ORIGINAL RESEARCH

Chikungunya in travellers returning to Canada: Surveillance report from CanTravNet surveillance data, 2006 to 2015

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BACKGROUND: Established in the Americas since late 2013, chikungunya is an emerging infection among travellers. **OBJECTIVE:** To examine demographic and travel correlates of chikungunya among Canadian travellers to establish a detailed epidemiological framework of this infection for Canadian practitioners encountering prospective and returned travellers. **METHODS:** Data regarding ill returned Canadian travellers presenting to a CanTravNet site between 2006 and 2015 were analyzed. **RESULTS:** During the study period, 22,387 ill travellers and immigrants presented to a CanTravNet site and, of these, 118 (0.5%) received a diagnosis of chikungunya. Those travelling for tourism were the most well-represented (n = 49, 41.5%), followed by those travelling to visit friends and relatives (n = 36, 30.5%). The Caribbean was the most likely source region, accounting for 64 (54.2%) diagnoses, followed by South Central Asia (n = 18, 15.3%). Haiti was the most well-represented source country, accounting for 22 (18.6%) cases. India, a high-volume destination for Canadians and the next most well-represented source country, accounted for 15 cases (12.7%), as did Jamaica. Median trip duration of those with chikungunya was 14 days, with 51.7% (n = 61) having a trip duration of ≤ 2 weeks and 21.2% (n = 25) ≤ 1 week. Musculoskeletal complaints at presentation were noted in 89% (n = 105), followed by fever in 54.2% (n = 64). **CONCLUSIONS:** The present analysis provides an epidemiological framework of chikungunya for Canadian practitioners encountering prospective and returned travellers. It reflects the emergence of chikungunya in the Americas, the risk associated with short-duration travel and substantiates efforts to educate travellers about the need for mosquito avoidance.

KEY WORDS: alphavirus; chikungunya; surveillance; tourism; travel medicine; vector-borne disease

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Chikungunya is an emerging vector-borne disease among Canadian travellers, particularly since the establishment of local transmission in the Americas in late 2013 (1,2). Vectored by *Aedes* mosquitoes, including the expansive *Aedes albopictus*, chikungunya has the potential for ongoing outbreaks of local transmission in North America (3,4), as

supported by reports of autochthonous transmission in the southern United States (5,6). Unlike *Aedes aegypti*, *Ae albopictus* is already present in temperate climates, and has been established in the southern parts of American states that share a terrestrial or aquatic border with Canada, including New York, Pennsylvania, and Ohio (7). As such, in addition to Canadian physicians becoming increasingly likely to encounter chikungunya in ill returned travellers, necessitating their familiarity with its epidemiology, clinical manifestations, and diagnostic and management approaches, there is the future potential for sporadic transmission near Canada's border. In January 2015, a national surveillance summary of chikungunya cases imported to Canada was published (2). However, because chikungunya is neither provincially nor nationally notifiable, this report was based on laboratory surveillance and, therefore, could be enhanced by the travel- and traveller-level granularity required to inform an epidemiological and clinical roadmap for front-line Canadian practitioners encountering patients with chikungunya.

To fill this knowledge gap, we undertook a Canada-specific traveller-level surveillance summary of chikungunya in a cohort of ill returned travellers presenting for care at CanTravNet sites over a nine-year period.

