

Online Supplement to the “Seattle & King County Annual Report on Tuberculosis 2008”

This supplement to the “Seattle & King County Annual Report on Tuberculosis 2008” contains additional programmatic and epidemiologic data from the Public Health – Seattle & King County TB Control Program.

We suggest that readers first review the main report titled “Seattle & King County Annual Report on Tuberculosis 2008” at:

www.kingcounty.gov/healthservices/health/communicable/TB

A report prepared by the Tuberculosis (TB) Control Program, Public Health - Seattle & King County

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Program activities

<< Core Activities >>

According to Washington state law (WAC 246-100-211), the local Health Department shall:

- Have primary responsibility for control of tuberculosis within the designated jurisdiction;
- Maintain a tuberculosis control program including:
 - (i) Prophylaxis,
 - (ii) Treatment,
 - (iii) Surveillance,
 - (iv) Case finding,
 - (v) Contact tracing, and
 - (vi) Other aspects of epidemiologic investigation;
- Maintain a tuberculosis register of all persons with tuberculosis, whether new or recurrent, within the local jurisdiction including information about:
 - (i) Identification of patient,
 - (ii) Clinical condition,
 - (iii) Epidemiology of disease,
 - (iv) Frequency of examinations;
- Impose isolation of a person with tuberculosis in an infectious stage if that person does not observe precautions to prevent the spread of the infection;
- Designate the place of isolation when imposed;
- Release the person from isolation when appropriate;
- Maintain and provide outpatient tuberculosis diagnostic and treatment services as necessary, including public health nursing services and physician consultation

The Public Health - Seattle & King County Tuberculosis (TB) Control Program maintains the following core TB control functions:

- *Assure completion of appropriate treatment for infectious TB cases*
- *Contact Investigations*
- *Evaluate high-risk immigrants and refugees*
- *Surveillance*
- *Medical Consultation and Training*
- *Triage people suspected to have TB disease*
- *Program Evaluation*

ASSURE COMPLETION OF APPROPRIATE TREATMENT FOR INFECTIOUS TB CASES

The highest priority of our TB control program is to assure the completion of appropriate treatment of persons with infectious TB disease. Treatment helps those who are suffering from TB and also stops transmission of the disease. Complete and appropriate treatment reduces the risk of disease relapse and prevents the development of drug resistant TB strains.

The TB Control Program achieves a high treatment completion rate (over 90%) by utilizing individualized case management and using a range of incentives and enablers that make it possible or easier for the TB patients to receive treatment by overcoming barriers such as transportation difficulties.

Medical providers are required, by Washington state law, to report every suspected case of TB to the health department of the patient's county of residence. Limited resources for directly observed therapy (DOT) in King County, where a health care worker or other designated person watches the TB patient swallow each dose of the prescribed drug, are prioritized for people who have pulmonary involvement. DOT provides an objective measure of assurance to the community that cases posing an imminent public health threat are indeed ingesting their treatment. DOT increases patient safety and capacity for patient education by ensuring frequent occurrence of interaction between program staff and patients.

Voluntary compliance with treatment is very successful. In rare instances, the TB Control Officer will issue directives to comply with evaluation and treatment. Violation of the directive is referred to the Prosecuting Attorney for consideration of court orders, including detention, if necessary.

CONTACT INVESTIGATIONS (MORE IN-DEPTH REPORTING ON P.21)

Persons with untreated tuberculosis disease of the lungs can spread TB bacteria to others. Approximately one in three household contacts of a person with infectious TB will acquire latent TB infection, in which living TB bacteria are present in an individual, but where the individual is asymptomatic and does not have clinically active disease. Finding newly infected contacts of persons with active TB disease is a very high priority, especially because people are at the highest risk of developing active TB disease in the first two years after acquiring latent TB infection. People with latent TB can be given treatment that greatly reduces their chances of developing active TB disease, by up to 92 percent.

