southern California. Children were disproportionately affected.

Epidemiologic, environmental, and laboratory evidence identified Raw Farm brand raw milk as the source of the outbreak. The time from initiation of CDPH investigation to

recall was less than one week. Swift identification of a foodborne outbreak source and rapid reporting to the state by investigators at a LHJ resulted in focused investigation and expedited targeted interventions, including product recall, which mitigated ongoing cases. Enhanced CFDA/FDB surveillance sampling and WGS of milk and clinical isolates were critical for confirming the source of the outbreak and facilitating the recall.

This investigation was subject to some limitations.

First, not all 171 patients who were counted as part of the outbreak, notably those with who were linked by laboratory data, were reached for interview. Due to the number of cases lost to follow up, the results may not be representative of all outbreak cases. In addition, some of those interviewed denied raw milk exposure. Further, cases continued to occur well after the product was recalled on October 24. Potential explanations for this include:

- It is not uncommon for some cases linked to an outbreak by laboratory data to have uncertain exposure routes. *Salmonella* infection can be indirect, including secondary infections where person-to-person transmission occurs.
- There is also the possibility of another unidentified source causing illness or a secondary product from the raw milk (e.g. raw milk cheese).
- The lag between a patient's illness onset and reinterview with the supplemental questionnaire may have resulted in poor recall for some patients, introducing possible recall bias in exposure history.
- Some patients may have opted not to disclose raw milk consumption history.

There were also limitations on laboratory capacity:

- Sequencing can only be performed on cultures and not on samples positive by culture-independent diagnostic tests, limiting the ability to confirm cases without samples available for culturing.
- Delays in case finding could arise from considerable lag time between specimen collection and WGS results.

However, this large outbreak reinforces the potential hazards of consuming raw milk, especially for those at higher risk for severe illnesses due to enteric pathogens including salmonellosis. This is true even when the milk is from a licensed producer that regularly undergoes product testing:

- The contamination of milk may be sporadic and bacterial loads can vary daily which could result in a failure to detect the pathogen.
- The presence of the pathogen may be too low in product samples to be detected by the test method but the numbers may be sufficient to cause illness.
- The presence of the pathogen may be too low to be detected at the time of the the initial test but grow because the raw milk was stored improperly during the time from production to the retail sale [Boor, Lucey].

RECOMMENDATIONS

- Continue to remind the public that consumption of raw milk, even from a licensed producer, remains a risk factor for enteric diseases. Diverting contaminated milk to raw cheese production is not necessarily safe.
 - Focus education on high risk populations including children, pregnant women, and immunocompromised persons.
- Encourage stool testing and culture for those consuming raw milk products who develop gastrointestinal symptoms in order to identify potential outbreaks as early as possible.
- Continue to support systems for collaboration between local, state and federal public health and regulatory partners in order to act rapidly on epidemiologic evidence in future food source outbreaks.

REFERENCES

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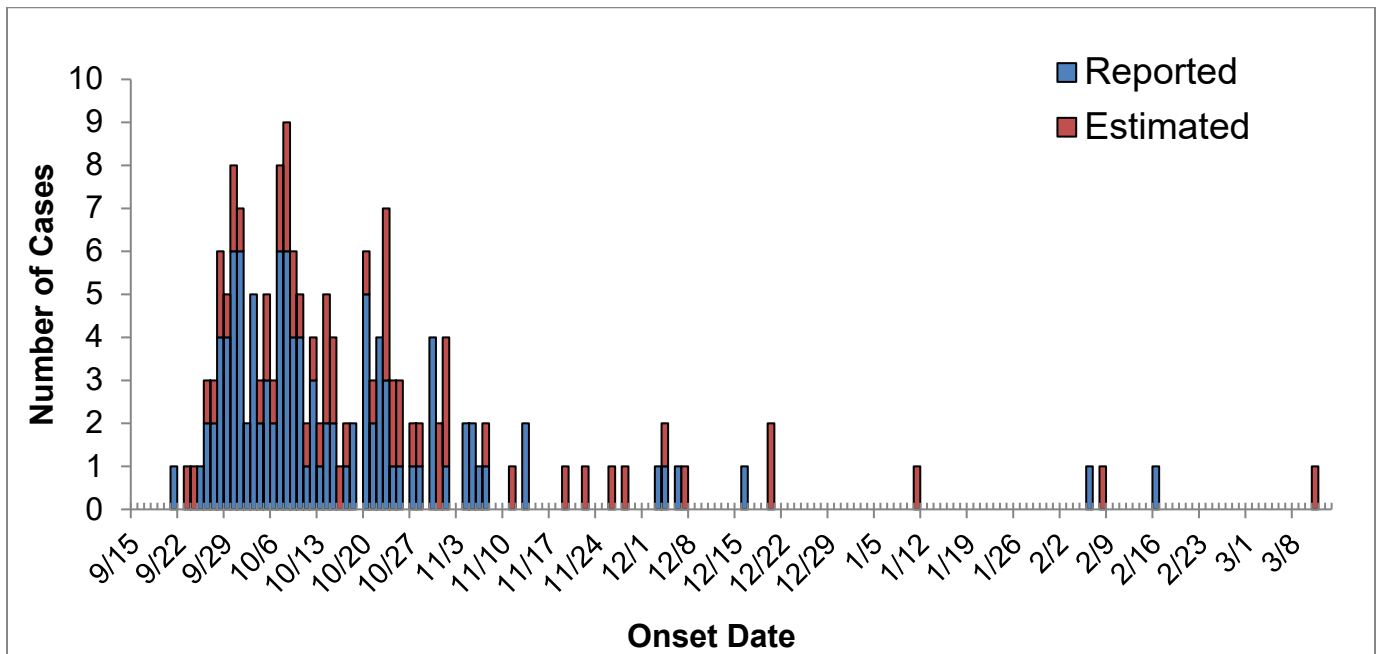
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Figure. S. Typhimurium cases associated with multijurisdictional outbreak linked to Raw Farm raw milk, by date of illness onset, California, September 2023-May 2024 (N=171)



Reported: Onset date of diarrhea symptoms.

Estimated: If diarrhea onset date is unavailable, symptom onset date is used, for cases missing onset date specimen collection date minus 3 days was used.