Epidemiology of Pediatric Tuberculosis in the United States, 1993–2012

Slide 1

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Slide 2 - Pediatric Tuberculosis Background

Tuberculosis (TB) is a reportable condition in all United States jurisdictions, and TB cases are reported to CDC in a standard format by public health authorities throughout the United States. These reports are summarized for pediatric cases in this slide set, for the years 1993 through 2012.

Pediatric TB is defined as TB disease in a person < 15 years old. The age group of "pediatric TB" is consistent with the convention used by the Division of HIV/AIDS Prevention, National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention (NCHHSTP), Centers for Disease Control and Prevention (CDC).

Pediatric TB is a public health problem of special significance. When children have TB disease, it indicates recent transmission (because they are young and the amount of time they could have been infected is limited) and usually primary disease from infection within the past 3–12 months. In comparison, adult TB disease often reflects reactivation of remotely acquired infection. In 2012, there were 9,945 cases of TB reported among all age groups, 486 (4.9%) were pediatric. There were 260 (2.6%) cases among children 0 – 4 and 226 (2.3%) cases among children 5 – 14.

Slide 3 - 2009 TB Case Definition and Verification

Reports of TB are counted according to a set of criteria (the "case definition") which is specific to the United States. Only incident cases that are diagnosed in the United States are included, and cases are verified by three levels of certainty, depending on the types of information that are available to healthcare practitioners and public health authorities. The verification of cases is an interactive process between healthcare practitioners and public health authorities and between public health authorities and CDC.

The verification of cases is especially important when considering the epidemiology of TB in children because a smaller fraction of cases among this age group are confirmed by bacteriology. Therefore, the statistics for children are more sensitive to changes in medical practice and notification than they are for adults.

Slide 4 - TB Cases, All Ages, by Age Group, 1993–2012

The number of TB cases in the United States has been decreasing for each age grouping. The relative changes are less apparent for the two younger age groups because the number of cases is smaller.

Slide 5 - TB Case Rates, All Ages, by Age Group, 1993–2012

When the TB case rates are shown on a logarithmic scale, the relative trends can be compared by inspection. Straight lines with a negative (i.e., downward) slope demonstrate a constant decline (i.e., exponential decay or rate of decrease). The pattern for the overall United States (white line), 1994–2000, is a good example of this. After 2000, the decline for the overall United States slowed. Lines that track in parallel show a stable rate ratio.

In this figure, the decline of the pediatric TB case rate (yellow line) is very similar to the rate for the overall United States (white line), with divergence in 2005–2006.

Slide 6 - Percent of Pediatric TB Cases by Age Group, 1993–2012

The pediatric age group (< 15) can be divided into four groups that reflect age-dependent differences in TB pathophysiology that have been noted historically:

- Age < 1: Infancy. Cases in this age group represent the most recent transmission and also are slightly more likely to be the severe forms of disease that were uniformly fatal before the discovery of chemotherapy.
- Age 1–4: Toddler/preschool. In this transitional age group, primary pulmonary TB is the most common form, and self-resolution of recent infection is a greater possibility.
- Age 5–9: School age. In this age group, primary pulmonary TB is the expected form of disease, but rare instances of contagious adult form/reactivation disease are reported.
- Age 10–14: Early adolescence. Another transitional period, where disease patterns more similar to adult forms become more prevalent.

Slide 7 - Pediatric TB Cases by Age Group, 1993–2012

Overall, the number of TB cases in all pediatric age groups has decreased, 1993–2012.

Slide 8 - TB Case Rates by Pediatric Age Groups, 1993–2012

The population-adjusted rates have been consistently greatest for the toddler/preschool age group, followed by the infant (<1 year old) group. Since 2006, infants have become the highest rate group. The logarithmic view of the case rates shows that the trend of decreasing in case rates varied from year to year but was similar overall among the groups.

Slide 9 - Pediatric TB Cases by Race/Ethnicity, 1993–2012

By the standard categories of race and ethnicity, the greatest number of cases since 1998 has been among Hispanic children.

