Q Fever Cluster Among Raw Milk Drinkers in Michigan, 2011

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Q fever is a zoonosis caused by Coxiella burnetii, a unique bacterium that is widespread but infrequently associated with human illness or outbreaks. We report on evidence of infection with C. burnetii in a small group of regular consumers of raw (unpasteurized) milk from the same dairy in Michigan.

Q fever is a worldwide zoonosis caused by Coxiella burnetii, an obligate intracellular bacterium. Coxiella burnetii is shed in large numbers by infected periparturient animals and can survive for long periods in the environment. In the United States, C. burnetii is enzootic among ruminants and wildlife [1]. Infected animals are often asymptomatic, although abortions occur in infected herds. A survey of unpasteurized bulk tank milk for C. burnetii DNA demonstrated that up to 90% of herds were positive in a 3-year period, suggesting that C. burnetii may be widespread in US dairy herds [2]. Surveys have found a seroprevalence of 3.1% among persons in the United States [3]. Most infections are asymptomatic (60%) or present as a nonspecific flu-like illness, which may explain the relatively few human cases reported in the United States [4, 5]. We report results of an investigation, in 2011, into a cluster of 5 individuals who consumed raw (unpasteurized) cow’s milk from the same dairy in Michigan and had serologic and/or clinical evidence of infection with C. burnetii.

MATERIALS AND METHODS

The Michigan Department of Community Health (MDCH) manages public health disease reporting electronically through the Michigan Disease Surveillance System (MDSS). Cases are primarily populated through mandatory laboratory reporting. Between 9 May 2011 and 22 August 2011, 5 individuals with serologic testing suggesting a diagnosis of acute Q fever were reported to MDSS. All 5 regularly consumed raw milk from a common dairy. Cases were in 3 different local health department jurisdictions, and the dairy was in a fourth. For this cluster, cases were defined as a person with (1) a clinically compatible illness (acute fever and pneumonia, hepatitis, or other manifestation) and (2) laboratory-supportive evidence for acute Q fever, defined as a 4-fold rise in immunofluorescence assay (IFA) phase II immunoglobulin G (IgG) titer in paired serum specimens (confirmed) or single IFA phase II IgG titer of ≥1:128 (probable), or (3) a person with laboratory-supportive evidence of infection with C. burnetii and an epidemiologic link to the implicated dairy and its milk [6]. Public health investigators conducted patient and/or provider interviews, medical record review, and assessment of risk factors for exposure to Q fever. The Michigan Department of Agriculture and Rural Development and public health officials conducted an off-site interview with the dairy owner.

RESULTS

Case 1, a 39-year-old woman, was hospitalized on 4 May 2011 with fever of 39.4°C, severe headache, neck stiffness, vomiting, photophobia, urinary retention, and left buttock pain radiating down her left lower extremity. Six weeks prior she had fevers and received a 5-day course of azithromycin for pneumonia. Since 2009, she and her family regularly consumed raw milk procured from a dairy through a cow-share arrangement. She had not been to the farm for 9 months, but her husband visited the farm monthly. Her white blood cell (WBC) count was 12 000 cells/µL. Cerebrospinal fluid (CSF) analysis showed a WBC count of 1280 cells/µL (49% lymphocytes, 39% neutrophils), glucose 48 mg/dL, and protein 175 mg/dL; opening pressure of 47 cm water; and a negative gram stain. Initial antimicrobials included vancomycin, ceftriaxone, ampicillin, and acyclovir. CSF bacterial, viral, fungal, and mycobacterial cultures; cytology; cryptococcal antigen; herpes simplex, enterovirus, and varicella-zoster polymerase chain reaction (PCR) studies; and Coccidioides and Histoplasma antibodies were negative. Serologic testing for West Nile virus, lymphocytic choriomeningitis virus, and Brucella showed negative results.
On the third hospital day, the patient became confused. Magnetic resonance imaging showed leptomeningeal enhancement of the brain, conus, and caudal nerve roots. Her Q fever phase II IgG titer was 1:256 (Table 1) and was reported to MDSS on 9 May 2011. She completely recovered except for mild vertigo after 18 days of ciprofloxacin and 21 days of doxycycline for Q fever meningoencephalitis.

