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Trends in clinical diagnoses of typhus group rickettsioses among a large U.S. insurance claims database

Cara C. Cherry, **Alison M. Binder**

Rickettsial Zoonoses Branch, Centers for Disease Control and Prevention, Atlanta, GA, USA

Abstract

Typhus group rickettsioses (TGRs) are vector-borne diseases that include murine typhus (*Rickettsia typhi*) and epidemic typhus (*R. prowazekii*). Twentieth-century public health interventions led to dramatic decreases in incidence; little is known about the contemporary TGR prevalence because neither disease is nationally notifiable. We summarized administrative claims data in a commercially insured population to examine trends in TGR medical encounters. We analysed data from 2003 to 2016 IBM® MarketScan® Commercial Databases to identify persons with inpatient or outpatient visits with an International Classification of Diseases, Ninth or Tenth Revision, Clinical Modification TGR-specific code. We summarized epidemiologic characteristics associated with incident diagnosis. We identified 1,799 patients diagnosed with a TGR. Patients resided in 46 states, and most were female (n = 1,019/1,799; 56.6%); the median age was 42 years (range: 0–64 years). Epidemic typhus (n = 931/1,799; 51.8%) was the most common TGRs, followed by murine typhus (n = 722/1,799; 40.1%). The majority of TGR patients were diagnosed in an outpatient setting (n = 1,725/1,799; 95.9%); among hospitalized patients, the majority received a murine typhus diagnosis (n = 67/74; 90.5%). TGRs are rarely diagnosed diseases. More patients were diagnosed with epidemic than murine typhus, even though *R. prowazekii* transmission requires body louse or flying squirrel exposure. Patients from all geographic regions were diagnosed with murine and epidemic typhus, despite historically recognized ranges for these diseases. The epidemiologic misalignment of insurance claims data versus historic TGRs data highlights the challenges of finding appropriate alternative data sources to serve as a proxy when national surveillance data do not exist.

Keywords

epidemic typhus; murine typhus; *Rickettsia prowazekii*; *Rickettsia typhi*; typhus group rickettsioses

1 | INTRODUCTION

Two typhus group rickettsiae are present in the United States—*Rickettsia typhi* and *R. prowazekii*. *Rickettsia typhi* is the aetiologic agent of murine typhus, also known as endemic

Correspondence Cara C. Cherry, Rickettsial Zoonoses Branch, Centers for Disease Control and Prevention, 1600 Clifton Rd NE, Atlanta, GA 30329, USA. imv5@cdc.gov.

CONFLICT OF INTEREST

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typhus or flea-borne typhus (Walker, 1996). The clinical features of murine typhus are non-specific and include fever, rash, headache, myalgia and gastrointestinal symptoms (Blanton & Walker, 2017). While the clinical course of murine typhus is typically uncomplicated, patients can develop severe manifestations, such as central nervous system abnormalities. Deaths have been reported in 4% of hospitalized patients (Blanton & Walker, 2017; Dumler, Taylor, & Walker, 1991). *Rickettsia prowazekii* is the causative agent of epidemic typhus, also known as louse-borne typhus or classical typhus (Walker, 1996). The clinical manifestations of louse-borne *R. prowazekii* include severe headache, high fever, malaise, constipation, cough and rash. Central nervous system manifestations, such as delirium, coma or seizures, are present in up to 80% of cases (Bechah, Capo, Mege, & Raoult, 2008). Case fatality rates of 15% have been reported in modern, large-scale outbreaks of epidemic typhus (Raoult et al., 1998). Recrudescent infection with *R. prowazekii*, known as Brill–Zinsser disease, can occur years or decades after primary epidemic typhus infection (Bechah et al., 2008; McQuiston et al., 2010). Stress or waning immunity likely plays a role in the re-activation of persistent *R. prowazekii* (Bechah et al., 2008). Brill–Zinsser disease is a milder disease; symptoms are generally shorter in duration than the initial primary infection (Bechah et al., 2008; Lutwick, 2001).

