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Tuberculosis Transmission or Mortality among Persons Living with HIV, United States, 2011–2016

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Abstract

Background: Persons living with HIV are more likely to have tuberculosis (TB) disease attributed to recent transmission (RT) and to die during TB treatment than persons without HIV. We examined factors associated with RT or mortality among TB/HIV patients.

Methods: Using National TB Surveillance System data from 2011–2016, we calculated multivariable adjusted odds ratios (aOR) with 99% confidence intervals (CI) to estimate associations between patient characteristics and RT or mortality. Mortality analyses were restricted to 2011–2014 to allow sufficient time for reporting outcomes.

Results: TB disease was attributed to RT in 491 (20%) of 2,415 TB/HIV patients. RT was more likely among those reporting homelessness (aOR:2.6, CI:2.0,3.5) or substance use (aOR:1.6, CI:1.2,2.1), and among blacks (aOR:1.8, CI:1.2,2.8) and Hispanics (aOR:1.8, CI:1.1,2.9); RT was less likely among non-U.S.–born persons (aOR:0.2, CI:0.2,0.3). The proportion who died during TB treatment was higher among persons with HIV than without (8.6% versus 5.2%; $p<.0001$). Among 2,273 TB/HIV patients, 195 died during TB treatment. Age ≥65 years (aOR:5.3, CI:2.4,11.6), 45–64 years (aOR:2.2, CI:1.4,3.4), and having another medical risk factor for TB (aOR:3.3, CI:1.8,6.2) were associated with death; directly observed treatment (DOT) for TB was protective (aOR:0.5, CI:0.2,1.0).

Conclusions: Among TB/HIV patients, blacks, Hispanics, and those reporting homelessness or substance use should be prioritized for interventions that decrease TB transmission. Improved adherence to treatment through DOT was associated with decreased mortality, but additional interventions are needed to reduce mortality among older patients and those TB/HIV patients with another medical risk factor for TB.

Keywords

HIV; tuberculosis; transmission; mortality

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Compliance with Ethical Standards

Disclaimer: The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

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Background

Tuberculosis (TB) is a leading cause of death among persons living with HIV (PLWH) worldwide. According to the World Health Organization (WHO), TB accounted for 1 out of every 3 deaths among persons with HIV in 2017 [1]. In the United States, HIV infection remains strongly associated with mortality among patients with TB [2–4].

In an individual host, the *Mycobacterium tuberculosis* and HIV pathogens potentiate each other, accelerating the course of both diseases and complicating management of TB disease [5,6]. Because PLWH with TB disease often have negative or atypical reactions to routine TB tests, such as tuberculin skin tests (TST), interferon-gamma release assays (IGRA), and chest radiographs, TB diagnosis may be difficult, resulting in delayed treatment [7,8]. Moreover, a higher proportion of TB cases among PLWH in the United States are attributed to recent transmission as opposed to reactivation of latent infection compared to those without HIV [9]. This is probably because immune compromise among PLWH results in rapid progression to TB after *M. tuberculosis* infection [5].

To our knowledge, there has been no comprehensive assessment of TB among PLWH in the United States since a study published in 2007, which analyzed TB/HIV comorbidity trends from 1993–2004 [10]. Albalak et al. found that the decline in TB/HIV comorbidity during 1993–2004 was driven by decreased case counts among US-born persons in the states having the most number of TB/HIV cases. TB/HIV comorbidity rates were highest among the U.S.-born, persons aged 25–44, non-Hispanic blacks, males, and persons residing in the Northeast and Southeast regions of the country.

Since the period analyzed in the Albalak study, there have been changes both in demographics of TB patients in the United States (e.g., increase in proportion of cases among non–U.S.-born persons, decrease in proportion of cases among persons experiencing homelessness) and in HIV care (e.g., introduction of increasingly effective antiretroviral medications) [9]. We sought to identify demographic and clinical characteristics associated with TB/HIV and to identify characteristics associated with recent TB transmission or mortality during TB treatment among PLWH.

