

Technical Notes

National Tuberculosis Surveillance System

Reporting areas (i.e., the 50 states, the District of Columbia, New York City, Puerto Rico, and other U.S. jurisdictions in the Pacific and Caribbean¹) report tuberculosis (TB) cases to CDC's National TB Surveillance System (NTSS) using a standard case report form, Report of Verified Case of Tuberculosis (RVCT). TB cases are verified according to the Tuberculosis Case Definition for Public Health Surveillance in Appendix A. TB cases are reported and counted according to the Recommendations for Reporting and Counting Tuberculosis Cases in Appendix B.

New features of the 2012 Report

The 2012 report has 20 new tables that feature data from new variables collected in the NTSS and from the Tuberculosis Genotyping Information Management System (TB GIMS):

- National Tuberculosis Genotyping Surveillance Coverage: United States, 2004–2012 (Table 13)
- National Tuberculosis Genotyping Surveillance Coverage: United States Affiliated Pacific Islands, 2004–2012 (Table 14)
- Genotyped Tuberculosis Cases with *Mycobacterium bovis* by Origin of Birth: United States, 2004–2012 (Table 15)
- Tuberculosis Risk Factors by Origin and Race/Ethnicity: United States, 2012 (Table 21)
- Epidemiologic Characteristics of Cases in GENType Clusters by Alert Levels Based on Log-likelihood Ratios (LLR): United States, 2010–2012 (Table 22)
- Tuberculosis Cases by Cluster Status: United States, 2010–2012 (Table 23)
- Tuberculosis Cases and Clusters by Cluster Size: United States, 2010–2012 (Table 24)
- Ten Most Frequently Reported GENTypes Among Genotyped Tuberculosis Cases: United States, 2010–2012 (Table 25)
- Five Most Frequently Reported GENTypes Among Genotyped Tuberculosis Cases: United States Affiliated Pacific Islands, 2010–2012 (Table 26)
- Tuberculosis Cases and Percentages by Reason Tuberculosis Therapy Stopped and Type of Move: United States, 2010 (Table 27)
- Deaths Prior to Tuberculosis Diagnosis or During Tuberculosis Therapy by Age Group: United States, 2010 (Table 28)
- Sputum Culture Conversion by Age Group: United States, 2010 (Table 29)
- Tuberculosis Cases and Percentages in Foreign-born Persons by Immigration Status at First Entry: Reporting Areas, 2012 (Table 36)
- Tuberculosis Risk Factors: Reporting Areas, 2012 (Table 40)
- Primary Reasons for Tuberculosis Evaluation: Reporting Areas, 2012 (Table 41)
- Tuberculosis Cases and Percentages by Residence in and Type of Correctional Facilities, Age > 15: Reporting Areas, 2012 (Table 42)
- Tuberculosis Diagnostic Tests by Type of Laboratory: Reporting Areas, 2012 (Table 52)
- Tuberculosis Genotyping Surveillance Coverage: Reporting Areas, 2012 (Table 53)
- County-based Tuberculosis Genotype Clusters Based on GENType: Reporting Areas, 2010–2012 (Table 54)
- Reason Therapy Was Extended Beyond 12 Months: Reporting Areas, 2010 (Table 58)

TB Case Definition

In 2009, the case definition was modified. TB cases are verified according to the following specified laboratory and clinical criteria.

Laboratory criteria for diagnosis

A case may be verified by the laboratory case definition with at least one of the following criteria: 1) isolation of *M. tuberculosis* complex from a clinical specimen, OR 2) demonstration of *M. tuberculosis* complex from a clinical specimen by nucleic acid amplification test (NAAT), OR 3) demonstration of acid-fast bacilli (AFB) in a clinical specimen when a culture has not been or cannot be obtained or is falsely negative or contaminated.

Clinical case criteria

A case may be verified by the clinical case definition in the presence of ALL of the following clinical criteria: 1) a positive tuberculin skin test (TST) result or positive interferon gamma release assay (IGRA) result for *M. tuberculosis*, AND 2) other signs and symptoms compatible with TB (e.g., abnormal chest radiograph, abnormal chest computerized tomography scan or other chest imaging study, or clinical evidence of current disease, AND 3) treatment with two or more anti-TB drugs, AND 4) a completed diagnostic evaluation.