Typhus group rickettsioses (TGRs) once caused high morbidity and mortality in the United States. Outbreaks of epidemic typhus developed in communities where close contact and limited resources allowed body lice to spread. The last outbreak of louse-borne epidemic typhus affected 63 persons and had a 42.8% case fatality rate (Armstrong, 1922). As body lice infestations declined, murine typhus became the predominant TGR in the United States. By the mid-1940s, over 5,000 cases of murine typhus occurred annually (Centers for Disease Control, 1980; Mohr, Good, & Schubert, 1953). Cases of TGRs have greatly diminished since World War II, due to effective insecticides, rodent reduction campaigns and improved standards of living and hygiene. Now, TGRs are diagnosed rarely in the United States (Davis, 1947; Mohr et al., 1953; Hoskinson et al., 2003; Pratt, 1958; Public Health Service Advisory Committee on Immunization Practices, 1978).

Over the past several decades, the geographic distribution and transmission pathways for TGRs have shifted (Adjemian et al., 2010; Azad, Radulovic, Higgins, Noden, & Troyer, 1997; Epidemic typhus associated with flying squirrels--United States, 1982). Researchers first identified murine typhus in the United States in 1910 (Maxcy, 1926), and transmission to humans was from exposure to infected faeces of *Xenopsylla cheopis* (rat flea) from *Rattus norveigicus* (brown rat) (Adams, Emmons, & Brooks, 1970; Azad et al., 1997). More recently, *R. typhi* ecology has shifted away from the classic urban rat– flea–rat cycle to exposure to the fleas (mostly *Ctencephalides felis*) of peridomestic animals (e.g. opossums, cats, dogs) present in suburban settings (Adams et al., 1970; Azad et al., 1997). However, clusters in urban settings still occur. Texas, which reports the highest number of murine typhus cases, has experienced a geographic expansion of murine typhus in the last decade. Once primarily restricted to South Texas, healthcare providers now diagnose patients in Austin, Dallas–Fort Worth and Houston areas (Adjemian et al., 2010; Elliott, Fournier, & Teltow, 1990; Campbell et al., 2009; Pieracci et al., 2017; Texas Department of State Health Services, 2017).

The epidemiology of epidemic typhus has undergone changes that are even more dramatic. Historically, people developed epidemic typhus from contact with an infected body louse (*Pediculus humanus corporis*) (Bechah et al., 2008). The last known U.S. case of louse-transmitted*R. prowazekii* infection was in 1922 (Armstrong, 1922; Public Health Service Advisory Committee on Immunization Practices, 1978). Since 1977, sporadic human cases of *R. prowazekii* infection have been diagnosed in patients with no evidence of body lice infestation; infection was associated with exposure to southern flying squirrels (*Glaucomys volans*) (Duma et al., 1981). Patients exposed to *R. prowazekii* from flying squirrels have similar clinical symptoms as the louse-borne form, but a less severe clinical course. No patients have died from epidemic typhus associated with flying squirrels (Epidemic typhus associated with flying squirrels--United States, 1982; The Centers for Disease Control, 1982). Despite the shifting ecology, epidemic typhus is a rarely described disease, and only ≈50 U.S. cases of epidemic typhus from flying squirrel exposure have been documented (Agger & Songsiridej, 1985; Chapman et al., 2009; Duma et al., 1981; McQuiston et al., 2010).

It is challenging to know the extent of ecological and geographic change seen in TGRs in the United States because neither TGR is currently nationally notifiable. While certain states (e.g. Texas, California, Hawaii) continue to make TGR reporting mandatory to the state or local health departments, the lack of national reporting has left a gap in the understanding of the burden, distribution and clinical presentation of TGRs across the United States. To gain a better understanding of trends in U.S. TGR healthcare encounters, we summarized administrative claims data from a large commercially insured population.

2 | MATERIALS AND METHODS

We conducted a retrospective descriptive analysis of the IBM® MarketScan®[1] Commercial Claims and Encounters (CCAE) database from 2003 to 2016. This database captures employer-sponsored health insurance claims data from >300 employers and 15 health plans, including enrollment information, inpatient and outpatient medical claims, and outpatient pharmacy data for enrollees 0–64 years of age, their spouses and their dependents, from all U.S. states. Data are de-identified and are compliant with the Health Insurance Portability and Accountability Act of 1996.