The TB Control Program takes a concentric circle approach to contact investigations. The closest contacts of a person with infectious TB are evaluated first, usually with symptom reviews and TB skin tests. If a high rate of infection is found in that group, the next closest circle is investigated. Conversely, once transmission to a statistically sufficient number of intensely exposed contacts has been excluded, the investigation is terminated and more distant contacts are not addressed. Since TB skin tests can turn positive eight to ten weeks after the last exposure, contacts are re-tested as late as ten weeks after exposure to determine whether infection occurred. Contacts are usually offered treatment only if they are infected, but highly vulnerable close contacts, such as infants and persons with HIV infection, may receive treatment regardless of the skin test result.

In addition to the management of people with active TB and those suspected to have TB, the TB Control Program tested an average of five contacts per infectious TB case.

Expanded contact investigations were conducted at 12 sites with over 720 contacts identified and 573 tested.

EVALUATE HIGH-RISK IMMIGRANTS AND REFUGEES

The TB Control Program provides direct service to complete the TB evaluation for recent immigrants whose screening chest X-rays were abnormal and suggestive of possible active TB ("Class B" immigrants). Although cleared upon emigration based on negative sputum examination (AFB smear and, occasionally, culture), two to five percent of such evaluations yield a diagnosis of smear-negative, culture-positive pulmonary TB in the U.S. Furthermore the majority of Class B immigrants with abnormal chest radiographs has a high risk of developing TB in the future (Horsburgh 2004¹).

In addition, the TB Control Program works closely with the Public Health Seattle & King County Refugee Health Program to evaluate all refugees for latent TB infection. In 2008, 357 home visits were made to 1145 refugees, including 1124 encounters for the reading of TB skin tests. Of these, 29% were skin test positive (induration size 10 millimeter or greater). Seven new active TB cases were discovered in 2008 through this screening process.

SURVEILLANCE

The TB Control Program as part of a national TB surveillance network, provides weekly reporting of active cases to state and national control programs. The program performs epidemiological analysis to track trends in local patterns of TB incidence, drug resistance, and other parameters. A report detailing epidemiologic TB data in King County is published annually (www.kingcounty.gov/healthservices/health/communicable/TB). Further, case counts are published in each edition of Epi-Log, a monthly epidemiological newsletter of Public Health - Seattle & King County.

In 2008, the TB Control Program used the Tuberculosis Information Management System (TIMS) database for case data reporting. TIMS was developed by the Centers for Disease Control and Prevention (CDC) for standardized TB data collection and analysis. Case reports are first transmitted through a secure modem to the state and are then forwarded to the federal program by the state for accurate epidemiological assessments. In addition, the TB Control Program uses several local databases for case and contact tracking.

MEDICAL CONSULTATION AND TRAINING

King County's TB Control Program serves as a resource for health care providers seeking:

- General information on TB screening, diagnosis, and treatment;

¹ Horsburgh CR. Priorities for the treatment of latent tuberculosis infection in the United States. *New England Journal of Medicine* (2004) 350(20): 2060-2067.

- Specialty consultation on diagnosis and management of persons who are exposed to TB, and who are diagnosed with latent TB infection or TB disease; and
- Lectures and in-services for physicians-in-training and community-based health care providers.

Additionally, the TB Control Program collaborates with local graduate and post-graduate educational programs to work on projects related to TB program activities.

TRIAGE PEOPLE SUSPECTED TO HAVE TB DISEASE

In King County, people suspected to have active TB are classified in two categories based upon intention to treat and to isolate.

a. High suspicion:

Based on clinical presentation, TB risk factors, radiographic findings and other clinical information, clinical specimens are collected and isolation and/or empirical TB treatment are initiated. Over 90% of individuals with "high suspicion" are confirmed to be active TB cases.

Approximately 150 persons with high suspicion were evaluated in 2008, of whom 121 had a diagnosis of active TB.

b. Low suspicion:

Based on clinical presentation, TB risk factors, radiographic findings and other clinical information, clinical specimens are collected but isolation and/or empirical TB treatment are NOT initiated. Approximately 5% of individuals with "low suspicion" are confirmed to be active TB cases. The majority of Class B immigrants/refugees evaluated through the TB Program are in this category. Approximately 360 patients were evaluated for low suspicion of TB disease in 2008, and 83% were Class B immigrants/refugees².

Clinical services were provided to 2,600 King County residents during 7,639 patient visits to the TB Clinic in 2008. Forty-six percent of patients who visited the clinic were uninsured.