Slide 10 - Pediatric TB Case Rates by Race/Ethnicity, 1993–2012

A very different picture emerges when the case counts are population adjusted to annual rates. The rates among all groups except white, non-Hispanic are similar, and the trends (i.e., slopes of the trend lines) for decreasing rates also are similar.

Rates are not shown for American Indian/Alaska Native children because the small case counts and small denominators give an unstable trend line.

Slide 11 - Pediatric TB Case Rates by Age Groups U.S.-born, 1994–2012

Important patterns of rate trends are shown by the comparison of the age groups separated into U.S.-born and foreign-born.

1. Within the two sets of age groups, when grouped by origin, the relative rates among ages are similar. For example, the early adolescence group (green lines) has the lowest rates for both U.S.-born and foreign-born.
2. The decline in case rates is similar among all the groups. That is, the lines are approximately parallel, and no consistent pattern of divergence is noted.

Slide 12 - Pediatric TB Case Rates by Age Groups Foreign-born, 1994–2012

For any specific age group, the difference in rates between U.S.-born and foreign-born is an order of magnitude. That is, the incidence rate is 10 times greater for foreign-born children in any age group. Some of the trend lines are erratic because of small numbers of cases and small denominators.

Slide 13 - Number and Percent of Pediatric TB Cases by U.S. and Foreign Birth, 1993–2012

In contrast to overall U.S. TB cases, less than half of pediatric cases are among foreign-born children, and the fraction has been fairly stable (23 - 29%) since 1993. Identifying U.S.-born children of foreign-born parents has only been possible since 2009 and is a subject of current studies.

Slide 14 - Number of Pediatric TB Cases with Foreign Birth by Birth Country*, by 4-Year Intervals, 1995–2012

For comparison, the counts from consecutive 6-year intervals are compared. Mexico has remained the most common country of origin for foreign-born children who have TB reported in the United States. The Philippines and Somalia have remained near the top of the list, and Ethiopia has increased in prominence. In comparison, the top countries of origin for all foreign-born persons during this time interval are Mexico, Philippines, Vietnam, India, China, Haiti and Republic of Korea.

Slide 15 - States with the Greatest Percent of the National Total Pediatric TB Cases, 1993–2012

The state with the greatest number of pediatric TB cases, 1993–2012, is California, with 23.9% of the cases during the interval.

Slide 16 - States with Greatest Numbers of Pediatric TB Cases, 1993–2012

Of these six states with the greatest numbers of pediatric cases, 1993–2012, California, Texas, Georgia, and Illinois exceed the national average fraction of cases that were in the pediatric age group: 6.2%. All six states matched or exceeded the national average (time-averaged) annual incidence rate for pediatric TB: 1.7 per 100,000 population.

Slide 17 - States with Greatest Percent of Pediatric TB cases, 1993–2012

However, the states with the most pediatric cases are not in the list of those with the greatest time-averaged percentage of their cases in the pediatric age group, which is headed by Alaska.

Slide 18 - States with Greatest Rate of Pediatric TB Cases, 1993–2012

Alaska also reports the greatest incidence rate of pediatric TB and is followed by the District of Columbia.

Slide 19 - Pediatric TB Cases by Case Verification Criterion*, 1993–2012

Half of pediatric TB cases are verified by the clinical case definition only, and a quarter of cases have bacteriological confirmation. The decision of a medical provider, which has the least specific verification criteria, accounts for a quarter of cases. Furthermore, these proportions are different for the pediatric age subgroups that were defined for earlier slides in this series.

Slide 20 - Pediatric TB Cases by Case Verification Criterion, 1993–2012

Provider diagnosis is common for all the pediatric age groups, but least common in the preadolescent group. Laboratory confirmation is most common for the infancy age group and least common for the school-age group.

Slide 21 - Pediatric TB Cases by Site of Disease, 1993–2012

TB most typically is a pulmonary disease, but the infection can manifest in any organ system. More than a quarter of pediatric cases involve an extrapulmonary site. Of these sites, disease in the lymphatic system is most common.