METHODS

Data source

Seven Canadian sites from five provinces (British Columbia, Alberta, Manitoba, Ontario, and Québec), also belonging to the GeoSentinel Global Surveillance Network, constitute CanTravNet, as described (8). These sites are large referral-based outpatient centres, staffed by specialists in travel and tropical medicine, that serve the Greater Vancouver/Victoria (British Columbia), Calgary (Alberta), Winnipeg (Manitoba), Toronto, Ottawa (Ontario), and Montréal (Québec) metropolitan areas, which could account for coverage of almost 50% of the Canadian population. Network sites have been established over time, with inaugural sites in Toronto (1997) and Ottawa (1997), and more recent additional sites in Victoria/Vancouver (2009), Montréal (2007 and 2011), Calgary (2012), and Winnipeg (2015). The Winnipeg site was added in late 2015 and did not contribute data to the present analysis. Data were collected using the GeoSentinel Surveillance Network data platform. This network is comprised of 60 specialized travel/tropical medicine clinics on six continents, which contribute denominalized and delinked clinician- and questionnaire-based travel surveillance data on all ill travellers examined, to a centralized Structured Query Language database (9) (for additional details see www.geosentinel.org). The GeoSentinel data collection protocol is reviewed cyclically by the institutional review board officer at the National Center for Emerging and Zoonotic Infectious Diseases at the US Centers for Disease Control and Prevention (Georgia, USA) and is classified as public health surveillance, not human subject research requiring submission to and approval from institutional review boards. Collected data include patient demographics, details of recent travel, five-year travel history, purpose of travel, and pretravel encounter history. Final diagnoses are made by attending physicians, and assigned a diagnostic code selected from a standardized list of >500 diagnostic entities, including etiological (eg, chikungunya) and syndromic (eg, arthritis) diagnoses. All CanTravNet sites contribute microbiologically confirmed data, where available, based on the best national reference diagnostic tests (including molecular diagnostics) available at the time. In Canada, the National Microbiology Laboratory (NML) in Winnipeg, Manitoba, is the only diagnostic laboratory performing testing for chikungunya, which, before mid-2015, included an immunoglobulin (Ig) M-based enzyme immunoassay, followed by confirmatory plaque-reduction neutralization test (PRNT) (2). A diagnosis of chikungunya is considered 'confirmed' by the NML if both IgM and PRNT are positive, where an isolated positive chikungunya IgM would be considered a 'probable' case (2). Further details regarding CanTravNet can be found at <http://www.istm.org/cantravnet> and additional details regarding the CanTravNet data source and definitions are as described (8).

Definitions and classifications

Reason for most recent travel

Six travel purpose designations were used, including tourism, business, missionary/volunteer research/aid work, visiting friends and relatives (VFR), military personnel, and medical tourists. VFR travel is defined as an immigrant who is ethnically and/or racially distinct from the majority population in their current country of residence, and who returns to his homeland to 'visit friends and relatives.' VFR travel also includes children of foreign-born parents (ie, second-generation immigrants) who return to their parent's homeland to visit friends and relatives. The term 'VFR' is typically applied to individuals travelling from a high-income country of current residence to a low-income country of origin (10).

Countries of exposure and travel were assigned to one of six hard-coded regional classifications (within the GeoSentinel database) where chikungunya is transmitted: Central America, the Caribbean, South America, sub-Saharan Africa, South Central Asia, and Southeast Asia.

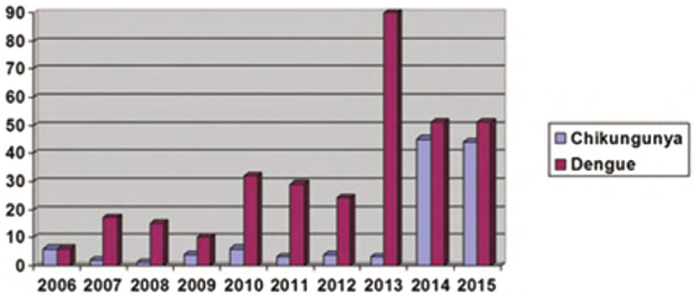

Figure 1: Initial year of presentation to a CanTravNet site by 118 ill returned travellers with chikungunya, 2006 to 2015. Before the Americas outbreak, the ratio of dengue to chikungunya diagnosed at CanTravNet sites peaked at 30:1 in 2013, with an annual average of 7.7 cases of dengue evaluated for every case of chikungunya. After the onset of the Americas outbreak, that ratio fell to 1.13 to 1.15 imports of dengue for every import of chikungunya. Total number of chikungunya cases according to year are as follows: 2006 (n = 6); 2007 (n = 2); 2008 (n = 1); 2009 (n = 4); 2010 (n = 6); 2011 (n = 3); 2012 (n = 4); 2013 (n = 3); 2014 (n = 45); 2015 (n = 44)

