

Outbreak of *E. coli* O157 Associated with Raw Milk Consumption - Connecticut, 2008

On July 16, 2008, through routine interviews of reported cases of hemolytic uremic syndrome (HUS), the Connecticut Department of Public Health (DPH) identified 2 children who reported drinking raw milk in the week before their illness. One of these children had culture-confirmed *Escherichia coli* O157 infection. One child had consumed raw milk purchased from a retail market, and the other had consumed raw milk purchased directly from Farm X where the raw milk was produced. The Connecticut Department of Agriculture (DOAg) was notified. In the following 2 weeks, 5 additional confirmed and 7 probable cases of *E. coli* O157 infection associated with consumption of raw milk produced at Farm X were identified. This report summarizes findings from the multiagency investigation.

Epidemiologic Investigation

The epidemiologic investigation conducted by the DPH included 1) active case finding by contacting all clinical laboratories throughout the state; 2) case finding through statewide notification of infectious disease physicians, emergency departments, and local health directors; 3) a community case-control study to determine the likelihood of raw milk as the source of infection; and 4) a household survey and case-control study among regular customers of Farm X to identify additional illnesses and assess risk factors for illness.

A confirmed case was defined as either a culture-confirmed *E. coli* O157 infection with the outbreak strains, or HUS in a Connecticut resident during June-July 2008. A probable case was defined as diarrhea for at least 2 days duration in a person on the Farm X customer list during June – July 2008. Diarrhea was defined as two or more loose stools in a 24-hour period.

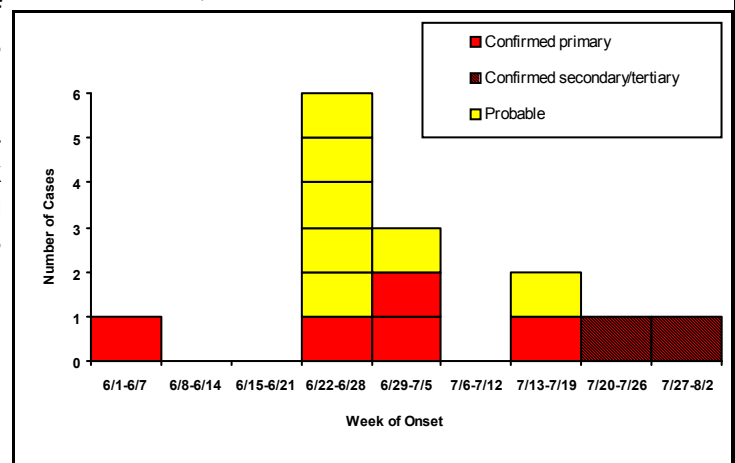
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A total of 14 cases (7 confirmed, 7 probable) were identified. Of the 7 confirmed cases, 5 were primary infections and involved raw milk consumption. A secondary infection occurred in a 12 month-old sibling of a person with a primary infection. A tertiary infection occurred in a 2 year-old child who had frequent close contact with the child with a secondary infection. The children with secondary and tertiary infections did not consume raw milk.

All persons ranged in age from 1 to 81 years; most were children (median 5 years); 8 (57%) were female. Cases involved residents of Harford (9), Litchfield (4), and Middlesex (1) counties. Five (36%) persons were hospitalized, 4 of whom were children ≤ 10 years of age; median length of stay was 16 days (range 1 - 33). Four (29%) persons were diagnosed with HUS or thrombotic thrombocytopenic purpura; all required either dialysis or plasmapheresis. No deaths occurred. Onsets of illness occurred between June 1 and July 28, 2008 (Figure 1).

Figure 1. Number of Confirmed and Probable Cases of *E. coli* O157 Infection by Week of Illness Onset, Connecticut, 2008



Community Case-Control Study. The study included the 5 persons with confirmed primary infections and 10 well persons (2 controls per case). Controls were matched to cases by age group (either <18 years or \geq 18 years) and by neighborhood. Interviews were done by telephone using a standardized questionnaire that included questions about exposures that are well-documented sources of *E. coli* O157 infection. The 5 ill persons were significantly more likely to have drank raw milk than the 10 well persons (OR=231.0, 95% CI 4.0-13304.1, $p<0.0001$) (Table 1). Of the 5 ill persons, 3 purchased raw milk from 2 separate retail markets (Market A and Market B), and 2 purchased raw milk directly from Farm X.