PROGRAM EVALUATION

The TB Control Program's efforts are benchmarked to the Washington state TB objectives. These objectives include indicators related to case, contact and high-risk populations and are assessed during a quarterly program cohort review. These targets will continue to be followed and will be supplemented by specific indicators set forth by the National TB Indicator Project (NTIP) beginning in 2010. The national TB program objectives include a set of standardized indicators and calculations for measuring performance and progress

² Class B immigrants are defined as having a chest x-ray consistent with inactive TB. In contrast, Class A immigrants are considered to have active TB based on a chest x-ray and a positive acid fast bacillus smear and may not travel until no longer infectious.

Further details regarding the state objectives can be found at:
<http://www.doh.wa.gov/cfh/TB/07TBManual.htm>

Further information regarding NTIP is available at: [CDC | TB | Fact Sheets | NTIP](#)

TABLE 1. WASHINGTON STATE TB OBJECTIVES FOR 2010 AND WHETHER THOSE TARGETS WERE MET IN KING COUNTY IN 2007 (LATEST YEAR FOR WHICH COMPLETE DATA WAS AVAILABLE)

Indicator	WA Target	Seattle and King County (2007data)	Goal Met?
Completeness for key RVCT variables for all newly diagnosed cases of TB reported to CDC using TIMS	>95%	>95%	Yes
Cases completing TB treatment within 12 months	85%	91%	Yes
Cases completing treatment	100%	95%	No
HIV status reported	95%	96%	Yes
Drug susceptibility results reported for culture-positive cases	>95%	100%	Yes
TB incidence rate among American Indian/Native Alaskans	18.8/100,000	27.6/100,000	No
Contacts identified to smear positive cases	84%	93%	Yes
Contacts to smear positive cases evaluated for infection (WA definition)	59%	88%	Yes
Contacts who started on LTBI treatment completed regimen (WA definition)	53%	70%	Yes
Class B's appropriately evaluated within 60 days of arrival	80%	66%	No

<< Special Projects >>

The TB Control Program is involved in a number of partnerships, including programmatic, research and educational efforts. The program disseminates summary data periodically through the website and other publications.

Community Partnerships

Community partners provide important collaborations with the TB Control Program. As an example, a community TB coalition created during the homeless TB outbreak meets on a quarterly basis. Issues discussed at the coalition meetings include re-evaluation of environmental factors that influence the transmission of TB in homeless shelters and ongoing items related to contact follow-up and screenings. Partnerships with Public Health Seattle & King County's HealthCare for the Homeless Network (HCHN), the REACH project, King County Jail Health, Harborview Medical Center, homeless service sites, and others have been enormously helpful and successful in our searches for homeless TB cases and contacts. These partnerships offer additional information and insight on behaviors and patterns that have resulted in refining the approach to control TB among the homeless.

The King County HCHN contracts with the TB Control Program to provide TB services including TB screening in shelters and directly observed therapy for homeless persons who have latent TB infection or active TB disease. The HCHN provides funding for a number of incentives and enablers, such as housing and food, which help homeless persons with TB disease complete their course of TB treatment while preventing transmission of TB to others, as well as providing staff support for case management activities.

Another area of collaboration uses advanced genotyping and enhances our ability to monitor TB transmission within King County and beyond. Partners include the TB laboratories of the CDC, Washington State Department of Health, Harborview Medical Center, Public Health – Seattle & King County, and Seattle Biomedical Research Institute (SBRI).

Tuberculosis Trials Consortium

The TB Control Program is one of 28 health departments and academic centers worldwide that comprise the TB Trials Consortium (TBTC). The CDC sponsors the TBTC to conduct large scale, multi-center trials of new diagnostic tools and regimens for the treatment of TB infection and disease. Ongoing studies include: Study 29, a phase II study of a regimen in which rifampin is substituted by rifapentine during intensive phase (first eight weeks) pulmonary TB treatment and Study 26, a phase II study of comparing a effectiveness of a three-month regimen of weekly rifapentine and isoniazid to that of a nine-month regimen of daily isoniazid (9INH) for latent TB infection.