Methods

Study population

We analyzed data on incident TB cases reported to the National TB Surveillance System (NTSS) from all 50 U.S. states and the District of Columbia during 2011–2016. A case of TB is defined as an episode of TB disease in a person meeting the laboratory or clinical criteria for TB. Cases are reported using the Report of Verified Case of Tuberculosis (RVCT) form [9]. TB cases among persons reported as having a diagnosis of HIV or a positive HIV test result at the time of TB diagnosis were classified as TB/HIV cases. Patients with HIV results recorded as unknown, indeterminate, refused, not offered, and test done/results unknown were excluded from the analyses.

Study outcomes

Analyses of factors associated with recent transmission of TB or mortality during TB treatment were conducted among only those with TB/HIV. Cases were attributed to recent transmission using genotyping data and an established plausible-source case method that was validated with epidemiologic data from local sources [11]. Briefly, CDC attributes a TB case to recent transmission if a plausible-source case can be identified in a person who has the same *M. tuberculosis* genotype, has an infectious form of TB disease, is at least 10 years of age, resides within 10 miles of the given TB case, and was diagnosed within 2 years before the given TB case. Because of low numbers of persons <15 years of age with TB/HIV, analyses were restricted to persons aged 15 years and older. Analyses of recent transmission were restricted to culture-confirmed, genotyped cases (approximately 75% of TB cases reported to NTSS).

Mortality was defined as reason for stopping treatment coded as “died” (referent group is persons not known to have died and reasons for stopping treatment include completed treatment, experienced adverse event, was lost to follow up, refused treatment, or other) and could be death due to any cause during TB treatment. Analyses of mortality during treatment were restricted to 2011–2014 data to allow sufficient time for reporting outcomes and excluded persons who were dead at time of TB diagnosis.

Data analyses

We describe the characteristics of patients with TB/HIV in the United States during 2011–2016 by comparing TB/HIV cases with TB/non-HIV cases. We calculated duration of treatment for all TB/HIV and TB/non-HIV cases who died during treatment. We also examined the outcomes of recent transmission or mortality during TB treatment by applying multivariable logistic regression with backward elimination to calculate adjusted odds ratios (aOR) with 99% confidence intervals (CI) for associations with demographic and clinical characteristics among PLWH. All variables were included in the initial model. Interaction was assessed among all variables identified as significantly associated with each outcome by backwards selection in each model, with plan to retain significant interaction terms and their components. Missing and unknown values were included in the tabulation of overall proportions of demographic and clinical characteristics associated with TB/HIV and TB/non-HIV but excluded from the univariate and multivariable analyses for RT and mortality. SAS version 9.3 (Cary, NC) was used for all analyses.

Other variables

Because of low numbers of patients in some groups and missing data, we created an “other” race/ethnicity group that included patients whose race/ethnicity was multiracial, Native Hawaiian/other Pacific Islander, or American Indian/Alaska Native. For the same reason, we also combined alcohol use, injecting drug use, and noninjecting drug use into a new “substance use” variable (coded “Y” if one or more of these risk factors was reported). Likewise, immunocompromise (other than HIV or diabetes), end-stage renal disease, receipt of TNF-alpha antagonist therapy, and history of organ transplant were combined into an “other medical risk factor for TB” variable. A new variable was also created to capture whether nucleic acid amplification (NAA) testing was performed by categorizing the

variable as “not done” versus any other outcome (i.e., positive, negative, unknown, or indeterminate). Receipt of directly observed therapy was defined as the process of a trained health care worker or other designated person (excluding a family member) watching the patient swallow at least some of their prescribed TB medications. Regions of the country (South, West, Northeast, and Midwest) were defined in NTSS and included in our analysis because previous studies have found differences in the proportions of PLWH with TB as well as differences in HIV care by geographical region [12,13].