Inclusion criteria

Demographic, clinical, and travel-related data on Canadians encountered after completion of their international travel and seen in any of six CanTravNet sites from May 9, 2006 to December 31, 2015 were extracted and analyzed. Only patients with probable or confirmed final diagnosis of chikungunya (specific etiology as described previously [8]) were included. 'Confirmed' chikungunya in the GeoSentinel database requires either virus isolation, positive polymerase chain reaction, or positive IgM, where 'probable' chikungunya rests on compatible clinical illness in an outbreak situation. Thus, the GeoSentinel definition of chikungunya is more clinically oriented and less stringent from a laboratory diagnostic perspective than the NML definition described above.

Analysis

Extracted data were managed in an Access (Microsoft Corporation, USA) database and analyzed descriptively. Travellers were described according to purpose of travel, demographics, travel metrics including pretravel encounter, diagnoses, country of exposure, and region of travel. Differences between groups of travellers were compared using Fisher's exact test or χ^2 analysis. All statistical computations were performed using SigmaStat 2.03 software (SPSS, IBM Corporation, USA) or GraphPad Prism software (GraphPad Software Inc, USA).

RESULTS

During the study period, 22,387 travellers and immigrants presented to a CanTravNet site. Of these, 118 (0.5%) received a diagnosis of chikungunya, which corresponds to approximately 15.4% (n = 74) of the total number of chikungunya cases (n = 479) reported in Canada through the NML over the eight-year period between 2006 and 2014 (2). Figure 1 depicts imported cases of chikungunya over time. Before the outbreak in the Americas, an average of 7.7 cases of dengue were seen at CanTravNet sites for |every case of imported chikungunya, with a peak ratio of 30:1 in 2013 (Figure 1). However, that ratio fell to 1.13–1.15 to 1 after the onset of the Americas outbreak. Those travelling for the purpose of tourism were the most well-represented (n = 49, 41.5%), followed by those travelling to VFR (n = 36, 30.5%), missionaries/volunteers/aid workers (n = 15, 12.7%), business travellers (n = 15, 12.7%), and medical tourists or military personnel (n = 3, 2.5%). Demographic characteristics of the 118 ill returned travellers with chikungunya presenting to CanTravNet sites are summarized in Table 1.

Table 2 lists countries of acquisition of chikungunya in the present analysis. The Caribbean was the most likely source region, accounting for 64 (54.2%) cases, followed by South Central Asia (n = 18, 15.2%), Central America (n = 11, 9.3%), Southeast Asia (n = 8, 6.8%), and sub-Saharan Africa (n = 7 [5.9%]) (Table 1). Haiti was the single most well-represented individual source country, accounting for 22 cases (18.6%). Although tourists were the most well-represented type of traveller with chikungunya overall, those who acquired their chikungunya in Haiti travelled for work as missionaries, volunteers, researchers, or aid workers (n = 9); to VFR (n = 5); for military travel (n = 2); or for business (n = 1). India, a particularly high-volume destination for Canadians and the second-most well-represented source country for chikungunya, accounted for 15 cases (12.7%), as did Jamaica. Haiti, India, and Jamaica were followed by the Dominican Republic (n = 6, 5.1%) and Barbados (n = 5, 4.2%) as top source countries. Top source regions according to purpose of travel are listed in Table 1. Those travelling for the purpose of VFR were proportionately more likely to acquire chikungunya in South Central Asia compared with other types of travellers (p = 0.026), which likely reflects the large overall contingent of Canadian VFR travellers to the Indian subcontinent. Similarly, those travelling for work as missionaries, volunteers, researchers, or aid workers were more likely than other types of travellers to acquire their chikungunya in Haiti (p<0.001).

