We conducted an investigation to identify potential exposures leading to *F. tularensis* infection (of any clinical form) among Sancaktepe Village residents. We defined a suspected case as onset of ≥1 specific symptoms (swollen lymph nodes in the neck or periauricular areas, sore throat, or swelling or redness of eyes) or ≥2 nonspecific symptoms (fever, chills, myalgia, or headache) during July 1–August 1, 2013. A probable case was onset of swollen lymph nodes plus sore throat or fever. A confirmed case was a suspected or probable case with a positive serologic test result.

We used the microagglutination test to detect *F. tularensis*–specific antibodies in patients’ blood; a titer ≥1:160 was the cut-off (2). Because of inadequate laboratory capacity to handle heavily polluted water, we used culture, but not PCR, to identify *F. tularensis* in implicated environmental samples.

Of 350 Sancaktepe Village residents, we excluded 46 who were absent during Ramadan 2013, the likely exposure period (explained in the next paragraph). From the remaining 304 residents, we identified 122 suspected case-patients, of whom 94 underwent blood microagglutination testing; 39 were positive (titers 1:160–1:2,560) for *F. tularensis*. No patient had a 4-fold rise in antibody titers between acute and convalescent phases of illness. On the basis of symptoms, we identified 16 additional probable cases among suspected case-patients who were not tested (7/13) or who had a negative microagglutination test result (9/24). The 55 confirmed or probable cases/case-patients are henceforth referred to as cases/case-patients.

The outbreak began on July 9, peaked in late July, and ended in early September 2013. Of the 304 residents, 55 (18%) were infected. The epidemic curve indicated a continuous common-source exposure and a likely exposure period that roughly coincided with Ramadan 2013 (July 8–August 7) (Figure). Cases occurred in all age groups (online Technical Appendix Table 1, http://wwwnc.cdc.gov/EID/article/21/12/14-2032-Techapp1.pdf) and village-wide. The attack rate did not differ significantly by sex: 18 (13%) of 137 male residents and 37 (22%) of 167 female residents were infected (relative risk [RR] 1.6, 95% CI 0.93–2.6). Clinical signs and symptoms included influenza-like symptoms and swollen lymph nodes in the neck or preauricular regions (online Technical Appendix Table 2).
We hypothesized that the outbreak was caused by waterborne bacteria for 3 reasons: case-patients predominantly had oropharyngeal symptoms; case-patients’ age and geographic distributions suggested a ubiquitous exposure; and villagers reported that the tap water had a dead-animal smell during Ramadan. A retrospective cohort study (excluding 46 persons with sore throat or swollen lymph nodes but not meeting definitions for probable or confirmed case-patients) showed that illness developed in 27% (46/173) of persons who drank tap water versus 11% (9/85) of persons who did not (RR 2.5, 95% CI 1.3–4.9). Other types of water were not associated with illness (Table). Sensitivity analyses showed slightly stronger associations between drinking tap water and illness when only confirmed cases (RR 3.4, 95% CI 1.4–8.4) or cases with onset during the week of July 22 (RR 3.0, 95% CI 1.1–8.4) were included.

We asked villagers whether they had engaged in game hunting or eaten game meat around Ramadan; no villagers had such exposures. In addition, according to the village administrator, no large, village-wide gathering had occurred around Ramadan. Inspection of the village’s main water storage tank revealed that the solar-powered chlorination device had malfunctioned. Water collected on August 22 had a chlorine level of 0 and elevated levels of total coliform (60 colony-forming units [CFUs]) and Escherichia coli (1 CFU). The main water storage tank was supplied by 2 water collection sites, A and B. Water from site A had unremarkable findings and low turbidity. Collection site B had 3 sources of water, 1 of which was surface water. A water sample from site B had high turbidity and contained a visible insect. Rodent activities, but not dead animals, were evident near the surface water ditch. Meteorologic data showed a lack of precipitation in this area for months. Water samples collected from site B on August 22 had high levels of total coliform (>100 CFU) and E. coli (50 CFU) (online Technical Appendix Figure). Culture of 2 water samples collected on August 28 and September 4, respectively, did not yield F. tularensis.

More than 300 wild and domestic animals worldwide have been found to be naturally infected with F. tularensis (1). F. tularensis subsp. holarctica, the only known disease-causing subspecies in Eurasia (5), is associated with water-associated rodents (e.g., beavers, muskrats). Humans can be infected with this subspecies by drinking contaminated water; having contact with contaminated streams, lakes, or rivers; having direct contact with contaminated objects (1,2); or eating uncooked contaminated food (6).

Tularemia surveillance in Turkey reported 4,827 tularemia cases nationwide during 2005–2011; contaminated water was presumed to have caused most cases, especially in rural areas (4). F. tularensis subsp. holarctica

Table. Risk for acquiring oropharyngeal tularemia among persons who drank water from different sources, Sancaktepe Village, Turkey, July–August 2013*

<table>
<thead>
<tr>
<th>Source of water consumed</th>
<th>No. cases/total no. exposed (%)</th>
<th>No. cases/total no. not exposed (%)</th>
<th>Relative risk (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tap</td>
<td>46/173 (27)</td>
<td>9/85 (11)</td>
<td>2.5 (1.3–4.9)</td>
</tr>
<tr>
<td>Well</td>
<td>2/8 (25)</td>
<td>53/250 (21)</td>
<td>1.2 (0.35–4.00)</td>
</tr>
<tr>
<td>Underground spring</td>
<td>25/136 (18)</td>
<td>30/122 (25)</td>
<td>0.75 (0.47–1.2)</td>
</tr>
<tr>
<td>Bottled</td>
<td>5/31 (16)</td>
<td>50/227 (22)</td>
<td>0.73 (0.32–1.70)</td>
</tr>
<tr>
<td>Other</td>
<td>2/8 (25)</td>
<td>53/250 (21)</td>
<td>1.20 (0.35–4.00)</td>
</tr>
</tbody>
</table>

*The outbreak was associated with Ramadan, which occurred during July 8–August 7, 2013.
has been isolated from drinking water sources in places where tularemia outbreaks occurred (7). The bacteria presumably came from dead animals; a single infected water animal (e.g., vole, lemming, or mouse) can contaminate up to 500,000 L of water (1), and F. tularensis can survive in untreated water for months (2). Free available chlorine residual concentrations routinely maintained in tap water systems can reduce F. tularensis by 4 log_{10} in 2 hours (8). However, the malfunction of the chlorination device at Sancaktepe Village’s main water storage tank enabled survival of the bacteria.

Our study had several limitations. F. tularensis was not isolated from water. Francisella species are fastidious and slow-growing and can be easily overwhelmed by competing organisms in environmental samples during culture (9). In addition, water samples were collected during late August–early September; by that time, the bacteria might have been cleared from the water. We spotted rodent activities, but no dead animals, near the implicated water source. The imperfect case definitions and potential subclinical infections in asymptomatic villagers might have led to misclassification, which tends to bias the association toward null; in other words, the observed association would have been stronger had there been no such bias, as evidenced by the sensitivity analysis that used laboratory-confirmed cases only.

Conclusions
This tularemia outbreak in northeastern Turkey was associated with drinking contaminated tap water. At our recommendation, the village administrator cut off the surface water source, repaired the chlorination device, and started checking chlorine levels regularly. No new outbreaks have subsequently occurred.

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References

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