Results

Of 55,387 incident TB cases reported to the NTSS during 2011–2016, 49,008 (88.5%) had known HIV status; 3,271 (6.7%) were classified as TB/HIV cases and 45,737 (93.3%) were classified as TB/non-HIV cases (Table 1). Overall, sex, age, and race/ethnicity were significantly associated with TB/HIV status ($p<.0001$). A greater proportion of TB/HIV cases were U.S.-born than of TB/non-HIV cases (46.4% versus 31.1%; $p<.0001$) and region was also significantly associated with TB/HIV status ($p<.0001$) with a larger proportion of TB/HIV cases than TB/non-HIV cases reported in the Southern region (51.7% versus 39.1%). A larger proportion of TB/HIV cases reported substance use (28.3% versus 15.4%; $p<.0001$) and homelessness (14.2% versus 5.4%; $p<.0001$) within the year prior to TB diagnosis than of TB/non-HIV cases.

Compared to TB/non-HIV cases, a greater proportion of TB/HIV cases had negative results on TB infection tests: negative tuberculin skin test (TST) (14.2% versus 8.4%; $p<.0001$) or negative interferon-gamma release assay (IGRA) result (11.6% versus 6.9%; $p<.0001$); a greater proportion of TB/HIV cases with pulmonary TB had a normal chest radiograph finding (15.0% versus 4.9%; $p<.0001$) (Table 2). However, a similar proportion of persons with TB/non-HIV had no nucleic-acid amplification (NAA) testing performed as those with TB/HIV (44.7% versus 45.1%; $p=.68$). Among 36,241 (74%) cases with culture and genotyping results, a greater proportion of TB/HIV cases had TB infection attributed to recent transmission than TB/non-HIV cases (20.4% versus 13.9%; $p<.0001$). The proportion of patients who were alive at diagnosis, were started on one or more anti-TB medications, and died during TB treatment during 2011–2014 was higher among TB/HIV cases than among TB/non-HIV cases (8.6% versus 5.2%; $p<.0001$). Median duration of treatment among TB/HIV cases who died during treatment was 58.5 days (min 1.0, max 1,021); among TB/non-HIV cases, median duration of treatment was 54.0 (min 1.0, max 1,081) ($p=.6$).

Among persons with TB/HIV, risk factors associated with TB being attributed to recent transmission in the multivariable analyses included homelessness (adjusted odds ratio (aOR): 2.6, 99% confidence intervals (CI): 2.0,3.5), non-Hispanic black race (aOR: 1.8, CI: 1.2,2.8), Hispanic ethnicity (aOR: 1.8, CI:1.1,2.9), and substance use (aOR: 1.6, CI: 1.2,2.1) (Table 3). Non-U.S.–born origin was associated with not being attributed to recent transmission (aOR: 0.2, CI: 0.2,0.3). Risk factors associated with mortality during treatment included age 65 years or greater (aOR: 5.3, CI: 2.4,11.6), age 45–64 years (aOR: 2.2, CI: 1.4,3.4), and having another medical risk factor for TB (aOR:3.3, CI: 1.8,6.2) (Table 4).

Receipt of DOT was protective against mortality (aOR: 0.5, CI: 0.2,1.0). No interaction terms were retained in any of the final models.

Discussion

Our key findings include higher odds of TB being attributed to recent transmission among PLWH reporting homelessness or substance use and among blacks and Hispanics, and lower odds among non-U.S.–born persons. Odds of death during TB treatment among PLWH were higher among persons age ≥45 years and those who had another medical risk factor for TB and lower among patients receiving directly observed treatment (DOT) for TB.