Table 1: Demographic characteristics of 118 returned travelers or new immigrants presenting to a CanTravNet site for care of Chikungunya, 2006–2015*

		Purpose of travel					
Characteristic	**All travellers (n = 118)**	**Tourism (n = 49)**	**Visiting friends and relatives (n = 36)**	**Missionary, volunteer, researcher, aid (n = 15)**	**Business (n = 15)**	**Military (n = 2)**	**Medical tourism (n = 1)**
Sex							
Male	25 (21.2)	7 (14.3)	10 (27.8)	2 (3.3)	5 (33.3)	1 (50.0)	0 (0)
Female	93 (78.8)	42 (85.7)	26 (72.2)	13 (86.7)	10 (66.7)	1 (50.0)	1 (100)
Age, years, median (range)	49 (18–80)	48 (18–74)	49.5 (24–74)	47 (22–80)	50 (29–65)	47 (39–55)	38 (—)
Type of patient							
Outpatient	118 (100)	49 (100)	36 (100)	15 (100)	15 (100)	2 (100)	1 (100)
Travel duration, d, median (range)	14 (2–775)	14 (4–273)	17 (6–483)	16 (3–775)	16 (2–251)	41 (28–76)	7 (NA)
Pretravel medical encounter							
Yes	35 (29.7)	12 (24.5)	7 (19.4)	7 (46.7)	9 (60.0)	0 (0)	0 (0)
No	55 (46.6)	27 (55.1)	20 (55.5)	3 (20.0)	5 (33.3)	0 (0)	0 (0)
Unknown	28 (23.7)	10 (20.4)	9 (25.0)	5 (33.3)	1 (6.7)	2 (100)	1 (100)
Geographical region of exposure							
Caribbean	64 (54.2)	25 (51.0)	18 (50.0)	11 (73.3)	7 (46.7)	2 (100)	1 (100)
South Central Asia	18 (15.3)	5 (10.2)	10 (27.8)	0 (0)	3 (20.0)	0 (0)	0 (0)
Central America	11 (9.3)	7 (14.3)	2 (5.6)	1 (6.7)	1 (6.7)	0 (0)	0 (0)
Southeast Asia	8 (6.8)	6 (12.2)	0 (0)	1 (6.7)	1 (6.7)	0 (0)	0 (0)
Sub-Saharan Africa	7 (5.9)	2 (4.1)	3 (8.3)	2 (13.3)	0 (0)	0 (0)	0 (0)
South America	4 (3.4)	0 (0)	3 (8.3)	0 (0)	1 (6.7)	0 (0)	0 (0)
Oceania	2 (1.7)	2 (4.1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Unknown	4 (3.4)	2 (4.1)	0 (0)	0 (0)	2 (13.3)	0 (0)	0 (0)
Birth country							
Canada	68 (57.6)	38 (77.6)	6 (8.3)	13 (86.7)	8 (53.3)	2 (100)	1 (100)
Outside Canada	50 (42.4)	11 (22.4)	30 (83.3)	2 (13.3)	7 (46.7)	0 (0)	0 (0)

Data presented as n (%) unless otherwise indicated. *The total cohort of travellers comprised 22,387 travellers between May 9, 2006 and December 31, 2015. This analysis includes only those travellers with a final diagnosis of chikungunya, except where indicated otherwise. Among those born outside of Canada, people who travelled for the purpose of visiting friends and relatives were defined as immigrants who were ethnically and/or racially distinct from the majority population in their current country of residence and who returned to their homeland to visit friends and relatives. This group also included children of foreign-born parents (ie, second-generation immigrants) who returned to their parents' homeland to visit friends and relatives

Table 2: Source countries for ill returned travellers (n = 118) with chikungunya seen at CanTravNet sites, 2006–2015

Exposure country	n (%)
Haiti	22 (18.6)
India	15 (12.7)
Jamaica	15 (12.7)
Dominican Republic	6 (5.1)
Barbados	5 (4.2)
Trinidad and Tobago	4 (3.4)
Costa Rica	3 (2.5)
Indonesia	3 (2.5)
Mexico	3 (2.5)
Saint Lucia	3 (2.5)
Colombia	2 (1.7)
Cuba	2 (1.7)
French Polynesia	2 (1.7)
Kenya	2 (1.7)
Malaysia	2 (1.7)
Nicaragua	2 (1.7)
Saint Vincent and The Grenadines	2 (1.7)
Sri Lanka	2 (1.7)
Thailand	2 (1.7)
Bahamas	1 (0.8)
Cambodia	1 (0.8)
Democratic Republic of the Congo	1 (0.8)
El Salvador	1 (0.8)
Grenada	1 (0.8)
Guadeloupe	1 (0.8)
Guyana	1 (0.8)
Honduras	1 (0.8)
Martinique	1 (0.8)
Mauritius	1 (0.8)
Pakistan	1 (0.8)
Panama	1 (0.8)
Saint Kitts and Nevis	1 (0.8)
Saint Martin	1 (0.8)
Tanzania	1 (0.8)
Venezuela	1 (0.8)
Virgin Islands, British	1 (0.8)
Unknown	4 (3.4)