Further details regarding the TBTC can be found at:

www.cdc.gov/nchstp/tb/tbtc/default.htm

Tuberculosis Epidemiologic Studies Consortium

The Tuberculosis Epidemiologic Studies Consortium (TBESC) consists of 17 sites across the U.S. and Canada. These sites collaborate on multiple special studies, thereby providing access to diverse populations at highest risk for TB and assuring that findings are generalizable across the U.S. and Canada. Currently, the Seattle TBESC site has completed recruitment for six projects/Task Orders (TOs) and is about to start recruitment for one project:

Completed studies:

TO 5 (Prevalence of latent TB among the Homeless)

TO6 (Investigating the resources in states with a low incidence of TB)

TO 8 (Multi-drug Resistant TB to better determine how MDR TB is acquired)

TO 9 (TB among the foreign-born to determine how to better prevent TB disease among foreign-born persons living in the U.S.)

TO 12 (Assessing the facilitators and barriers to LTBI testing and treatment in primary care medicine of foreign-born individuals)

TO13, phase 1 (Assessing the frequency of LTBI testing and treatment in King County by healthcare providers)

Ongoing study:

TO25 (Tuberculosis Mortality in the United States: Epidemiology and Prevention Opportunities)

Additional details regarding the TBESC can be found on

<http://www.cdc.gov/nchstp/tb/TBESC/TOC.htm>

TB Educational Course for Healthcare Professionals

In 2008, the Seattle & King County's TB Control Program collaborated with Francis J. Curry National TB Center in San Francisco to hold the 5th annual, two-day "TB Intensive" course for healthcare professionals who provide health care services to high-risk populations. Our partners for this activity include the American Lung Association of Washington, the Washington Thoracic Society, the University of Washington/Harborview Medical Center, the Washington State TB Advisory Council, the Firland Foundation, the Washington Department of Health.

EPI-LOG:

Working closely with the Communicable Disease Control, Epidemiology & Immunization Section of Public Health – Seattle & King County, sections of "TB update" were published in Epi-Log (November and December 2008 issues), a monthly publication distributed to health care providers in Seattle & King County. These updates discussed recent TB epidemiology, TB Control Program activities, and the role of health care providers in controlling TB in Seattle & King County.

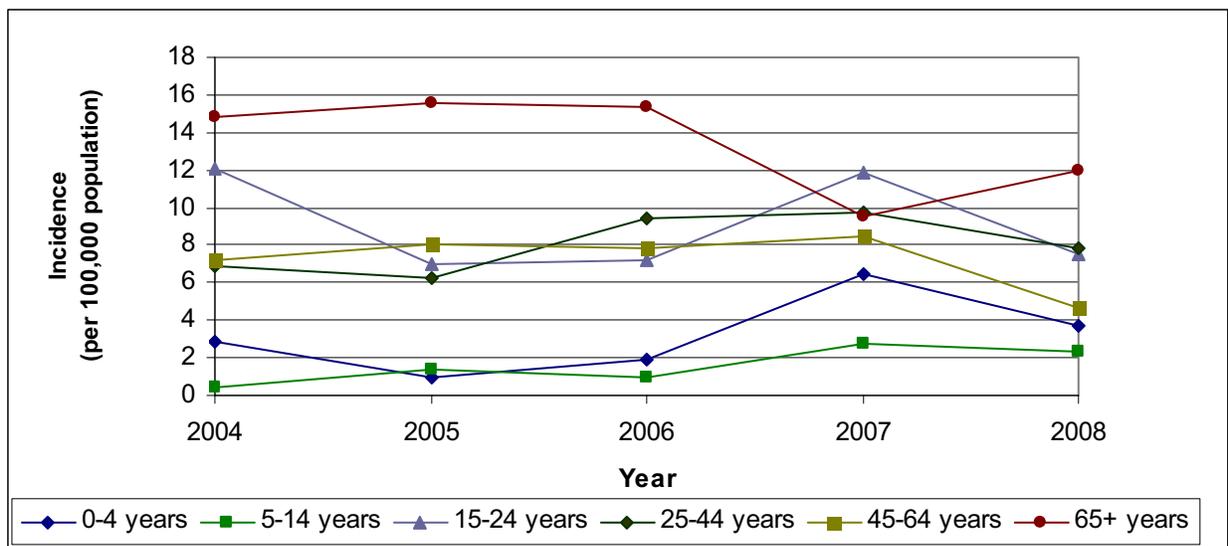
TB Program Epidemiological Profile Supplement

This epidemiological profile supplements existing data in the 2008 Annual TB Summary and provides additional information regarding patient demographics, risk factors, data trends, and recent outbreaks.