As seen in previous studies, clinical characteristics included a higher proportion of negative TB test results (e.g., TST, IGRA, chest radiograph), which complicates case detection and can lead to a delayed diagnosis of TB disease [7,8]. These findings can help inform healthcare providers regarding clinical presentation of persons with TB/HIV and reinforce the need for heightened awareness of TB among PLWH, even in the setting of negative test results. In addition, despite recommendations that NAA testing be done directly on clinical specimens in all persons with HIV suspected of having pulmonary TB given a greater sensitivity than AFB smear microscopy among this population, we found that rates of NAA testing were similar among those patients with and without HIV [14]. Increased use of these tests among PLWH might lead to increased identification of TB among this population and improved outcomes. For example, one recent randomized clinical trial of use of a rapid PCR-based assay for detection of *M. tuberculosis* DNA in clinical specimens as a point-of-care assay at HIV diagnosis resulted in a 22% lower all-cause mortality among TB/HIV patients with advanced disease [15]. Better use of current rapid diagnostic tests for TB and development of new diagnostic tools for prompt diagnosis of TB may help to reduce both recent transmission and mortality among this group. Additionally, given the difficulty in diagnosing TB among PLWH, further development of improved tools to diagnosis TB among this population is needed.

We found a higher proportion of TB attributed to recent transmission (versus reactivation of latent TB infection) among PLWH (15.1%) compared to the proportion in those without HIV (10.3%). This finding is not surprising given that there is an increased likelihood that TB infection will rapidly progress to disease in PLWH [5], making it more likely to find a plausible source case within two years of diagnosis for attribution to recent transmission. In our analysis, most risk factors associated with recent transmission among PLWH were similar to those factors associated with RT overall in previous analyses [16]. These risk factors, including homelessness and substance use, may indicate exposure in congregate or group settings [17,18]. These settings could be prioritized for TB prevention efforts. We observed a lower odds of TB attributed to RT among persons born outside of the United States, which is consistent with previous analyses that have shown that TB disease among this population is more frequently due to reactivation of latent TB infection [19,20].

Our study supports previous analyses that found that a greater proportion of PLWH died during TB treatment than of those without HIV, and that similar to the general population, older PLWH were more likely to die during TB treatment [3,12]. Our finding that

individuals with another medical risk factor for TB were more likely to die during TB treatment may be an indicator of extent or seriousness of TB disease or of the other medical condition. Finally, our finding that there was lower mortality among PLWH treated by DOT reinforces the long-standing CDC recommendation to use DOT with all TB patients, especially PLWH [21]. Unlike a previous study that showed that recent transmission was significantly related to mortality among both patients with and without HIV, our study did not show any significant relationship between recent transmission and mortality among PLWH [22] However, this previous study used a different method to determine recent transmission which may explain the discrepancy in findings. Additional information regarding the HIV status of those with TB/HIV would be helpful in interpreting any findings among this group. In 2020, NTSS will begin collecting data on CD4 cell count at TB diagnosis for persons with HIV. This marker of level of immunocompromise may be helpful in better understanding whether TB patients are on an effective HIV antiretroviral therapy regimen at TB diagnosis, as well as their increased risk for early mortality during TB treatment.

This study has certain limitations. HIV status was not available for 11.5% of cases reported in the NTSS. NTSS does not currently collect data on CD4 count, HIV viral load, or antiretroviral treatment, making it difficult to interpret TB/HIV outcomes. Some co-morbidities might be underreported. Drug susceptibility testing was not available for all cases. Recent transmission analyses were restricted to only culture-confirmed, genotyped cases (75% of TB reported to the NTSS) with complete data for the plausible-source case method. We did not have information regarding the status of patients who did not complete treatment for reasons other than death, some of whom might have died. If that were the case, then our estimate of mortality during treatment was underestimated, and the associations with mortality attenuated. In addition, the NTSS does not capture cause of death; however, a recent study found that approximately 72% of deaths in patients being treated for TB are probably due to TB [2].

Conclusions

The decreased likelihood of PLWH with TB to have positive TB test results requires a heightened suspicion by HIV and TB healthcare providers for TB infection among this population. Increased use of NAA testing may help in identifying TB among patients with negative initial screening test results. Enhancing efforts to test populations with HIV in congregate settings associated with recent TB transmission, as well as treatment for latent TB infection and implementation of infection control measures, will likely prevent TB and decrease TB transmission. Finally, focusing attention on populations at greater risk for mortality during TB treatment, along with consistent use of DOT, are needed to improve TB care outcomes among PLWH.

