MULTI-AGENCY RESPONSE TO A FLEA-BORNE TYPHUS OUTBREAK ASSOCIATED WITH A MOBILE HOME COMMUNITY

BACKGROUND

Flea-borne typhus is an acute febrile illness caused by *Rickettsia typhi* or *R. felis*. Persons typically become infected when the feces of a carrier flea enters the body through a bite or other break in the skin [1]. Most infections present as self-limited illness; however, infection for some progress to a more serious febrile illness and require hospitalization [2,3]. Deaths have been documented but are rare [4].

In Los Angeles County (LAC), cats, opossums, and the cat flea (*Ctenocephalides felis)* maintain the suburban life cycle of flea-borne typhus [1,5,6]. The flea acquires the bacteria from small urban mammals such as opossums that can harbor these bacteria. Opossums, a peridomestic animal, carry large numbers of fleas and often inhabit areas near human habitation where there is readily available food and harborage. Fleas may move from opossums to domestic pets (dogs and cats) and then to humans where they cause infection.

Flea-borne typhus is not a nationally reportable condition, so the number of cases occurring in the US is unknown. Cases primarily occur in Texas, Hawaii, and California where typhus is endemic. Providers and laboratories are mandated to report suspect cases to their local public health departments in these places. The majority of California's cases occur in LAC. In 2014, 51 cases were reported in California; 44 (86%) were LAC residents. This number corresponds to an LAC incidence of 0.47 per 100,000 [7].

On June 16, 2015, a local hospital infection preventionist alerted the Acute Communicable Disease Control program (ACDC) of three hospitalized flea-borne typhus cases occurring from April 23, 2015 to June 9, 2015 among residents of a 95-unit mobile home community (MHC). ACDC coordinated a multi-agency investigation of this outbreak in order to identify additional cases, identify and mitigate risk factors, and prevent further cases from occurring.

METHODS

Risk Factor Identification

To assess for risk factors at the MHC, several multi-agency site investigations of the MHC were conducted from June through November 2015. These agencies included ACDC, Environmental Health (EH), Community Health Services (CHS), Veterinary Public Health (VPH), and San Gabriel Valley Mosquito and Vector Control District (SGV).

Community Outreach

Printed health education materials (Figure 1) in English and Spanish were distributed to residents, and a community outreach meeting was hosted at a location adjacent to the MHC. Meeting invitations, notification of the investigation, and educational pamphlets were distributed to residents in English and Spanish (Figure 2). The notification letter urged residents to contact ACDC if they had been ill with fever

and headache or rash anytime since March 1, 2015, one month before the earliest case onset. All residents who contacted ACDC were interviewed by an ACDC investigator using a standardized questionnaire, which included information on individual demographics, clinical signs and symptoms, and possible exposures. Those with persisting symptoms were referred to their personal healthcare provider. ACDC consulted these providers and coordinated collection of a serological sample and testing.

Case Review and Case Finding

Outbreak-associated cases were defined as persons with the following criteria and symptom onset between March 1 and August 31, 2015:

- residence within the MHC,
- fever with headache or rash, and
- positive *R. typhi* or *R. rickettsii* laboratory test (immunoglobulin M (IgM) >1:64 and/or immunoglobulin G (IgG)>1:64).

ACDC increased surveillance for additional flea-borne typhus cases linked to this MHC. Disease surveillance staff reviewed all cases reported to DPH from January 1 through August 31, 2015 for possible links to the MHC. ACDC also contacted laboratory directors from four acute care facilities that could have evaluated an MHC resident or persons residing within this geographical area for an acute febrile illness. ACDC requested that laboratory directors review data for positive *R. typhi* or *R. rickettsii* laboratory tests (IgM >1:64 and/or IgG>1:64) and submit results to ACDC. A Los Angeles Health Alert Network[9] (LAHAN) notification was sent to emergency rooms and urgent care providers that served MHC residents and persons within this area. It requested that providers consider the possibility of flea-borne typhus in patients presenting with acute onset of fever, headache, rash, and myalgia. Clinicians were asked to collect serum specimens from suspect cases and to report suspect cases to ACDC.

To confirm etiology, available samples were transported to the LAC Public Health Laboratory (PHL). Samples were tested for *R. typhi* and *R. rickettsii* IgG and IgM via indirect immunofluorescence antibody testing (IFA).