Medical encounters for TGRs were identified using the International Classification of Diseases, Ninth or Tenth Revision, Clinical Modification (ICD-9/10-CM) codes. We created the following mutually exclusive diagnostic categories based on the TGR-specific code(s) associated with the incident diagnosis: epidemic typhus (ICD-9-CM 080; ICD-10-CM A75.0), endemic (murine) typhus (ICD-9-CM 081.0; ICD-10-CM A75.2) and Brill–Zinsser disease (ICD-9-CM 081.1; ICD-10-CM A75.1). Scrub typhus (ICD-9-CM 081.2; ICD-10-CM A75.3; *Orientia tsutsugamushi*) is not a TGR and is not endemic to the United States; therefore, we excluded scrub typhus from this analysis. We included an inpatient admission, emergency department visit or outpatient encounter if a code for a TGR was listed in either the first or second diagnosis category from the CCAE database. We counted only the first

[1]IBM Watson Health and MarketScan are trademarks of IBM Corporation in the United States, other countries or both.

outpatient or inpatient visit with a TGR code during the study period; we considered the date of the inpatient admission or outpatient visit as the incident diagnosis. We summarized demographic characteristics (e.g. age, sex and U.S. Census region) associated with the incident diagnosis for all persons and by diagnostic category, and we evaluated changes in diagnostic patterns during the study period.

2.1 | Longitudinal disease patterns

We identified all inpatient admissions and outpatient encounters associated with a TGR code following incident diagnosis for patients initially diagnosed with epidemic typhus to determine whether any patients subsequently were diagnosed with Brill–Zinsser disease. We also calculated the number of follow-up visits (inpatient or outpatient) with a TGR code in the following 12 months after the initial diagnosis for all patients.

2.2 | Costs

We calculated the costs of the initial hospitalization or outpatient visit by summing total payments associated with the incident diagnosis. Total costs included the primary insurance payment, co-insurance payment, patient copayment, procedure(s), laboratory testing and prescriptions associated with the TGR diagnosis. Costs of inpatient medications were incorporated into the total payment for the hospital stay. Outpatient prescriptions were included in the total cost calculation if they were an antimicrobial drug possibly prescribed for treatment of TGRs within 30 days of the incident outpatient TGR encounter.

2.3 | Statistical methods

Descriptive statistics were calculated using SAS version 9.4 (SAS Institute).

2.4 | Ethical considerations

This protocol underwent human subject review at the Centers for Disease Control and Prevention and was determined not to be research involving human subjects; approval from an institutional review board was not required.

3 | RESULTS

From 1 January 2003 to 31 December 2016, an average of 33,604,425 (range: 16,159,068–53,131,420) unique persons were enrolled in the MarketScan® database each year. For this period, we identified 1,799 unique patients with a diagnosis code for a TGR. There were 931 epidemic typhus patients (51.8%) and 722 murine typhus patients (40.1%). Recrudescent infection with *R. prowazekii* (Brill–Zinsser disease) was coded for 146 patients (8.1%; Table 1). The yearly average number of diagnoses of murine typhus was 51.6 patients (range: 5–102). For epidemic typhus, the yearly average was 66.5 new patient diagnoses (range: 25–105), while for Brill–Zinsser, 10.4 patients a year were diagnosed on average (range: 2–19; Figure 1).

For each TGR examined, the majority of patients diagnosed were female (murine typhus: n = 376/722; 52.1%; epidemic typhus: n = 552/931; 59.3%; Brill–Zinsser: n = 91/146; 62.3%; Table 1). The median age for Brill–Zinsser patients (51 years) was older than epidemic (41

years) or murine typhus (39.5 years). While frequency counts were nearly equally distributed among age groups for murine typhus and epidemic typhus, the majority of Brill–Zinsser patients were in the 45–64 years age groups, though 13 Brill–Zinsser patients were under the age of 18 (Table 1).