Farm X Customer Case-Control Study. A list of regular raw milk customers was provided by Farm X. Nineteen households were identified from this list. Households were interviewed by telephone and asked about purchase of raw milk and other products from Farm X, and whether anyone in the household became sick with diarrhea since June 1. Sixteen (84%) of 19 households were interviewed; 4 (25%) households reported at least 1 person with diarrhea since June 1. Of the 44 persons in these households, 7 (16%) met the probable case

definition. Households with ill persons were significantly more likely to have purchased more raw milk (\geq 16 bottles during the month of June) than households with no illness (OR=33.0, 95% CI 1.6-698.0, $p=0.0269$).

To determine dose-response effects of drinking raw milk, households with persons with probable infections were combined with households with case-patients with confirmed infections for analysis. Controls were defined as well persons within the same households. Persons were significantly more likely to develop illness as the amount of raw milk consumed increased (p -value for trend=0.0102).

Environmental Investigation

The environmental investigation conducted by the DOAg included on-site visits to Farm X to assess milking procedures, cleaning and sanitization, construction and repair of milk handling equipment, refrigeration, processing, and packaging of raw and pasteurized milk. Milk, environmental, and animal samples were also collected during these visits and tested at the DPH State Laboratory. The local health department (LHD) also conducted on-site visits to the farm. Farm workers were interviewed, and general hygienic conditions were assessed.

Table 1. Number and Percentage of Exposures to *E. coli* O157 Among Case Patients and Controls, by Food Item/Exposure, Connecticut, 2008

Exposure	Cases		Controls		OR	95% CI	p-value
	No.	(%)	No.	(%)			
Raw milk	5/5	(100)	0/10	(0)	231.0*	(4.0 - 13304.1)	<0.0001
Raw cheese	2/5	(40)	0/10	(0)	15.0*	(0.6 - 394.1)	0.0952
Ground beef	1/5	(20)	8/9	(89)	0.03	(0.01 - 0.6)	0.0230
Bagged lettuce	1/5	(20)	5/9	(56)	0.2	(0.02 - 2.6)	0.3007
Whole head lettuce	2/4	(50)	2/9	(22)	3.5	(0.3 - 43.2)	0.5301
Spinach	1/3	(33)	2/9	(22)	1.8	(0.9 - 30.8)	1.0000
Tomatoes	3/5	(60)	5/9	(56)	1.2	(0.1 - 11.1)	1.0000
Jalapenos	0/4	(0)	0/9	(0)	n/a		
Swimming	3/5	(60)	8/9	(89)	0.2	(0.01 - 2.9)	0.5055
Visit farm	2/5	(40)	0/9	(0)	13.6*	(0.5 - 358.6)	0.1099
Contact w/ farm animals	1/5	(20)	0/8	(0)	5.7*	(0.2 - 169.5)	0.3846

* Correction of 0.5 used in cells containing zero

Farm X processed and sold both raw and pasteurized milk. Approximately 800 pounds of milk were produced per day; approximately half of the milk was packaged as pasteurized, and half was retail raw milk. The farm conducted voluntary weekly analyses of raw milk, utilizing an out-of-state private laboratory. Analysis of 3 separate samples of raw milk collected during the last week of June through the second week of July had elevated levels of coliform bacteria, which could be an indicator of fecal contamination and/or a coliform type bacterial infection of the udder. *Escherichia coli* was not found in these samples. Based on these test results, the farm voluntarily stopped producing retail raw milk on July 9. During the investigation, the farm also stopped the sale pasteurized milk.

The milk production areas on the farm consisted of a stanchion barn where a herd of 28 Jersey dairy cows were milked using a vacuum pipeline system, an attached room that housed the refrigerated bulk milk storage tank, and a milk processing plant located in a separate building with an adjacent room for retail sales. Approximately 93 gallons of milk were produced per day. Twice a week, milk was pumped through a hose from the bulk tank into a portable refrigerated tank, transported approximately 150 feet to the processing plant, and then pumped from the portable tank into a holding tank. The milk was then packaged into ½ gallon re-useable glass containers using an industry standard filling and capping machine. Packaging of raw milk occurred only after processing of pasteurized milk was completed. As needed (e.g., when pre-bottled raw milk ran out), raw milk was also bottled directly from the bulk milk storage tank located in the room attached to the barn. This was done by manually filling the glass containers using a “gooseneck-shaped” stainless steel tube that could be temporarily attached to the outlet of the bulk tank. The bottle was then capped by hand.

Overall, the environmental investigation conducted by the DOAg found that milking procedures, raw milk handling, storage, processing, and disinfection were acceptable and consistent with industry practice. However, several specific practices and observations were noted to be of concern including manual bottling of raw milk directly from the bulk tank, failure to cap valves, an improper seal around the shaft of the transport tank, and a biofilm protein residue found inside the transport tank.