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Table 1.

Demographic and Risk Factor Characteristics of Persons with TB/HIV and TB/Non-HIV, 2011–2016

	TB/HIV (col%) N=3,271	TB/Non-HIV (col%) N=45,737	P value*
Demographic characteristics			
Age group			
15–24	123 (3.8)	5,398 (11.8)	
25–44	1,608 (49.2)	15,226 (33.3)	
45–64	1,420 (43.4)	15,076 (33.0)	
65+	120 (3.7)	10,028 (21.9)	
Unknown	0 (0)	9 (0.0)	<.0001
Sex			
Male	2,326 (71.1)	28,082 (61.4)	
Female	945 (28.9)	17,651 (38.6)	
Unknown	0 (0)	2 (0)	<.0001
Race/ethnicity			
Non-Hispanic white	266 (8.1)	6,376 (13.9)	
Non-Hispanic black	1,810 (55.3)	9,261 (20.3)	
Hispanic	900 (27.5)	13,174 (28.8)	
Asian	248 (7.6)	15,530 (34.0)	
Other	37 (1.1)	1,272 (2.8)	
Unknown	10 (0.3)	124 (0.3)	<.0001
Origin of birth			
U.S.-born	1,518 (46.4)	14,239 (31.1)	
Non–U.S.-born	1,752 (53.6)	31,477 (68.8)	
Unknown	1 (0.0)	21 (0.1)	<.0001
Region[a]			
Midwest	297 (9.1)	5,586 (12.2)	
Northeast	630 (19.3)	7,195 (15.7)	
South	1,690 (51.7)	17,877 (39.1)	
West	654 (20.0)	15,079 (33.0)	<.0001
Risk Factors			
Substance use[b,c]	924 (28.3)	7,040 (15.4)	<.0001
Correctional facility[d]	183 (5.6)	1,894 (4.1)	<.001
Homelessness[c]	464 (14.2)	2,448 (5.4)	<.0001
Long-term care facility[d]	55 (1.7)	737 (1.6)	.79
Medical Risk Factors			
Diabetes mellitus	141 (4.3)	7,342 (16.1)	<.0001
Other medical risk factor[e]	182 (5.6)	2,904 (6.4)	.07

*Chi-square and Fisher's exact tests were used to analyze difference in proportions.

[a]Midwest: ND,SD,NE,KS,MN,IA,MO,WI,IL,IN,OH,MI

Northeast: PA,NJ,NY,CT,RI,MA,VT,NH,ME

South: TX,OK,AR,LA,MS,TN,KY,WV,MD,DC,DE,VA,NC,SC,FL,GA,AL

West: WA,OR,ID,CA,NV,MT,WY,UT,CO,AZ,NM,AK,HI

[b]Substance use includes injection drug use, noninjection drug use, or excess alcohol use.

[c]Within year prior to diagnosis

[d]At time of diagnosis

[e] Includes end-stage renal disease, immunosuppression other than HIV, TNF-alpha antagonist therapy, or post-organ transplant.

Table 2.