Table 3: Presenting complaint of ill returned travellers (n = 118) with chikungunya evaluated at CanTravNet sites, 2006–2015

Presenting Symptom	n (%)*
Musculoskeletal	105 (89.0)
Fever	64 (54.2)
Skin	36 (30.5)
Fatigue	28 (23.7)
Gastrointestinal	16 (13.6)
Abnormal laboratory tests	13 (11.0)
HEENT	8 (6.8)
Neurological	5 (4.2)
Other	27 (22.9)

*Percent >100 as each traveller can have >1 presenting complaint

Of 118 cases of chikungunya among ill returned travellers presenting for care at a CanTravNet site, musculoskeletal complaints were the presenting symptom in 89% (n = 105), followed by fever in 64 (54.2%) (Table 3). Other common presenting symptoms in those with chikungunya included rash (n = 36, 30.5%), fatigue (n = 28, 23.7%), and gastrointestinal complaints (n = 16, 13.6%). Five (4.2%) ill returned travellers with chikungunya reported neurological complaints at presentation. All 118 travellers with chikungunya were managed as outpatients (Table 1).

Approximately 30% (n = 35) of travellers with chikungunya in the present analysis had received pretravel care (Table 1). The second most well-represented group of travellers with chikungunya, VFRs, had the lowest rate of pretravel encounter (Table 1). Interestingly, the third and fourth most well-represented groups of travellers, those travelling for missionary/volunteer/research/aid work or business had the highest uptake of pretravel encounters (46.7% and 60%, respectively).

Of 118 ill returned travellers with chikungunya presenting for care at a CanTravNet site, 51.7% (n = 61) had a trip duration ≤ 2 weeks, while 21.2% (n = 25) travelled ≤ 1 week(s). Five percent (n = 6) of ill returned travellers with chikungunya acquired their illness during a two-, three- or four-day trip. Median time to presentation at a CanTravNet site following travel was 37 days (range 0 to 250 days; interquartile range 12 to 68.5 days). Forty-one (34.7%) ill returned travellers with chikungunya presented for care at a CanTravNet site within 28 days of travel, while 28 (23.7%) presented ≥60 days post-travel, and 16 (13.6%) presented ≥90 days post-travel, supporting that many travellers presented for care of chronic arthropathic symptoms.

Sixteen (13.6%) ill returned travellers with chikungunya had another co-infection, most of which (68.8%) were dengue (Table 4). India was the most well-represented country of acquisition for chikungunya co-infections (n = 5, 31.3%); however, in 2014 and 2015, all chikungunya co-infections were acquired in the Caribbean or Central America (Table 4).

Table 4: Co-infections of ill returned Canadian travellers presenting for care at a CanTravNet site, 2006 to 2015

Age, years/sex	Travel reason	Country of acquisition	Coinfection	Season, Year
49/female	Tourism	Barbados	Dengue	Spring, 2015
69/female	Tourism	Cuba	Mononucleosis	Spring, 2015
37/female	Tourism	Costa Rica	Dengue	Winter, 2015
63/female	Tourism	Barbados	Strongyloidiasis	Fall, 2014
36/female	Tourism	Jamaica	Dengue	Fall, 2014
60/female	Tourism	St. Lucia	Dengue	Summer, 2014
38/female	Missionary/volunteer/aid work	Haiti	Dengue	Summer, 2014
67/female	Missionary/volunteer/aid work	Haiti	Dengue	Summer, 2014
32/female	Business	Haiti	Cyclosporiasis	Summer, 2014
34/female	Tourism	Thailand	Dengue	Spring, 2013
45/male	Visiting friends and relatives	India	Dengue	Winter, 2011
54/female	Business	India	Dengue	Winter, 2010
67/female	Tourism	India	Strongyloidiasis	Fall, 2010
28/female	Missionary/volunteer/aid work	Kenya	*Plasmodium falciparum* malaria	Spring, 2008
34/female	Business	India	Dengue	Fall, 2006
48/female	Visiting friends and relatives	India	Dengue	Fall, 2006