The LHD identified conditions that indicated poor hygienic practices: 1) the stainless steel tube used to dispense raw milk directly from the bulk tank was stored in an exposed unsanitary bucket and would need to be sanitized before use; and 2) lack of hand soap, a malfunctioning hot water knob at the hand washing sink, soiled floors, and presence of flies in the bulk milk storage tank room. Staff personnel were also uncertain about the sanitization process of the dish machine that washes and sanitizes the glass bottles that are used and re-used for both pasteurized and/or raw milk when the customer returns the bottles to Farm X. In addition, the raw milk bottles did not display the consumer advisory required by regulation; however, a consumer advisory with the language required by regulation was posted at the point of sale.

There were 11 farm workers at the time of the LHD’s investigation. All workers were interviewed regarding gastrointestinal illness and raw milk consumption. Most workers reportedly drank raw milk on a daily basis. One farm worker reported diarrhea on July 11. A stool sample collected from this worker on July 20, 2008 tested negative for *E. coli* O157.

Laboratory Investigation

The DPH State Laboratory conducted testing of human, milk, environmental, and animal specimens. Of the 7 confirmed case-patients, 6 were culture-confirmed with *E. coli* O157:NM (non-motile) at the DPH State Laboratory. All 6 isolates exhibited shiga toxin production. Five of the 6 *E. coli* O157:NM isolates yielded indistinguishable pulsed-field gel electrophoresis (PFGE) patterns (Pattern A) when restricted with XbaI and BlnI enzymes. The remaining isolate yielded patterns (Pattern B) that differed by 1 band on each enzyme. A serum sample was collected from 1 HUS case that was not culture-confirmed. The serum sample was forwarded to the Centers for Disease Control and Prevention; testing showed elevated antibody titer to *E. coli* O157.

Milk sampling included 6 pasteurized samples collected from the farm, 8 raw samples collected from the farm, 1 raw sample collected from the home of a case-patient, and 28 individual samples from each dairy cow. In addition, samples of each cow’s milk had been collected and analyzed at a veterinary diagnostic laboratory for the presence of

coliform mastitis causing bacteria; 54 of these culture plates were recovered from the veterinary diagnostic laboratory and forwarded to the DPH State Laboratory for further testing. Thirty-nine environmental samples representing milk contact surfaces, surfaces of feeding areas, drinking water tubs, mud from the pasture, and cattle milking platforms in the barn were collected and tested. Thirty-four fecal samples from all animals on the farm were collected and tested. *Escherichia coli* O157:NM with PFGE Pattern A was recovered from the feces of 1 cow. All other samples collected tested negative for *E. coli* O157.

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Editorial Note:

Raw milk and raw milk products (e.g., unpasteurized cheeses) have been implicated in transmission of foodborne diseases including brucellosis, campylobacteriosis, listeriosis, salmonellosis, and *E. coli* O157 infection. *Escherichia coli* O157 infection, which is estimated to affect 73,000 persons in the United States annually, can result in serious illness including HUS and death particularly in young children and the elderly (1). From 1998-2005, raw milk or raw milk products were implicated in 45 foodborne outbreaks nationwide, accounting for more than 1,000 cases of illness (2). Cattle are a natural reservoir for *E. coli* O157 bacteria, which are shed in cows' feces. Cow's milk intended for human consumption can become contaminated with *E. coli* O157 during milking, processing, or packaging. Pasteurization destroys pathogens and has been proven to improve the safety of milk more so than any other measures, including certification of raw milk (3).

Several findings from this investigation indicated that consumption of raw milk from Farm X was the cause of the outbreak: 1) a community case-control study implicated Farm X raw milk as the vehicle

associated with illness; 2) a case-control study of Farm X customers suggested that there were additional undiagnosed diarrheal illnesses and that households with ill members were more likely to have purchased a greater amount of Farm X raw milk; 3) the risk of illness increased with the amount of raw milk consumed; and 4) PFGE patterns from isolates of case-patients and a cow on Farm X were identical or closely related.

Although the exact mechanism by which the raw milk was contaminated with *E. coli* O157 could not be determined, several previous outbreaks have demonstrated that even raw milk collected using stringent hygienic methods cannot be considered free of pathogens (4). Using standard hygiene practices (e.g., careful hand washing, appropriate sanitization of equipment) can reduce but not eliminate the risk of milk contamination.

To reduce the risk of *E. coli* O157 and other infections, consumers should not drink raw milk or consume raw milk products. Young children and the elderly are at increased risk for severe consequences of *E. coli* O157 infection, including HUS and death, and therefore should not drink raw milk.

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