AGE

In 2008, the mean age of TB cases in King County was 41 years (median 37 years) with a range from 1 to 92 years. The highest incidence per 100,000 population was in the 65+ age group (11.6 per 100,000) (Figure 1).

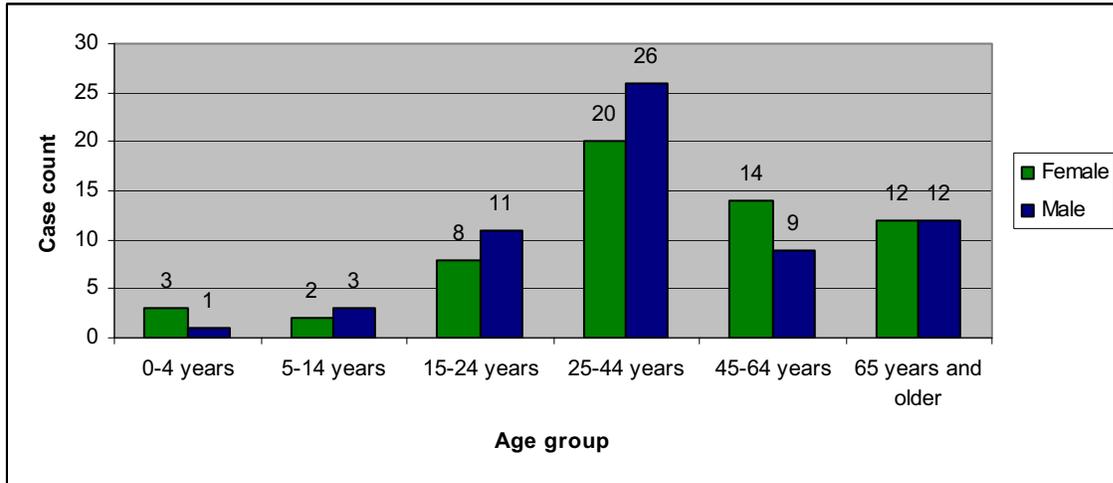
FIGURE 1. TB INCIDENCE (PER 100,000) BY AGE GROUP, 2008, KING COUNTY, WASHINGTON



Males and females, ages 25 to 44 years old had the highest number of cases of TB, (26 and 20 cases, respectively) (Figure 2).

More female than male cases of TB were reported in the 0-4 and 45-64 year old age groups. The number of cases reported in individuals 65 years of age and older was equally divided between males and females. All other age groups had more males than females with TB.

FIGURE 2. TB CASE COUNT BY GENDER AND AGE GROUP, 2008, KING COUNTY, WASHINGTON



COUNTRY OF ORIGIN

Region of birth from 2004-2008 among Foreign-Born TB Cases

As per the recent article by Cain et al 2008³, the relative yield of finding and treating latent TB infection is particularly high among individuals from most countries of sub-Saharan Africa and Southeast Asia. This section more closely examines foreign-born cases by region of birth from 2004-2008 (Table 2).

TABLE 2. COUNTRY OF ORIGIN AMONG FOREIGN-BORN TB CASES, 2004- 2008, KING COUNTY, WASHINGTON

Country/Year	2004	2005	2006	2007	2008	Total 2004-08
Vietnam	15	12	15	21	9	72
Ethiopia	13	9	12	14	12	60
Somalia	8	8	8	17	16	57
Philippines	11	13	20	3	9	56
Mexico	5	9	12	7	14	47
India	5	8	12	11	6	42
China	4	6	9	5	4	28
Kenya	1	1	1	3	6	12
Other countries	35	29	27	41	23	155
Total foreign-born cases	97	95	116	122	99	529

Southeast Asia

During the five year time period 2004-8, 156 King County residents were diagnosed with active TB who were born in Southeast Asia, representing 29% of the foreign- born TB cases and 23% of all TB cases in King County. Countries within this region include Vietnam (72 cases), the Philippines (56 cases), Cambodia (14 cases), and Laos (7 cases). Cases originating from Southeast Asia during this five-year period had a mean and median age of 50 years (range: 2 to 94 years). 56% were male, and 2% were known to be co-infected with HIV. Estimates of TB incidence from countries in Southeast Asia range from 103 cases per 100,000 in Malaysia to 500 cases per 100,000 in Cambodia with a median of 172 cases per 100,000 individuals⁴.