Case 2, a 47-year-old woman, was reported on 24 May 2011 (Table 1). Case 3, a 43-year-old woman, was reported on 16 June 2011 (Table 1). For 2 years, family members of cases 1, 2, and 3 alternated visits to the farm to collect raw milk for the group. Case 2 complained of malaise for several months and case 3 complained of subjective fevers, myalgias, and malaise. Both sought testing for Q fever following the hospitalization of case 1.

To identify additional cases, on 16 June 2011 the MDCH notified local health departments and healthcare providers of a cluster of Q fever cases in raw milk drinkers via a health alert. The dairy owner did not permit officials to inspect the farm or collect samples for C. burnetii testing, but did submit a raw milk sample to an out-of-state laboratory. She reported to officials that the sample was positive for C. burnetii by PCR, but denied reproductive health problems within the herd. She refused to provide a list of customers to public health officials but agreed to notify her estimated 200 customers that consuming raw milk from her farm or visiting the farm placed them at risk for developing Q fever. Customers were notified through e-mail and flyers placed in the milk house. The information provided was developed by the owner, and health officials were not permitted to review the contents prior to distribution. Because there was no documentation that all dairy customers were notified, MDCH issued a notice on 23 June 2011, alerting the public about the cluster of Q fever cases among customers of a raw milk dairy in Michigan.

Case 4, the 39-year-old husband of case 1, was reported on 12 July 2011 (Table 1). He regularly consumed raw milk, and made monthly trips to the dairy. He has adult-onset Still’s disease, received infliximab infusions every 8 weeks, and only complained of fatigue beginning in May. Owing to his immunocompromised status, he received doxycycline and is being monitored for chronic Q fever. Case 5, a 41-year-old woman, was reported on 11 August 2011 (Table 1). She sought testing after she learned of the hospitalization of case 1. She had fatigue and headaches for several months and a mild respiratory illness in July. She received half a share of raw milk weekly from another cow-share member of the dairy, but had never visited the dairy.

**DISCUSSION**

The majority of acute Q fever is asymptomatic, but among symptomatic patients common manifestations include self-limited febrile illness, pneumonia, and hepatitis [4]. Diagnosis relies primarily on serologic testing and IFA is the reference technique with high specificity and sensitivity. Phase II antibodies prevail in acute disease and presence of phase I IgG titer ≥1:800 suggests chronic Q fever [4]. The index patient had meningoencephalitis, a rare manifestation of acute Q fever, and may have had Q fever pneumonia preceding her presentation [4]. Her serologic response may have been attenuated by partial treatment with azithromycin 6 weeks prior to

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**Table 1. Coxiella burnetii Serology in a Michigan Raw Milk Cluster**

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Age (Years)</th>
<th>Sex</th>
<th>Date Specimen Collected</th>
<th>Phase II Titers&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Phase I Titers&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Classification&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>39</td>
<td>F</td>
<td>5 May 2011</td>
<td>&lt;16 256</td>
<td>&lt;16 16</td>
<td>Probable</td>
<td>Milk only for past 9 months</td>
</tr>
<tr>
<td>2</td>
<td>47</td>
<td>F</td>
<td>20 May 2011</td>
<td>&lt;16 2048</td>
<td>&lt;16 256</td>
<td>Probable</td>
<td>Farm/milk</td>
</tr>
<tr>
<td>3</td>
<td>43</td>
<td>F</td>
<td>6 June 2011</td>
<td>&lt;16 512</td>
<td>&lt;16 256</td>
<td>Probable</td>
<td>Farm/milk</td>
</tr>
<tr>
<td>4</td>
<td>39</td>
<td>M</td>
<td>26 May 2011</td>
<td>16 &lt;16</td>
<td>&lt;16 &lt;16</td>
<td>Confirmed</td>
<td>Farm/milk</td>
</tr>
<tr>
<td>5</td>
<td>41</td>
<td>F</td>
<td>21 July 2011</td>
<td>256 ≥1024</td>
<td>128 256</td>
<td>Probable</td>
<td>Milk only</td>
</tr>
</tbody>
</table>

Abbreviations: IFA, immunofluorescence assay; IgG, immunoglobulin G; IgM, immunoglobulin M.