Typhus group rickettsioses patients resided in 46 states and the District of Columbia. For each specific TGR, most patients resided in one geographic region. For murine typhus, 54.2% (*n* = 391/722) lived in the South, while 59.9% of epidemic typhus patients (*n* = 558/931) were from the Northeast. Of note, almost twice as many patients coded for Brill–Zinsser resided in the South (*n* = 68/146; 46.6%) compared to the Northeast (*n* = 36/146; 24.7%), despite most epidemic typhus patients living in the Northeast (Table 1).

Seasonality for date of diagnosis varied between diseases. May–August were the peak months for murine typhus diagnosis. Diagnosis of epidemic typhus had a less clear seasonal pattern with peaks in April and August. Murine and epidemic typhus seasonal patterns varied by geographic region; within a region, murine and epidemic typhus often peaked in different seasons. For epidemic typhus seasonality by region, the Northeast exhibited little seasonal variation; the South peaked in late summer (August). The Midwest increased in the spring (March–May), but also in July. The West peaked in the fall (October), but had a similar peak in the spring (April). Murine typhus seasonality also varied. In the Northeast, murine typhus diagnoses peaked in December, but also showed an increase in the summer months (July and August). In the South, the highest percentage of diagnoses was in May and August. Both the Midwest and West showed a summer seasonality; however, the West had increased diagnoses from June to September, while the Midwest had a clear peak in June (Figure 2).

3.1 | Clinical care and cost

The majority of all TGR patients were diagnosed in an outpatient setting (*n* = 1,725/1,799; 95.9%), with only 2.8% (*n* = 48/1,725) of outpatients seeking care in an emergency department not leading to inpatient hospitalization. The median cost of outpatient care was lower for murine typhus (median = $99.95; IQR = $65.87–$170.68) compared to epidemic typhus (median = $107.36; IQR = $69.33–$204.19) and Brill–Zinsser disease (median = $122.49; IQR = $48.95–$280; Table 2). Hospitalization was rare (*n* = 74/1,799; 4.1%). While <1% of epidemic typhus (*n* = 6/931) and Brill–Zinsser (*n* = 1/146) patients were hospitalized, 9.3% of murine typhus patients (*n* = 67/722) were admitted to a hospital (Table 3). Hospitalization length of stay was longer for patients with murine typhus (mean = 3.6 days; range = 1–11 days) compared to epidemic typhus patients (mean = 2.6 days; range = 1–5 days). No in-hospital deaths were recorded; all patients were discharged to home. The median cost of hospitalization among murine typhus patients was $12,064.41 (IQR = $8,444.99–$16,979.50), and the median cost for epidemic typhus was $8,614.86 (IQR = $4,416.77–$37,388.50; Table 3).

In the 12 months following incident TGR diagnosis, outpatients had an average of 1.4 additional outpatient encounters associated with a TGR code (range: 1–31 visits; Table 2). Murine typhus outpatients had the largest percentage of patients requiring more than one additional outpatient visit (*n* = 102/655; 15.6%) and had the highest percentage of follow-up

hospitalizations (n = 7/655; 1.1%). None of the inpatients had any other follow-up care associated with a TGR diagnosis code in the 12 months after the hospitalization. Among epidemic typhus patients, none went on to receive a diagnosis of Brill–Zinsser disease over the course of evaluation in MarketScan®.

4 | DISCUSSION

Typhus group rickettsioses are infrequently diagnosed diseases among the U.S. commercially insured population. Despite the rarity of these diseases, we were surprised to discover that epidemic typhus was the most commonly diagnosed TGR. We hypothesized that only a limited number of epidemic typhus cases would be diagnosed based on human body lice being virtually absent from the U.S. population and exposure to flying squirrels likely limited (Bechah et al., 2008; McDade, 1987). Yet, more patients in the MarketScan® population were diagnosed with epidemic typhus each year than the combined published cases of epidemic typhus in the last four decades. Similarly, while the number of patients in MarketScan® diagnosed with Brill–Zinsser each year was low (average 10.5 cases/ year), this greatly exceeds the seven documented U.S. cases of Brill–Zinsser published since 1970 (McQuiston et al., 2010). Thirteen Brill–Zinsser patients were under the age of 18 years, including diagnoses in 1- and 2-year-old patients. Paediatric cases are unlikely, as the child would need to contract a primary infection with *R. prowazekii* and later recrudesce. We found that no epidemic typhus patients in MarketScan® went on to develop Brill–Zinsser disease, though our study period was limited and recrudescence is known to occur decades after primary infection (Bechah et al., 2008; McQuiston et al., 2010).