In King County, 71% of cases from Southeast Asia resided in the United States for five or more years prior to diagnosis of TB. The remaining cases from Southeast Asia were split between people who resided in the U.S. for less than one year (12%) and one to four years (12%).

East Africa

From 2004 to 2008, 130 people with active TB originally were from East Africa, representing 24% of the foreign-born cases and 19% of all TB cases for this time period in King County. People from this region who had TB came from Ethiopia (60 cases), Somalia (57 cases), Kenya (12 cases), and Tanzania (1 case). Cases originating from

³ Cain et al (JAMA 2008; 300(4): 405-412

⁴ WHO 2007

East Africa during this five-year period had a mean age of 32 years (median: 28 years). 56% of cases were male, and six percent of cases with known HIV status were co-infected with HIV.

Of cases counted 2004 to 2008, at the time of diagnosis 25% lived in the U.S. for less than one year, 42% one to five years, and 31% for five years or more. In 2008, proportions were similar to what is typically observed in King County with 15% of cases residing in the U.S. for less than one year at TB diagnosis, 59% one to five years, and 24% for five years or more.

Other regions

From 2004 through 2008 245 people diagnosed with TB were born in countries outside of Southeast Asia and East Africa. "Other regions" represents 46% of foreign-born and 36% of all TB cases for this time period in King County. Highest burden countries within this region include Mexico (47 cases), India (42 cases), and China (28 cases). Cases originating from the regions outside of Southeast Asia and East Africa had a mean age of 46 years (median: 39 years). 60% of these cases were male, and 7% of those with known HIV status were co-infected with HIV.

Outbreak among Marshall Islanders: an Update

From February 2007 through early 2008, nineteen cases of tuberculosis (TB) were diagnosed among the Marshallese community in Washington. In contrast, from 1992-2006, no cases of TB were reported among Marshallese in the state. Thirteen of these were diagnosed in King County, with five new cases in the state in 2008.

Seven cases were identified in King County through an intensive contact investigation along with 161 close contacts. One hundred forty-three of 161 contacts were fully evaluated and a high proportion of contacts (59%) were diagnosed with latent TB infection. Seventy-six individuals began treatment for latent infection, over 75% of who completed therapy. These efforts ensured interruption of further TB transmission in King County. The last contact identified during this investigation completed treatment in December 2008. Two of the King County cases were identified as having moved to King County after the original TB case infectious periods.

TB AMONG THE HOMELESS

Characteristics of homeless people diagnosed with active TB in King County from 2002-2008 are shown in Table 3.