Provider Diagnosis

Provider diagnosis is not a component of the case definition for TB as described in Appendix A. However,

¹Other U.S. jurisdictions include American Samoa, the Commonwealth of the Northern Mariana Islands, the Federated States of Micronesia, Guam, the Republic of the Marshall Islands, the Republic of Palau, and U.S. Virgin Islands.

when cases of TB are diagnosed but do not meet either the clinical or laboratory case definition, reporting areas have the option of verifying TB cases based on provider diagnosis as described in Appendix B. Through 2008, the RVCT did not collect information on IGRA results. If an IGRA was performed in lieu of the TST, then the RVCT would have indicated that the TST was not performed. Thus, culture- and smear-negative cases without a TST that are diagnosed by a positive IGRA result prior to 2008 were considered to have been confirmed by provider diagnosis. However, starting in 2009, positive results for an IGRA are included as part of the clinical case definition for TB confirmation. Anergic patients with a clinical presentation consistent with TB but without laboratory evidence of *M. tuberculosis* complex would also be an example of provider diagnosis and one which has not changed over time.

TB Case Verification Criteria Calculation

The software for TB surveillance developed by CDC includes a calculated variable for TB case verification called “Vercrit,” which was modified in 2009. The new variables, **Nucleic Acid Amplification Test Result, Interferon Gamma Release Assay (IGRA) for *Mycobacterium tuberculosis* at Diagnosis, and Initial Chest CT Scan or Other Chest Imaging Study** were added in the Vercrit calculation.

“Vercrit” is calculated by using the following criteria in hierarchical order:

1. Positive culture
2. Positive nucleic acid amplification test
3. Positive acid-fast bacilli test
4. Clinical case confirmation
5. Provider diagnosis

Changes in Reporting and Counting TB Cases

In 2009, the Recommendations for Reporting and Counting Tuberculosis Cases in Appendix B were modified. TB cases that are verified but not countable for morbidity statistics can now be reported to CDC as a measure of programmatic and case management burden. However, data on noncountable TB cases are incomplete and not included in this report.

The recommendations for counting TB cases among immigrants, refugees, and foreign visitors were revised based on the recommendations in the 2007 Technical Instructions for Tuberculosis Screening and Treatment for Panel Physicians.² Regardless of Panel Physician

²CDC. *Immigration Requirements: Technical Instructions for Tuberculosis Screening and Treatment, 2007*. Atlanta: CDC, Division of Global Migration and Quarantine, revised September 2007; http://www.cdc.gov/ncidod/dq/pdf/ti_tb_8_9_2007.pdf.

classification or citizenship status, immigrants and refugees examined after arriving in the United States and diagnosed with clinically active TB requiring anti-TB medications should be reported and counted by the locality of their current residence at the time of diagnosis. Foreign visitors diagnosed with TB, receiving anti-TB therapy, and planning to remain in the United States for 90 days or more should be reported and counted by the locality of current residence.

New and Expanded RVCT Variables

Data on demographic, clinical, laboratory, initial treatment, and treatment outcomes are collected through the RVCT’s three data collection reports:

1. Report of Verified Case of Tuberculosis: for all patients with a verified case of TB.
2. Initial Drug Susceptibility Report (Follow-Up Report 1): for all patients who had a culture that was positive for *M. tuberculosis* complex.
3. Case Completion Report (Follow-Up Report 2): for all patients who were alive when TB was diagnosed.

In 2009, the RVCT was modified and expanded to include 11 additional variables. Modifications to the RVCT accommodate the changing epidemiology of TB in terms of risk factors, new drug treatments, and enhanced laboratory capacity for diagnostic tests. The 2012 Report contains new tables reflecting the addition of these variables.

The instructions for completing the RVCT forms and the definitions for all data items are available at: CDC. Report of Verified Case of Tuberculosis (RVCT) Instruction Manual. Atlanta, GA: U.S. Department of Health and Human Services, CDC, 2009. <http://www.cdc.gov/tb/programs/rvct/InstructionManual.pdf>.

Tabulation and Presentation of TB Data

This report presents summary data for TB cases reported to CDC in 2012. TB cases are tabulated by year in which the reporting area verified that the patient had TB and included the patient in its official annual TB case count. Since 2004, the published report has reflected updated information on the numbers of cases of confirmed TB for each year from 1993 onward. Totals for the United States include data from the 50 states, the District of Columbia (DC), and New York City.