Not only is the number of epidemic typhus diagnoses unexpected, but the seasonality of these diagnoses differs from established epidemiologic knowledge. Epidemic typhus mostly occurs in the coldest months (December–February), when heavy coats and poor sanitation foster body lice proliferation and when flying squirrels congregated in dense clutters and are more likely to move into human dwellings (Agger & Songsiridej, 1985; Bechah et al., 2008; The Centers for Disease Control, 1982; Sonenshine et al., 1978). Yet, patients in this data set were diagnosed across all months, with peaks in April and August. Patients resided in all geographic regions, though the majority were from the Northeast.

Unlike epidemic typhus, the murine typhus patients in the MarketScan® population better resembled established epidemiology for this disease. Overall, the seasonality and geographic distribution of MarketScan® patients diagnosed with murine typhus matched the expected patterns. Today, nearly all cases of murine typhus occur in southern Texas, southern California and Hawaii and cases peak in the warmer months of late spring through early fall (Blanton, Vohra, Bouyer, & Walker, 2015; Civen & Ngo, 2008; Hoskinson et al., 2003; Pieracci et al., 2017). In the MarketScan® population, more than 75% of patients resided in the south and west regions and diagnoses peaked during the months of May–August. The Northeast, which comprised only 14% of murine typhus cases, did not exhibit an expected seasonality, with diagnoses peaking in December.

While these unexpected findings might suggest that more TGR cases exist than previously believed, these results also might reflect a lack of familiarity with TGRs among the

healthcare community. TGRs suffer from challenging nomenclature. Both diseases have multiple common names that are similar in nature (epidemic vs. endemic; louse-borne vs. flea-borne). The common names for infection with *R. prowazekii* no longer match the current epidemiology of the disease in the United States, as it neither causes epidemics nor is carried by lice. Both TGR may be referred to simply as "typhus" or "typhus fever," which, in turn, could be confused with typhoid fever (*Salmonella* serotype Typhi). In both ICD-9-CM and ICD-10-CM diagnosis codes, epidemic typhus is the first TGRs listed. Without access to medical records, it is impossible to validate the diagnostic codes used for these patients. Additionally, healthcare providers might have assigned a TGR code to the visit before they had laboratory results to confirm disease. The most common laboratory method to diagnose TGRs is a serologic test, such as indirect immunofluorescence antibody assay (Bechah et al., 2008; Blanton & Walker, 2017). *Rickettsia typhi* and *R. prowazekii* antigens cross-react, preventing species-specific results; cross-reaction with spotted fever group Rickettsia also has been reported (Ormsbee et al., 1978). A confirmed TGR diagnosis cannot be made based on a single serologic titre value. Confirmatory diagnosis requires a fourfold or greater increase in IgG antibody titre in samples collected 2–4 weeks apart, during acute and convalescent phases of illness, or positive results using a molecular assay, such as polymerase chain reaction (Bechah et al., 2008; Blanton & Walker, 2017). Diagnostic limitations, similarities in nomenclature and clinical presentation, and epidemic typhus being the first listed TGRs in ICD-CM might account, in part, for the higher number of epidemic typhus diagnoses.

While this analysis has offered insight into suspected TGRs health encounters in the United States, the use of administrative data to characterize disease trends is subject to limitations. First, administrative claims data are generated for reimbursement, not epidemiologic research. Diagnostic codes provided by healthcare providers or billing specialists to insurance companies for reimbursement are subject to transcription errors. As a result, misclassification of TGRs diagnoses is possible; this is suggested by clinical and epidemiological inconsistencies in the data, including the identification of Brill–Zinsser cases in children, and the absence of any fatal cases among hospitalized patients. We lacked access to the medical records, laboratory results and travel history to determine the validity of cases. Lastly, the data used for this study consisted of persons <65 years of age with commercial health insurance that was provided to IBM Watson Health by large, self-insured employers. Medicaid or Medicare enrollees, military personnel or those without insurance were not included; risk for TGRs might differ among these populations as compared to that of the privately insured. Therefore, the results presented may not be generalized to the overall U.S. population.