RESULTS

Risk Factor Identification

On June 18, 2015, EH and SGV visited the 95-unit MHC. EH visited cases' residences and provided education regarding risk reduction. SGV inspected the entire grounds and identified multiple sanitation concerns: large numbers of free-roaming cats (>30), cat and dog feces throughout the grounds, pet food and water bowls outside residences, and an abundant flea population. Two opossums were trapped by SGV on June 18 and 22 wherein 615 and 1,087 fleas were identified, respectively, when combed. A pool of five fleas from each opossum was tested for rickettsial organisms by the Orange County Mosquito and Vector Control District. Fleas from the two opossums tested positive for *R. felis* via polymerase chain reaction (PCR), but *R. typhi* was not detected.

[9] www.publichealth.lacounty.gov/eprp/lahan/lahan.htm

On June 24, 2015, SGV issued a summary abatement notice to the property owner and property manager but not the residents. The notice required the owner to remove all feces from the grounds, eliminate the availability of pet food outdoors, enforce property rules limiting the number of pets and requiring pet registration with management, provide bi-weekly flea abatement, and remove feral animals.

A follow-up site visit with representatives from ACDC, EH, SGV, VPH, and CHS was conducted on August 13, 2015. Consistent with the June site visit, investigators observed many free-roaming cats, dog and cat feces, and pet food left outside. There were several aspects that likely also increased the presence of feral cats and fleas. First, three community dumpsters were present, uncovered, and overfilled with refuse. In addition, the foundation supporting and surrounding the mobile home was damaged. This offered potential harborage for wildlife. Also, a noticeable flea population persisted despite flea abatement efforts by the management company.

SGV re-contacted management to reiterate the order for bi-weekly flea abatement by a private company. SGV monitored the flea population by placing six glue boards (16 cm x 11 cm in size) throughout the neighborhood on a bi-weekly basis to assess for the presence of fleas. At the start of September, an average of 14 fleas were trapped on the boards. In November 2015, two consecutive visits yielded an average of zero fleas collected, suggesting a sustained reduction in the presence of fleas.

Community Outreach

A total of three residents contacted ACDC in response to the investigation letter. One was referred to his primary care physician due to persisting symptoms consistent with the case definition. However, laboratory results determined that he did not meet the case definition.

The community meeting was held adjacent to the MHC on August 24, 2015 with representatives from ACDC, EH, SGV, VPH, CHS, city council, and the office of a state senator. Approximately 20 residents attended the community meeting. An ACDC physician presented information about flea-borne typhus and advice for reducing its transmission including instructing residents not to leave pet food outdoors. VPH distributed flea collars free of charge to attendees for their pet cats or dogs. CHS public health nurses performed free on-site blood draws and completed the standardized questionnaire for five attendees who reported experiencing symptoms consistent with flea-borne typhus since March 1, 2015. Two additional outbreak-associated cases were identified.

Case Review and Case Finding

Two additional outbreak cases were identified among MHC residents at the community meeting as described. However, no additional cases were identified within the geographic area of the MHC using case finding and provider outreach methods employed during the investigation. Follow up through December 2015 to ensure implemented control measures were effective yielded no additional cases.

A total of five confirmed flea-borne typhus cases were identified within the MHC; three initially reported by the hospital infection preventionist and two additional cases that were identified through

investigational activities and confirmed via IFA (Table 1). Initially, Case A's lab values did not meet the CDPH flea-borne typhus case definitions but was reclassified as a confirmed case due to the epidemiologic link to the MHC. Illness onset ranged over three months, from April through June 2015, but was unknown for the non-hospitalized cases. Cases were primarily female (4/5) with a median age of 48 (range 42-67). All cases owned at least one dog; two cases also owned at least one cat. Of the five cases, three were hospitalized for a total of 15 nights (average = 5). All five cases recovered without complication.

DISCUSSION

An outbreak of flea-borne typhus occurred in a LAC MHC in the summer of 2015, resulting in a total of five identified cases. It is likely that additional cases occurred as part of this outbreak but remain undetected due to the non-specific, typically mild presentation of this disease and the residents' limited access to health care.

In LAC, the incidence and geographic spread of typhus cases has increased over recent years. Total cases increased from 31 in 2010 (0.3 per 100,000) to a peak of 68 cases in 2013 (0.7 per 100,000), with a slight decrease to 44 cases in 2014 (0.5 per 100,000). Despite this overall increase, typhus clusters remain an unusual occurrence. Prior to this investigation, the last documented cluster in LAC occurred in 2005 [8].