Trend data are presented in Tables 1 through 15. Age group tabulations are based on the patient’s age in the month and year the patient was reported to the health department as a suspected TB case. State or metro-

politan area data tabulations are based on the patient's residence at diagnosis of TB.

Rates

Rates are expressed as the number of cases reported each calendar year per 100,000 persons. Population denominators used in calculating TB rates were based on official census and midyear postcensal estimates from the U.S. Census Bureau. In Tables 1, 30, and 31, the U.S. total populations for 2000–2009 were taken from the U.S. Census Annual Estimates of the Resident Population for the United States, Regions, States, and Puerto Rico (April 1, 2000 to July 1, 2009); populations for 2010–2012 were taken from the U.S. Census Annual Estimates of the Resident Population for the United States, Regions, States, and Puerto Rico (April 1, 2010 to July 1, 2012).

In 2003, two modifications were made to the RVCT form: 1) entries for multiple race (two or more races reported for a person) were allowed, and 2) the previous category of “Asian/Pacific Islander” was divided into “Asian” and “Native Hawaiian or Other Pacific Islander.” To calculate rates in Table 2, denominators for 2000–2011 were obtained from the Annual Estimates of the Resident Population by Sex, Race, and Hispanic Origin for the United States (April 1, 2000 to July 1, 2009) and Annual Estimates of the Resident Population by Sex, Race, and Hispanic Origin for the United States (April 1, 2010 to July 1, 2012). The population source for nativity is the Current Population Survey and is used to calculate case rates for U.S. and foreign-born TB. This population source includes populations for the 50 states and D.C., those born abroad of U.S. parents, and those born in U.S. outlying areas (the U.S.-affiliated areas) as the U.S.-born population.

To calculate rates for Table 4, denominators were obtained from the Annual Estimates of the Resident Population by Sex and Five-Year Age Groups for the United States (April 1, 2000 to July 1, 2009) and Annual Estimates of the Resident Population for Selected Age Groups by Sex: (April 1, 2010 to July 1, 2012). Denominators for computing 2012 rates in Table 17 were obtained from U.S. Census Monthly Postcensal Resident Population, by single year of age, sex, race, and Hispanic origin. In 2004, the method for calculating the annual percentage change in the TB case rate was modified. Unrounded figures are applied to calculate the percentage change in the case rate.

In Table 5, the populations for U.S.-born and foreign-born persons for 1993 and 1994 were obtained from Quarterly Estimates of the United States Foreign-born

and Native Resident Populations: April 1, 1990–July 1, 1999. Denominators for computing the 1995–2012 rates were based on extrapolations from the U.S. Census Current Population Survey (July Supplement).

Mortality Data

Official TB mortality statistics for the United States are compiled by the National Center for Health Statistics (NCHS), CDC. The annual mortality rate is calculated as the number of deaths due to TB in that year, divided by the estimated population for the year, multiplied by 100,000 (Table 1). The number of deaths for 2010 was obtained from the NCHS, National Vital Statistics Report, Vol. 61, No. 4, May 8, 2013. The finalized numbers of deaths for 2011 and 2012 were not available at the time of this publication.

Drug Resistance

Drug-resistance patterns are displayed in separate tables with drug-resistance trend data by previous TB status and origin of birth. Isoniazid (INH) resistance and multidrug resistance (MDR) are shown in Tables 8 and 9, respectively.

Completion of Tuberculosis Therapy

Tables 10, 59, 60, and 61 present rates of completion of TB therapy (COT). Data collected by RVCT Follow Up Report-2 on date and reason therapy stopped (e.g., patient completed therapy) were used to calculate rates of COT. Cases were stratified by the indicated length of therapy, based on American Thoracic Society/CDC/Infectious Diseases Society of America treatment guidelines³ in effect during the period covered, and the patient's initial drug-susceptibility test results, age, and site of disease.