The epidemiology of murine typhus in the MarketScan® population mostly agreed with known seasonal and geographic patterns, but the number of epidemic typhus and Brill–Zinsser diagnoses was unexpected and did not reflect the established epidemiology of these diseases. Understanding the incidence and clinical presentation of rare, non-reportable disease is challenging. Researchers successfully have used alternative data sources, such as medical billing claims data, to make estimates of disease incidence or burden for other non-reportable conditions (Gastanaduy, Hall, Curns, Parashar, & Lopman, 2013; Lykins et al., 2016; Nelson et al., 2015; Nelson, Saha, & Mead, 2016). However, we found that this

approach did not prove to be a reliable proxy for surveillance data. Other approaches, such as analyses of commercial diagnostic testing, death certificate data or clinician surveys, should be considered to understand the burden of these rare diseases. A better understanding of the current epidemiology of TGRs will allow for the most up-to-date clinical education to increase healthcare provider awareness.

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DISCLAIMER

The findings and conclusions of this report are those of the authors and do not necessarily represent the official position of CDC.

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Impacts

- Murine typhus and epidemic typhus are vector-borne diseases that exist in the United States but are not nationally notifiable. The paucity of contemporary typhus group rickettsiosis (TGR) data available limits understanding about the national prevalence of these diseases.
- Evaluation of administrative claims data from a commercially insured population discovered an epidemiologic misalignment of insurance data compared to historically accepted TGR data, including discrepancies in geographic distribution, seasonality and an unexpected number of epidemic typhus diagnoses.
- Without national surveillance, public health officials struggle to describe the epidemiology and clinical characteristics of rare diseases. Finding alternative data sources to characterize TGR national trends is challenging.

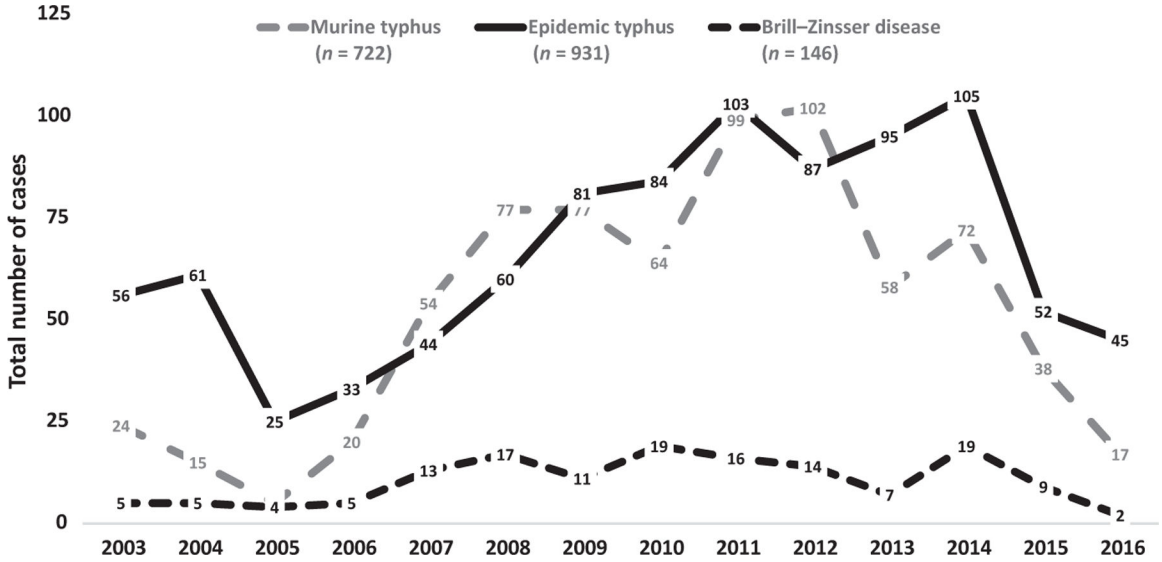

FIGURE 1.