Clinical Characteristics of Persons with TB/HIV and TB/Non-HIV, 2011–2016

Clinical characteristics	TB/HIV n (col%) N=3,271	TB/Non-HIV n (col%) N=45,737	P value*
Negative tuberculin skin test[a]	464 (14.2)	3,844 (8.4)	<.0001
Negative IGRA[a]	379 (11.6)	3,162 (6.9)	<.0001
Negative sputum smear[a,b]	1,323 (49.7)	16,212 (44.4)	<.0001
Negative sputum culture[a,b]	598 (22.5)	7,598 (20.8)	<.001
No nucleic acid amplification testing done	1,463 (44.7)	20,625 (45.1)	.68
Normal chest radiograph[a,b]	399 (15.0)	1,786 (4.9)	<.0001
Disease site Pulmonary only Extrapulmonary only Both	 1,880 (57.5) 609 (18.6) 782 (23.9)	 32,157 (70.3) 9,166 (20.0) 4,384 (9.6)	 <.0001
Previous TB	213 (6.5)	2,258 (4.9)	<.001
TB attributed to recent transmission[c]	495 (20.4)	4,730 (13.9)	<.0001
Deceased at diagnosis	86 (2.6)	344 (0.8)	<.0001
Drug Resistant TB Susceptible Isoniazid(INH) (mono) Rifampin (Rif) (mono) INH/Rif (MDR)	 2,254 (88.9) 210 (8.3) 21 (0.8) 28 (1.1)	 32,096 (89.7) 2,931 (8.2) 74 (0.2) 519 (1.5)	 <.0001
Receiving directly observed therapy (DOT)[d]	2,104 (92.6)	27,570 (91.1)	<.001
Completed treatment[d]	1,898 (83.5)	27,028 (89.3)	<.0001
Did not complete treatment	375 (16.5)	3,224 (10.7)	<.0001
Reasons for not completing treatment[d,e] Died Lost to follow-up Moved Experienced adverse event Refused Other Unknown	 195 (52.0) 47 (12.5) 0 (0) 2 (0.5) 34 (9.1) 78 (20.8) 19 (5.1)	 1,567 (48.6) 343 (10.6) 5 (0.2) 92 (2.9) 193 (6.0) 784 (24.3) 240 (7.4)	 <.0001

*Chi-square and Fisher's exact tests were used to analyze difference in proportions.

[a]For diagnostic tests, reference group is all other possible outcomes for the test.

[b]Among cases with pulmonary disease.

[c]Among 36,241 cases for whom recent transmission could be assessed. Estimated using algorithm described in France AM, et al. A Field-Validated Approach Using Surveillance and Genotyping Data to Estimate Tuberculosis Attributable to Recent Transmission in the United States. Am J Epidemiol. 2015;182: 799–807.

[d]Among cases from 2011–2014 who were alive at diagnosis and started treatment with one or more drugs.