DISCUSSION

Our analysis of surveillance data provides more granular detail for a subset of ill returned Canadian travellers with chikungunya, and establishes an epidemiological framework for Canadian practitioners encountering prospective and returned travellers. Our data further highlight the recent emergence of chikungunya in the Americas. Approximately 79% of cases of chikungunya in the present analysis occurred in females, a phenomenon noted previously (11), and in contrast to epidemiological studies of other vector-borne diseases such as malaria and dengue (12,13). Higher rates of chronic chikungunya arthropathy among females (14–16) may reflect biological and behavioural risk factors (eg, exposure to infective bites, immunological factors, re-engagement in manual work during convalescence) (15,16), although their overrepresentation in epidemiological analyses may simply reflect a higher propensity for care-seeking or interpretation of symptoms (16).

One-half of ill returned travellers with chikungunya in the present analysis acquired the infection during trips of ≤ 2 weeks duration. Due to a lack of vaccine or chemoprophylaxis, and the day-biting proclivities of the mosquito vector, prevention of chikungunya rests on use of daytime mosquito avoidance through the application of personal protective measures such as insecticide-treated clothing and/or insect repellants (17,18). Use of insecticide-treated bed nets will have little to no effect on the prevention of chikungunya. Even trips lasting ≤ 1 week carried risk, accounting for 21% of cases of chikungunya in the present analysis. Poor access to pretravel counselling, the perception of lower risk with shorter itineraries within the Americas, particularly the Caribbean, and poor translation of the pretravel counselling that did occur into preventive action on the part of the traveller all may have contributed to the chikungunya burden observed in this group of primarily short-term travellers. Continued and innovative reinforcement of personal protective vigilance, including insect precautions, in the pretravel setting, even for possibly low-risk itineraries, is important.

Our data reflect the emergence of chikungunya in the Americas in late 2013, with 79 cases (67%) arising from the Caribbean, Central America, or South America, and Haiti being the single most common source country. Although tourists were the most well-represented type of traveller with chikungunya in the present analysis, not a single tourist acquired their illness in Haiti. Rather, the high proportion of cases from Haiti reflects the large contingent of VFR and business travellers to Haiti, along with missionaries, volunteers, researchers, and aid workers. VFR travellers and missionaries/aid workers tend to travel for longer periods of time and to reside in more rural, basic accommodations where exposure to infective mosquito bites is presumably higher than that of the average tourist traveller to the Caribbean.

The emergence of chikungunya in the Americas and ongoing autochthonous transmission throughout Asia, sub-Saharan Africa, and Oceania, challenges the assessment and differential diagnosis of febrile arthropathies in returned

travellers, where geographical restriction of alphaviruses was previously assumed. Overlapping geographical distributions of chikungunya with other alphaviruses, including O'nyong-nyong, Semliki forest virus, Sindbis, and Mayaro virus, as well as other potentially travel-acquired infections such as dengue, Zika virus, parvovirus, many rickettsioses, and gonorrhea/chlamydia, impede the restricted approach to diagnosis of febrile arthropathies in travellers. Most confirmatory diagnostic tests for such viral pathogens are organism specific, and rely on amplification of specific viral nucleic acid, or detection of specific viral antigens or host antibodies. Thus, if a particular virus with similar clinical manifestations to chikungunya is not initially considered in the differential diagnosis, the diagnosis will be missed. With ongoing expansion of vector ranges, especially that of *Ae albopictus* (19,20), continued expansion of the more established arbovirus dengue, and emergence of viruses such as chikungunya, Zika (21,22), and Mayaro (23,24) in travellers, syndromic diagnostic approaches using multiplexed platforms are likely to help fill this diagnostic gap.