Annual incident case counts within the MarketScan® population for murine typhus, epidemic typhus and Brill–Zinsser disease—United States, 2003–2016. The greatest number of patients diagnosed in a year for epidemic typhus ($n = 105$) was in 2014 and for murine typhus ($n = 102$) in 2012. Nineteen patients were diagnosed with Brill–Zinsser in both 2010 and 2014

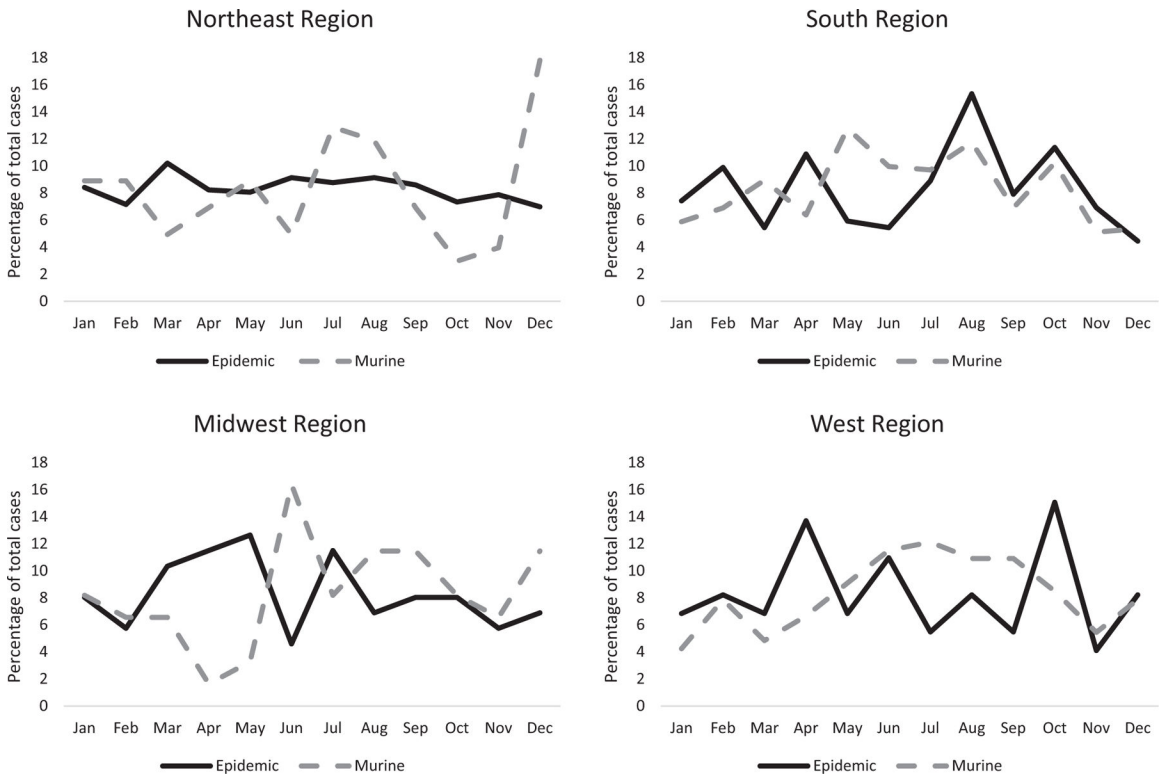

FIGURE 2.

Seasonality of murine typhus and epidemic typhus diagnoses by geographic region—United States, 2003–2016. Seasonality varied by geographic region. Among epidemic typhus patients, month of diagnosis varied. The Northeast exhibited little seasonal variation; the South peaked in late summer (August). The Midwest had an increase in diagnoses in the spring (March–May), but also in July. The West peaked in the fall (October), but had a similar peak in the spring (April). Murine typhus seasonality also varied. In the Northeast, murine typhus diagnoses peaked in December, but also showed an increase in the summer months (July and August). For the South, the highest percentage of total diagnoses was in May and August. Both the Midwest and West showed a summer seasonality