[e]Among only those who did not complete treatment.

IGRA = interferon-gamma release assay

CT = computed tomography

Table 3.

Characteristics Associated with Cases Attributed to Recent Transmission (RT) among Persons with TB/HIV (N=2,415), 2011–2016

Characteristics	Not RTn (col%) N=1,924	RTn (col%) N=491	Crude OR (99% CI)	aOR (99% CI)
Demographic Characteristics				
Age group				
15–24	68 (3.5)	16 (3.3)	1.1 (0.5,2.2)	
25–44	979 (50.9)	218 (44.4)	Ref	
45–64	804 (41.8)	244 (49.7)	**1.4 (1.0,1.8)**	
65+	73 (3.8)	13 (2.7)	0.8 (0.4,1.8)	
Sex				
Male	1,358 (70.6)	378 (77.0)	**1.4 (1.0,1.9)**	
Female	566 (29.4)	113 (23.0)	Ref	
Race/ethnicity				
Non-Hispanic-white	131 (6.8)	43 (8.8)	Ref	
Non-Hispanic-black	1,001 (52.2)	333 (68.0)	1.0 (0.6,1.6)	
Hispanic	550 (28.7)	103 (21.0)	**0.6 (0.3,1.0)**	Ref
Asian	206 (10.8)	7 (1.4)	0.1 (0.0,0.3)	**1.8 (1.2,2.8)**
Other	28 (1.5)	4 (0.8)	0.4 (0.1,1.9)	**1.8 (1.1,2.9)**
Origin				
U.S.-born	679 (35.3)	386 (78.6)	Ref	Ref
Non-U.S.–born	1,244 (64.7)	105 (21.4)	**0.1 (0.1,0.2)**	**0.2 (0.2,0.3)**
Region[a]				
Midwest	203 (10.6)	27 (5.5)	Ref	
Northeast	375 (19.5)	74 (15.1)	1.5 (0.8,2.8)	
South	946 (49.2)	298 (60.7)	**2.4 (1.4,4.1)**	
West	400 (20.8)	92 (18.7)	1.7 (0.9,3.2)	
Social Risk Factors				
Substance use[b,c]	457 (23.8)	244 (49.7)	**3.2 (2.5,4.3)**	**1.6 (1.2,2.1)**
Correctional facility[d]	94 (5.0)	30 (6.3)	1.3 (0.7,2.2)	
Homelessness[c]	202 (10.5)	167 (34.1)	**4.4 (3.2,6.0)**	**2.6 (2.0,3.5)**
Long-term facility[d]	22 (1.1)	9 (1.8)	1.6 (0.6,4.5)	
Medical Risk Factors				
Diabetes mellitus	90 (4.7)	21 (4.3)	0.9 (0.5,1.7)	
Other medical risk factor[e]	99 (5.2)	32 (6.5)	1.3 (0.7,2.2)	
Clinical Characteristics				
Positive sputum smear[f]	832 (50.7)	234 (53.7)	1.1 (0.8,1.5)	
Abnormal chest radiograph[f]	1,317 (80.3)	367 (84.2)	1.2 (0.8,1.9)	
History of previous TB	91 (4.7)	41 (8.4)	**1.8 (1.1,3.0)**	
Drug Resistant TB				
Susceptible	1,689 (89.1)	430 (88.1)	Ref	
Isoniazid	151 (8.0)	47 (9.6)	1.2 (0.8,1.9)	
Rifampin	18 (1.0)	3 (0.6)	0.7 (0.1,3.3)	
INH/Rif (MDR)	26 (1.4)	1 (0.2)	0.2 (0.0,2.1)	