TABLE 3. CHARACTERISTICS OF HOMELESS PEOPLE DIAGNOSED WITH TB BY COUNT DATE

Year		2002 (n=29)	2003 (n=35)	2004 (n=25)	2005 (n=25)	2006 (n=22)	2007 (n=15)	2008 (n=13)
		n(%)						
Gender								
	Male	25 (86)	28 (80)	22 (88)	23 (92)	21 (95)	11 (73)	13 (100)
	Female	4 (14)	7 (20)	3 (12)	2 (8)	1 (5)	4 (27)	0 (0)
Age group								
	0-4	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
	5-14	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (7)	0 (0)
	15-24	0 (0)	2 (6)	7 (28)	1 (4)	0 (0)	0 (0)	1 (8)
	25-44	16 (55)	15 (43)	7 (28)	8 (32)	9 (41)	4 (27)	8 (62)
	45-64	13 (45)	16 (46)	10 (40)	15 (60)	13 (59)	10 (67)	3 (23)
	65+	0 (0)	2 (6)	1 (4)	1 (4)	0 (0)	0 (0)	1 (8)
Race								
	White	6 (21)	11 (31)	4 (16)	10 (40)	14 (64)	3 (20)	7 (54)
	Black	11 (38)	10 (29)	12 (48)	11 (44)	5 (23)	8 (53)	3 (23)
	Asian	0 (0)	0 (0)	1 (4)	1 (4)	0 (0)	1 (7)	0 (0)
	American Indian/Alaska Native	11 (38)	14 (40)	8 (32)	1 (4)	3 (14)	3 (20)	2 (15)
	Native Hawaiian/Pacific Islander	1 (3)	0 (0)	0 (0)	2 (8)	0 (0)	0 (0)	0 (0)
Ethnicity								
	Hispanic	3 (10)	4 (11)	1 (4)	5 (20)	6 (27)	2 (13)	7 (54)
Birthplace								
	US-born	24 (83)	32 (91)	13 (52)	14 (56)	14 (64)	12 (80)	5 (38)
	Foreign-born	5 (17)	3 (9)	12 (48)	11 (44)	8 (36)	3 (20)	8 (62)
HIV Positive		9 (31)	2 (6)	0 (0)	3 (12)	4 (18)	2 (13)	4 (31)

Note on TB outbreak among the homeless

In late 2002, a TB outbreak was detected among the homeless. Based on diagnosis date, a single strain was responsible for 17 (57%) of 30 cases among the homeless (Figure 4). In 2003, this outbreak strain was responsible for 26 (74%) of 35 cases (Figure 5). Since 2003, the TB Control Program, community healthcare providers, and various agencies that serve this population have made intensive efforts to control this outbreak. The number of homeless TB cases matching the outbreak strain dropped considerably since the outbreak (between nine and 11 cases yearly between 2004 and 2006, four cases in 2007, and three in 2008). However, in 2007, five non-homeless individuals presented with the same outbreak strain. Two had a history of homelessness, two were linked to each other and were migrant laborers and the fifth had no documented transient or homeless lifestyle.

Reactivation of TB disease caused by the outbreak strain is still taking place, as indicated by genotyping results (7% of culture positive cases in 2007, 3% of culture positive cases in 2008). It is uncertain whether remote or recent transmission is playing a larger role in the persistence of the outbreak strain among this population.