In Table 60, the first column shows the total number of cases reported during 2010. The remaining columns are grouped under three headings: therapy of 1 year or less indicated therapy, greater than 1 year indicated, and overall. Patients eligible to complete therapy within 1 year had to have been alive at diagnosis, and initiated therapy with at least one drug. Eligible patients did not have rifampin resistance, did not die during therapy, did not move out of country during treatment, and did not have meningeal TB, regardless of age. In addition, TB patients under the age of 15 were not eligible to complete therapy within 1 year if they had disseminated disease (defined as miliary tuberculosis and/or a positive tuberculosis blood culture). Patients with culture-negative disease, those with an unknown culture status,

³ CDC. Treatment of Tuberculosis, American Thoracic Society, CDC, and the Infectious Diseases Society of America. *MMWR* 2003;52(No.RR-11):1-77.

and those with culture-positive disease but unknown initial drug-susceptibility test results were included under the category of 1 year or less of therapy indicated.

In Table 60, each group under an indicated length of therapy has an initial column showing the number of cases in persons who were alive at diagnosis and prescribed an initial regimen of one or more drugs, and who did not die during therapy. This number was used as the denominator in COT rate calculations.

COT rates, shown as percentages, were only calculated for areas reporting reason therapy stopped for at least 90% of cases shown in the overall column. For the group with an indicated length of therapy of 1 year or less, rates are shown for both COT in 1 year or less (COT \leq 1 year) and for COT, regardless of duration (i.e., duration of therapy \leq 1 year, $>$ 1 year, or unknown). For COT \leq 1 year, the numerator included only those patients completing therapy in \leq 366 days (based on the dates therapy started and stopped). Patients with missing dates were classified as “treatment not completed” for this calculation.

Rates of COT, regardless of duration, were calculated by dividing the number of patients reported as having completed therapy by the number of total eligible patients. Patients with an outcome other than completed therapy (i.e., moved, lost, refused treatment, or other) were classified as “treatment not completed.” Patients with an unknown outcome were also classified as “treatment not completed.” For the remaining two groups of indicated therapy length ($>$ 1 year and overall), only rates of COT, regardless of duration, are presented. Table 10 provides rates for COT \leq 1 year and for COT, regardless of duration, only for the group with an indicated therapy of \leq 1 year. Table 59 presents rates of COT by ethnicity and non-Hispanic race and by state for those in whom therapy \leq 1 year was indicated.

Because streptomycin is no longer being used as part of the standard treatment for TB disease, streptomycin has been removed from the calculated variable for initial drug regimen. Consequently, a separate column for the treatment regimen of isoniazid, rifampin, pyrazinamide (IRZ), ethambutol, streptomycin (E/S) is no longer reported in Tables 10 and 49.

Site of TB Disease

Miliary disease is classified as both an extrapulmonary and a pulmonary form of TB (Tables 7, 38, and 39). In publications prior to 1997, miliary disease was classified as extrapulmonary TB unless pulmonary disease was reported as the major site of TB disease. Begin-

ning in 2009, miliary disease could not be classified as a site of TB disease because it is a clinical or radiologic finding and should be recorded under **Initial Chest Radiograph**, **Initial Chest CT Scan**, or **Other Chest Imaging Study**.

Reporting of HIV Status

Information on HIV status for persons with TB is shown in Tables 11 and 51; Table 11 additionally shows trend data for persons aged 25–44 years. The completeness of reporting on HIV status among persons with TB has significantly improved to 92% of TB cases tested among persons aged 25–44 years in 2012; however, this variable is still underreported among jurisdictions. Data on the HIV-infection status of persons with reported TB cases should be interpreted with caution. These data are not representative of all TB patients with HIV infection.

HIV testing is performed after a patient receives counseling and gives informed consent. TB patients who are tested anonymously may choose not to share the results of HIV testing with their health care provider. TB patients managed in the private sector may receive confidential HIV testing, but results may not be reported to the TB program in the health department. In addition, many factors may influence HIV testing of TB patients, including the extent to which testing is targeted or routinely offered to specific groups (e.g., 25- to 44-year-old males, injecting drug users, homeless persons), and the availability of and access to HIV testing services. These data may overrepresent or underrepresent the proportion of TB patients known to be HIV infected in a reporting area.

Primary Occupation for the Past Year

Table 48 now reflects the new 2009 RVCT variable, **Primary Occupation Within the Past Year**, which replaces the **Occupation Within Past 24 months of TB Diagnosis** in previous reports. Following the 2009 RVCT revision, “Multiple Occupation” was removed and the “Retired” and “Not Seeking Employment” categories were added.