Note: Bolded values indicate statistical significance at α=.01. Due to rounding, some confidence intervals may show 1.0.

[*] Only cases with isolates available that had genotyping results could be evaluated with the RT algorithm. TB cases among non–U.S.-born persons diagnosed within 100 days of arrival to the United States were considered likely due to reactivated disease and thus not considered attributed to RT.

[a] Midwest: ND,SD,NE,KS,MN,IA,MO,WI,IL,IN,OH,MI

Northeast: PA,NJ,NY,CT,RI,MA,VT,NH,ME

South: TX,OK,AR,LA,MS,TN,KY,WV,MD,DC,DE,VA,NC,SC,FL,GA,AL

West: WA,OR,ID,CA,NV,MT,WY,UT,CO,AZ,NM,AK,HI

[b] Substance use includes injection drug use, non-injection drug use, and excess alcohol use

[c] Within year prior to diagnosis

[d] At time of diagnosis

[e] Includes end-stage renal disease, immunosuppression other than HIV, TNF-alpha antagonist therapy, post-organ transplant

[f] Among cases with pulmonary disease.

Table 4.

Characteristics Associated with Mortality during Treatment among Persons with TB/HIV (N=2,273), 2011–2014

Characteristics	Died During Treatment n (col%) N=195	Not Known to Have Died During Treatment n (col%) N=2,078	Crude OR (99% CI)	aOR (99% CI)
Demographic Characteristics				
Age group				
15–24	5 (2.6)	77 (3.7)	1.1 (0.3,3.8)	
25–44	63 (32.3)	1,083 (52.1)	Ref	**2.2 (1.4,3.4)**
45–64	107 (54.9)	859 (41.3)	**2.1 (1.4,3.3)**	**5.3**
65+	20 (10.3)	59 (2.8)	**5.8 (2.8,12.3)**	**(2.4,11.6)**
Sex				
Male	129 (66.2)	1,484 (71.4)	0.8 (0.5,1.2)	
Female	66 (33.9)	594 (28.6)	Ref	
Race/ethnicity				
Non-Hispanic white	18 (9.2)	161 (7.8)	Ref	
Non-Hispanic black	111 (56.9)	1,148 (55.4)	0.7 (0.4,1.6)	
Hispanic	49 (25.1)	588 (28.4)	0.8 (0.4,1.6)	
Asian	13 (6.7)	154 (7.4)	0.8 (0.3,2.0)	
Other	4 (2.1)	23 (1.1)	1.6 (0.3,7.2)	
Origin				
U.S.-born	110 (56.4)	972 (46.8)	Ref	
Non–U.S.-born	85 (43.6)	1,106 (53.2)	0.7 (0.5,1.0)	
Region[a]				
Midwest	18 (9.2)	187 (9.0)	Ref	
Northeast	34 (17.4)	419 (20.2)	0.8 (0.4,1.8)	
South	102 (52.3)	1,059 (51.0)	1.0 (0.5,2.0)	
West	41 (21.0)	419 (20.2)	1.0 (0.5,2.2)	
Social Risk Factors				
Substance use[b,c]	61 (31.3)	582 (28.0)	1.2 (0.8,1.9)	
Correctional facility[d]	9 (4.6)	133 (6.4)	0.7 (0.3,1.8)	
Homelessness[c]	35 (18.0)	290 (14.0)	1.4 (0.8,2.3)	
Long-term facility[d]	7 (3.6)	26 (1.3)	3.0 (1.0,9.1)	
Medical Risk Factors				
Diabetes mellitus	20 (10.3)	78 (3.8)	**2.9 (1.5,5.8)**	
Other medical risk factor[e]	29 (14.9)	96 (4.6)	**3.6 (2.0,6.5)**	**3.3 (1.8,6.2)**
Clinical Characteristics				
Disease site				
Pulmonary	128 (65.6)	1,167 (56.2)	Ref	
Extrapulmonary	22 (11.2)	398 (19.2)	**0.5 (0.3,0.9)**	
Both	45 (23.1)	513 (24.7)	0.8 (0.5,1.3)	
NAAT done	113 (58.0)	1,058 (50.9)	1.3 (0.9,2.0)	
History of previous TB	17 (8.7)	127 (6.1)	1.4 (0.7,2.9)	
TB attributed to recent transmission[f]	47 (24.1)	318 (15.3)	1.6 (1.0,2.5)	
Drug Resistant TB				
Susceptible	146 (89.0)	1,412 (89.3)	Ref	
Isoniazid (INH) (mono)	11 (6.7)	140 (8.9)	0.8 (0.3,1.8)	
Rifampin (Rif) (mono)	2 (1.2)	12 (0.8)	1.6 (0.2,11.7)	
INH/Rif (MDR)	5 (3.1)	17 (1.1)	2.8 (0.8,10.8)	

Characteristics	Died During Treatment n (col%) N=195	Not Known to Have Died During Treatment n (col%) N=2,078	Crude OR (99% CI)	aOR (99% CI)
Receiving DOT	131 (90.3)	1,512 (95.4)	**0.5 (0.2,1.0)**	**0.5 (0.2,1.0)**

Note: Bolded values indicate statistical significance at α=.01. Due to rounding, some confidence intervals may show 1.0.

[a]Midwest: ND,SD,NE,KS,MN,IA,MO,WI,IL,IN,OH,MI

Northeast: PA,NJ,NY,CT,RI,MA,VT,NH,ME

South: TX,OK,AR,LA,MS,TN,KY,WV,MD,DC,DE,VA,NC,SC,FL,GA,AL

West: WA,OR,ID,CA,NV,MT,WY,UT,CO,AZ,NM,AK,HI

[b]Substance use includes injection drug use, non-injection drug use, and excess alcohol use

[c]Within year prior to diagnosis

[d]At time of diagnosis

[e]Includes end-stage renal disease, immunosuppression other than HIV, TNF-alpha antagonist therapy, post-organ transplant

[f]Among 36,241 cases for whom recent transmission could be assessed. Estimated using algorithm described in France AM, et al. A Field-Validated Approach Using Surveillance and Genotyping Data to Estimate Tuberculosis Attributable to Recent Transmission in the United States. Am J Epidemiol. 2015;182: 799–807.

NAAT: Nucleic acid amplification test

DOT: Directly observed therapy