Chikungunya is an arthritogenic virus, leading to a nonspecific acute syndrome of fever, arthralgia, myalgia, headache, and rash, which is then followed by a chronic disabling polyarthritis of variable duration in the convalescence of most patients. Eighty-nine percent of ill returned travellers with chikungunya in the present analysis had a musculoskeletal presenting complaint, while only 54% reported fever as their presenting symptom, and 30% complained of a chikungunya associated rash. One-fifth of patients also presented for care ≥2 months post-travel, supporting that their chronic arthropathy was the motivation for seeking care, rather than their acute, febrile syndrome, which would have begun within two weeks of returning from travel. Neurological complications are believed to be a more rare manifestation of chikungunya, but are increasingly reported (25). Of 300 patients with acute chikungunya studied in India, a full 16% suffered from one of encephalitis, myelopathy, peripheral neuropathy, myeloneuropathy, or myopathy (25). That 4.2% of ill returned travellers with chikungunya in the present analysis had a neurological presentation underscores that chikungunya remains on the differential diagnosis of travel-acquired febrile neurological syndromes, which would also include West Nile virus, HIV, Japanese encephalitis, tick-borne encephalitis, neuroborreliosis, enteroviruses, and acute HSV.

Another factor that complicates the initial diagnostic assessment is the presence of co-infections, which may have overlapping or entirely different symptoms to chikungunya. In our study, we documented co-infections in 13.6% of ill returned travellers with chikungunya, most of which were dengue, which has a very similar acute presentation to chikungunya and also relies on serological diagnosis, making it difficult to interpret which infection is responsible for acute manifestations. In one missionary to Kenya, chikungunya-falciparum malaria co-infection underscores the need for malaria testing in all febrile returned travellers from the tropics, regardless of other clinical manifestations or positive diagnostic tests supporting other infections.

Analysis of CanTravNet data has several limitations, which have been described previously (8). The present analysis pertains only to the sample of ill returned travellers who presented to a CanTravNet centre; thus, our conclusions may lack generalizability. Our network captured approximately 15.4% of all chikungunya cases imported to Canada over an overlapping eight-year period. This is only an estimate given different classification of probable versus confirmed cases by NML compared with GeoSentinel. Ill returned travellers with very mild and rapidly resolving chikungunya may have been less likely to be referred to a CanTravNet site from primary care or even the emergency departments; thus, our data may disproportionately represent those with more severe acute illness or chronic chikungunya arthropathy. Our ability to comment on changing rates of imported chikungunya over time is hindered by the accrual of additional sites in the network, but also by few imported cases before the Americas outbreak in 2013 to 2015. Although our data supported that chikungunya was mostly acquired by short-term travellers, our database may under represent those who acquired chikungunya on long-duration travel because these individuals may have convalesced while abroad and not sought care on return. Our data cannot estimate incidence rates or destination-specific numerical risks for chikungunya (9, 26). Because the Winnipeg site was new to CanTravNet in 2015, returning travellers to Manitoba are under-represented. Data regarding pretravel medical consultation was missing for 24% of ill returned travellers. Finally, our network does not capture significant numbers of pediatric cases and, as such, our data may not be generalizable to the pediatric population in Canada.

CONCLUSIONS: The data collected by the CanTravNet Surveillance Network can be used to better inform pre-travel chikungunya risk assessment, and post-travel diagnostic approach to febrile arthropathies. These data also illuminate changing patterns of imported chikungunya over time, and document that in 13.6% of ill returned travellers with chikungunya, another co-infection was also present. Chikungunya has emerged as a specific cause of fever and arthropathy in returned travellers and, although

mostly acquired in the Caribbean, India was the second most common source country of imported chikungunya over the nine-year period studied, accounting for 13% of cases. Barriers to the uptake of effective personal protective measures should be systematically assessed, especially in this group of predominantly short-term travellers.

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