The etiologic agent of flea-borne typhus has received increased debate. *R. typhi* is traditionally considered the etiologic agent of flea-borne typhus. However, *R. felis* was detected in the fleas obtained from opossums in our investigation. This suggests that the causative agent of this outbreak was possibly *R. felis*, a rickettsial agent that is serologically indistinguishable from *R. typhi* in humans due to cross-reactivity [9,10]. PCR testing of samples obtained from acutely ill patients is necessary to make the distinction between the two organisms; these samples were not available during our investigation [10]. *R. felis* serology tests are not commercially available nor is PCR testing for *R. felis* or *R. typhi*. Future efforts should be made to acquire samples in acutely ill persons with suspected flea-borne typhus and tested via PCR for both *R. felis* and *R. typhi* by appropriate laboratories.

Limitations of this investigation included the amount of time required to coordinate the multiple agencies involved, which highlights the need to continually foster relationships with outside agencies. As a result, our on-site testing of residents occurred at a time when cases were no longer acutely ill. However, there was evidence that *R. felis* was still circulating in the community at the time of our involvement. Investigators successfully remediated that risk factor and improved overall environmental conditions.

Overall, this response demonstrated that the implementation of a multi-faceted intervention can interrupt the suburban transmission cycle of flea-borne typhus. Multiple interactions with the management were needed to sufficiently improve site conditions and decrease the flea population. More intimate engagement of community members and provision of pet flea control supplies was ultimately required in order to affect a change in the community. Infectious disease epidemiologists, community health providers, veterinarians, environmental health specialists, vector control experts, and city representatives were required to address the many factors contributing to the outbreak. One year post-

outbreak, we have received no additional reports of cases occurring in the MHC or surrounding area, suggesting that our efforts were successful in mitigating the outbreak.

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Figure 1. Community Meeting Invitation

Figure 2. Community Meeting Invitation

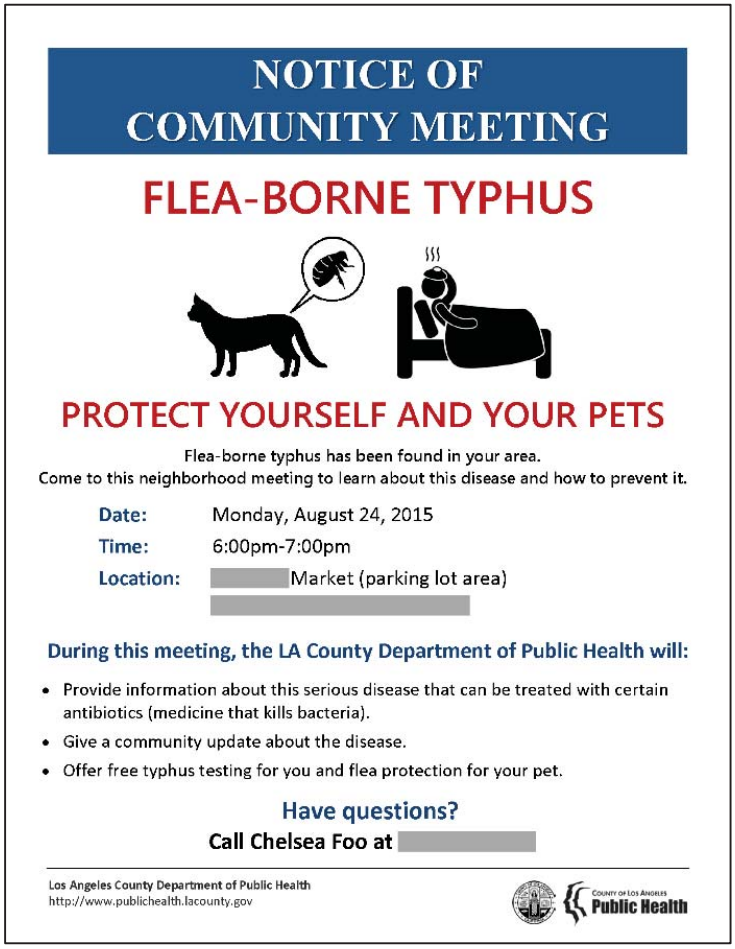

Table 1: Case Characteristics

Case	Age Group	Sex	Cat Owner	Dog Owner	Onset Date	Hospitalized	Hospital Nights	R. Typhi		R. Rickettsii	
								IgG	IgM	IgG	IgM
A	45-54	M	Yes	Yes	4/20/15	Yes	6	<64	1:64	N/A	N/A
B	35-44	F	No	Yes	4/9/15	Yes	4	1:128	≥1:256	N/A	N/A
C	65-74	F	Yes	Yes	6/5/15	Yes	5	1:128	1:128	N/A	N/A
D	45-54	F	No	Yes	Unknown	No	0	1:128	<64	1:64	<64
E	45-54	F	No	Yes	Unknown	No	0	1:64	<64	1:128	<64