Slide 22 - Percent of Pediatric TB Cases by Site of Disease, 1993–2012

The fraction of pediatric TB cases with extrapulmonary involvement varies by the age subgroups. The preadolescent group is most likely to have extrapulmonary disease alone and at least an extrapulmonary site of disease, but the infant group is most likely to have combined pulmonary and extrapulmonary disease.

Slide 23 - Percent of Pediatric TB Cases with Any Extrapulmonary Involvement* by Age Group and Selected Sites of Disease, 1993–2012

When the extrapulmonary sites are compared by age group, disease in the lymphatic system is the most common form in all age groups. Disseminated disease, represented by miliary TB, and disease of the central nervous system (meningeal) are more common in the younger age groups, while bone and joint disease is most common in the preadolescent group.

Slide 24 - Percent of TB Cases in Children Age < 1 Year With Any Extrapulmonary Involvement*, 1993–2012

Foreign-born infants with extrapulmonary TB are more likely to have TB of the lymphatic system than U.S.-born children. U.S.-born children have a greater fraction of disease in the central nervous system (meningeal). The reasons for these differences are unknown.

Slide 25 - Percent of TB Cases in Children Age 1–4 Years With Any Extrapulmonary Involvement*, 1993–2012

Differences for the older groups are less pronounced. For the toddler/preschool group, disease of the central nervous system (meningeal) still is greater for U.S.-born children than for foreign-born children, but the difference is not as pronounced as it is for infants.

Slide 26 - Percent of TB Cases in Children Age 5–9 Years With Any Extrapulmonary Involvement*, 1993–2012

The patterns for extrapulmonary TB in school age children are similar to those of the pre-school age group, with a slightly greater percentage for lymphatic disease in both U.S.-born and foreign-born children.

Slide 27 - Percent of TB Cases in Children Age 10–14 Years With Any Extrapulmonary Involvement*, 1993–2012

Among children 10-14 years old, the fraction of cases that are extrapulmonary is still greater, with a persistent predominance in U.S.-born children. Lymphatic sites are diminished somewhat and all other categories account for the overall increase.

Slide 28 - Pediatric TB Cases by HIV Status, 1993–2011*

TB is an indicator disease for HIV infection, but the rate of testing in pediatric TB cases that is reported with surveillance results is low: 24%. The minimum estimate is 0.9%, that is, <1% of reported cases include the notice of a positive HIV test result. However, of the subset of cases that include an HIV test result, 3.7% have a positive result.

All TB patients, regardless of age, should be offered opt-out testing for HIV infection, in accordance with national guidelines.

Slide 29 - Number and Percent of Culture-confirmed Pediatric TB Cases with Drug Resistance, 1993–2011

Drug resistance results are possible only for TB cases that are confirmed by culture results and the rates that are shown here are based on those cases. That fraction of cases with resistance to at least one drug increased through 2005 then dropped through 2007 before increasing steeply in 2008, then dropping in 2009 through 2011, the most recent year with complete reporting. However, the fraction of cases with multidrug resistance, that is, resistance to at least isoniazid and rifampin, has remained small and stable (~2%).

Slide 30 - Pediatric TB Cases by Use of Directly Observed Therapy (DOT), 1993–2010

The American Thoracic Society, the American Academy of Pediatrics, and CDC strongly recommend directly observed therapy for all TB patients. DOT means that the ingestion of each dose of medication is observed by a trained worker, who should not be a family member. The fraction of pediatric cases with at least partial DOT reported has increased since 1993.

Slide 31 - Pediatric TB Cases by Treatment Outcome 1993–2010

The treatment-completion rate is high: 95.4% averaged over the years with final treatment data. Death is an uncommon reason for the end of treatment, although the death rate of 0.5% is greater than expected for a population in this age group. (For all age groups in the United States, death is the reason that therapy is stopped for approximately 7% of TB patients.)

Slide 32 - Deaths Occurring Among Pediatric TB Cases, by Age Group, 1993–2010

However, death associated with a report of TB is more common for the youngest age group, infants. For the statistics shown here, death at the time of diagnosis (i.e., before treatment is started) and during treatment are combined. Cause of death is not included in TB case reports.