Reason Therapy Stopped

Tables 12 and 57 report a new 2009 RVCT data entry option; these tables now include a patient’s adverse reaction to anti-TB drug therapy as an option for the reason therapy stopped. The 2009 RVCT revision removed the option of “Moved” as a valid response to the variable **Reason Therapy Stopped** and this option is not reported after 2009.

Metropolitan Statistical Areas

Tables 63 through 67 present data by metropolitan statistical areas (MSAs) with an estimated 2012 population of 500,000 or more. MSAs are defined by the federal Office of Management and Budget, and the definitions were based on the application of the 2010 OMB standards to 2010 Census and 2006-2010 American Community Survey data announced as of February 2013 (<http://www.whitehouse.gov/sites/default/files/omb/bulletins/b-13-01.pdf>).

The MSA definitions apply to all areas except the six New England states; for these states, the New England County Metropolitan Areas (NECMAs) are used. MSAs are named for a central city in the MSA or NECMA, may include several cities and counties, and may cross state boundaries. For example, the TB cases and case rates presented for the District of Columbia in Table 30 include only persons residing within the geographic boundaries of the District. However, the TB cases and case rates for the Washington, D.C., MSA (Table 63) include persons residing within the several counties in the metropolitan area, including counties in Maryland, Virginia, and West Virginia.

A city/MSA with incomplete or unavailable data was not included in the tables and some cities' or MSAs' total numbers may be underreported owing to missing information.

National Tuberculosis Genotyping Service (NTGS)
NTGS laboratories primarily use two genotyping methods: spoligotyping and MIRU–VNTR. Both methods require only a small amount of culture material, provide digital results, and are relatively quick. IS6110-restriction fragment length polymorphism (IS6110-RFLP) and retrospective 24-locus MIRU–VNTR for older isolates can be performed, if requested, and may help in further differentiating genotype clusters. All isolates are prepared for long-term storage at genotyping laboratories or CDC.

Tuberculosis Genotyping Information Management System (TB GIMS)

In March 2010, TB GIMS was launched by CDC as a secure Web-based system to support ongoing use of TB genotyping data in TB control activities. TB GIMS facilitates systematic data collection of TB genotyping results and integrates genotyping results with epidemiologic data collected by the National TB Surveillance System (NTSS) to form a national and centralized database. Primary users of TB GIMS include TB laboratories that submit isolates for genotyping, national CDC-contracted genotyping laboratories, state and local TB control programs, and CDC that apply this informa-

tion for TB control activities.

Genotyping results from the national genotyping laboratories or CDC are uploaded into TB GIMS as they become available. Line-listed data from the National TB Surveillance System are also uploaded into TB GIMS weekly. Once genotyping results have been linked to individual patient surveillance data in TB GIMS, the record is considered complete. Complete records are essential for most of the applications of TB genotyping, including all reports and maps as well as using the outbreak detection system to identify potential chains of transmission and outbreaks.

There have been 13 system updates adding new reports, data management functions, and other tools since TB GIMS was released in March 2010. As of June 2013, there were 446 local, state, and federal users of the system.

Genotype Clustering

A genotype cluster consists of two or more cases in a jurisdiction during a specified time period with *M. tuberculosis* isolates that share matching genotypes. The jurisdiction and time period used vary based on the specific application. Cases that are part of the same genotype cluster are likely to be related by TB transmission in some way; however, the cases may not be directly related (i.e., one case did not necessarily give TB to another case in the cluster) or recently related (i.e., both cases may have gotten TB from the same person, but the exposure may have happened years ago). Therefore, while we use genotype clustering to identify likely TB transmission, transmission must be confirmed using field data from contact investigations or other sources. In TB GIMS, clustering is defined as 2 or more cases with matching genotypes (spoligotype and 24-locus MIRU–VNTR) in a single county within a 3-year time period.

Mycobacterium bovis

Mycobacterium bovis can be defined on the basis of spoligotyping results; spoligotyping is a tool for differentiating *M. bovis* from *M. tuberculosis*. The spoligotyping-based definition requires either (1) the absence of spacers 3, 9, 16, and 39–43; the presence of at least 1 of the spacers 29–32; and the presence of at least 1 of the spacers 33–36; or (2) the absence of spacers 3, 9, 16, and 39–43 and 2 copies of the repeated sequence at MIRU locus 24.