<sup>a</sup> For this cluster, cases were defined as a person with (1) a clinically compatible illness (acute fever and pneumonia, hepatitis, or other manifestation) and (2) laboratory-supportive evidence for acute Q fever, defined as a 4-fold rise in IFA phase II IgG titer serology in paired serum specimens (confirmed) or a single IFA IgG titer of ≥1:128 to phase II antigen (probable), or (3) a person with laboratory-supportive evidence of infection and an epidemiologic link to the implicated dairy.

<sup>b</sup> Cutoff for phase I and phase II IgM and IgG is <1:16.
presentation. Her husband complained only of fatigue but did demonstrate a 4-fold increase in phase II IgG and immunoglobulin M titers. The remaining 3 cases had nonspecific symptoms and serologic evidence of recent *C. burnetii* infection based on a single serum sample, but did not follow up for convalescent testing. Chronic infection occurs in <5% of infected persons and manifests predominantly as culture-negative endocarditis. Pregnant individuals and persons with valvulopathy, prosthetic valves, vascular grafts, or immunosuppressive conditions are at higher risk for chronic Q fever [4].

Inhalation of contaminated aerosols is the principal route of Q fever transmission; ingestion of raw milk products is considered a rare route of transmission [4, 7]. This is the first report of *C. burnetii* infection associated with raw milk consumption in Michigan. All cases regularly consumed raw milk from the same dairy for at least 1 year and demonstrated serologic and/or clinical evidence of recent *C. burnetii* infection. Customers collected milk from bulk tanks in the farm’s milking parlor and also interacted with the farm environment and animals. Exposure to infected livestock, inhalation of contaminated aerosols, and consumption of contaminated milk were all potential routes of exposure in this cluster. Case 1 had not visited the farm in 9 months, and case 5 had never visited the farm, making raw milk consumption the only plausible route of exposure in these 2 cases.

In recent years, raw milk consumption has increased in popularity, despite public health efforts to discourage it [8–10]. Direct consumer purchase of raw milk is permitted in 29 states, and 10 additional states permit the sale of raw milk for pet food or through cow-share arrangements [8]. A recent study found that 42.9% of purchased raw milk samples obtained in the United States were PCR positive for *C. burnetii*. When mice were inoculated with the positive samples, 2 of 6 samples led to *C. burnetii* infection [11]. In Michigan, direct consumer purchase of raw milk is illegal, but purchase through a cow-share arrangement is not expressly prohibited. Such dairies are not inspected or regulated by the state nor required to meet minimum food safety standards. Public health investigations into these operations are hampered by lack of authority to regulate private commerce and lack of funding and political will to pursue potentially litigious cases. As a result, officials could not inspect the dairy farm, collect milk samples for testing, obtain the names of the cow-share owners, or conduct an in-depth epidemiologic investigation of all potentially exposed customers.

Raw milk is a common source of food-borne illness due to a variety of zoonotic pathogens [9, 12]. States that restrict raw milk sales have fewer dairy-associated outbreaks [8]. This outbreak highlights the risk of Q fever through regular consumption of raw milk, further supports public health efforts directed at discouraging the consumption of raw milk, and raises the question of whether consumption of raw dairy products is a more important mode of transmission for *C. burnetii* than has been previously recognized. Improving public and physician awareness of Q fever and routes of exposure is important for both prevention and timely diagnosis.

**Note**

**Potential conflicts of interest.** All authors: No reported conflicts. All authors have submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Conflicts that the editors consider relevant to the content of the manuscript have been disclosed.

**References**