TABLE 1

Demographic characteristics of patients (n = 1,799) diagnosed with typhus group rickettsioses—United States, 2003–2016

	Murine typhus (n = 722)		Epidemic typhus (n = 931)		Brill–Zinsser disease (n = 146)		Total typhus group rickettsioses (n = 1,799)	
	n	**%**	***n***	**%**	***n***	**%**	***n***	**%**
Age (years) at index date								
Median	39.5	—	41	—	51	—	42	—
Range	0–64	—	0–64	—	1–63	—	0–64	—
IQR	32	—	31	—	17	—	32	—
Age group (years)								
0–17	166	23.0	168	18.0	13	8.9	347	19.3
18–34	140	19.4	204	21.9	13	8.9	357	19.8
35–44	115	15.9	142	15.3	27	18.5	284	15.8
45–54	150	20.8	209	22.5	39	26.7	398	22.1
55–64	151	20.9	208	22.3	54	37.0	413	23.0
Sex								
Male	346	47.9	379	40.7	55	37.7	780	43.4
Female	376	52.1	552	59.3	91	62.3	1,019	56.6
Geographic region								
Northeast	101	14.0	558	59.9	36	24.7	695	38.6
Midwest	61	8.5	87	9.3	16	11.0	164	9.1
South	391	54.2	202	21.7	68	46.6	661	36.7
West	165	22.7	73	7.8	23	15.8	261	14.5
Unknown	4	0.6	11	1.2	3	2.1	18	1.0

Table 2

Clinical characteristics and first clinical visit costs for outpatients (n = 1,725) diagnosed with typhus group rickettsioses—United States, 2003–2016

	Murine typhus (n = 655)		Epidemic typhus (n = 925)		Brill–Zinsser disease (n = 145)		Total typhus group rickettsioses (n = 1,725)	
	n	**%**	***n***	**%**	***n***	**%**	***n***	**%**
Place of service								
Emergency department	17	2.6	29	3.1	2	1.4	48	2.8
Other facility types	638	97.4	896	96.9	143	98.6	1,677	97.2
Follow-up care								
Hospitalization	7	1.1	1	0.1	1	0.7	9	0.5
>1 Outpatient visit	102	15.6	111	12	8	5.5	221	12.8
Mean number of visits	1.4	—	1.4	—	1.1	—	1.4	—
Range	1–17	—	1–31	—	1–5	—	1–31	—
SD	1.3	—	2	—	0.6	—	1.7	—
Cost of care for initial visit ($USD)								
Mean	192.3	—	308.22	—	253.02	—	259.2	—
Median	99.95	—	107.36	—	122.49	—	105.01	—
IQR	104.81	—	134.86	—	231.05	—	123.62	—

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TABLE 3

Clinical characteristics and hospitalization costs for inpatients (n = 74) diagnosed with typhus group rickettsioses—United States, 2003–2016

	Murine typhus *n* = 67		**Epidemic typhus *n* = 6**		**Brill–Zinsser disease *n* = 1**		**Total typhus group rickettsioses *n* = 74**	
	n	**%**	***n***	**%**	***n***	**%**	***n***	**%**
Hospitalization length (days)								
Mean length of stay	3.6	—	2.6	—	4	—	3.5	—
Range	1–11	—	1–5	—	—	—	1–11	—
SD	2.1	—	2.0	—	—	—	2	—
Discharge status								
Discharged to home	64	95.5	5	83.3	1	100.0	70	94.6
Transferred to another facility[a]	0	0.0	0	0.0	0	0.0	0	0.0
Died[a]	0	0.0	0	0.0	0	0.0	0	0.0
Missing	3	4.5	1	16.7	0	0.0	4	5.4
Hospitalization cost ($USD)								
Mean hospital charges	14,197.72	—	18,269.16	—	13,994.33	—	14,525.09	—
Median	12,064.41	—	8,614.86	—	13,994.33	—	11,855.13	—
IQR	8,535.00	—	32,972.00	—	0.00	—	8,666.00	—

[a]Beginning in the 2016 data year, values indicating death or transfer to law enforcement are no longer used to protect patients' privacy.