FIGURE 4. GENOTYPIC STRAINS OF TB AMONG HOMELESS PEOPLE, BY TREATMENT START DATE, 2002-2008, KING COUNTY, WASHINGTON

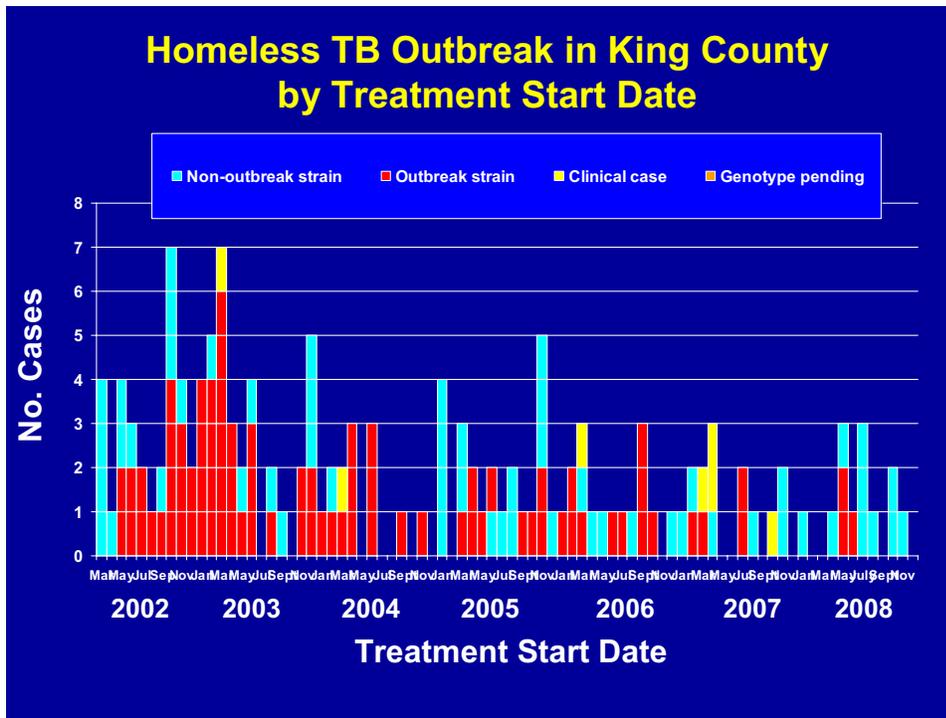
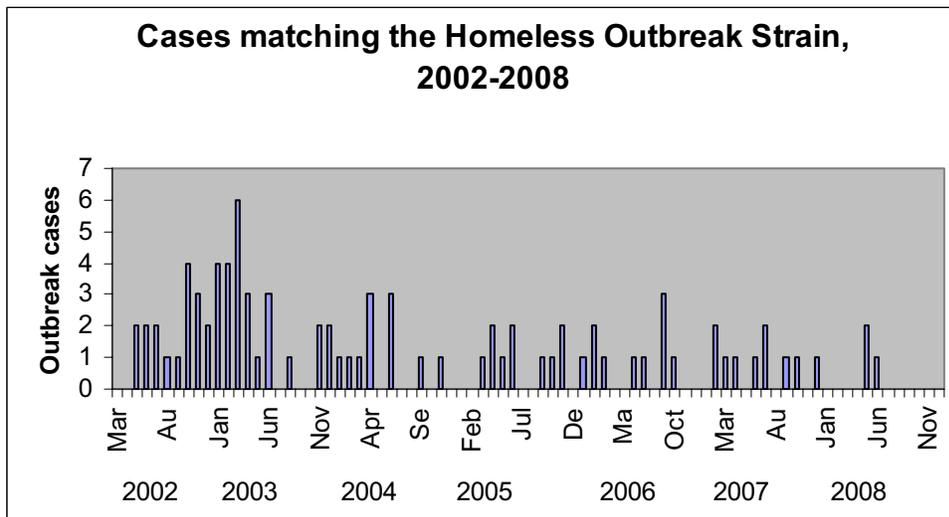


FIGURE 5. HOMELESS TB OUTBREAK STRAIN CASE COUNTS PER MONTH, BY TB TREATMENT START DATE, 2002-2008



In 2008, the TB Control Program conducted contact investigations at four homeless shelters. 144 individuals were identified as close contacts to infectious TB cases at these settings. 52 (36%) of these contacts were located and screened for both active and latent TB, of whom 8% were newly skin test positive.

TB DISEASE CHARACTERISTICS AND TREATMENT IN KING COUNTY

Disease characteristics

In 2008, 45% of King County TB cases were exclusively pulmonary, 34% were exclusively extrapulmonary, and 21% had both pulmonary and extrapulmonary components of their TB disease (Table 4).

TABLE 4. SITE OF TB DISEASE*, 2004-2008, KING COUNTY, WASHINGTON

Year	2004	2005	2006	2007	2008
	n(%)	n(%)	n(%)	n(%)	n(%)
Disease Site					
Pulmonary	96 (72)	83 (66)	100 (69)	126 (78)	80 (66)
Pleural	9 (7)	10 (8)	13 (9)	11 (7)	12 (10)
Lymphatic	28 (20)	31 (24)	32 (22)	44 (27)	27 (22)
Bone and/or Joint	3 (2)	5 (4)	8 (6)	10 (6)	7 (6)
Genitourinary	1 (1)	2 (2)	2 (2)	3 (2)	2 (2)
Miliary	2 (1)	1 (1)	3 (2)	0	2 (2)
Meningeal	2 (1)	2 (2)	1 (1)	3 (2)	1 (<1)
Peritoneal	2 (2)	2 (2)	5 (4)	2 (1)	1 (<1)
Other	5 (4)	9 (7)	4 (3)	4 (2)	17 (14)

*Categories not mutually exclusive; one case may have multiple sites of disease.

Nationally, in 2007, 71% of cases were pulmonary 20% of cases were extrapulmonary, and 8% had both pulmonary and extrapulmonary components to their TB disease. Reasons for the differences between local and national data may include better ascertainment of extrapulmonary cases locally (both improved diagnosis and reporting) than in the U.S. as a whole, more complete and specific coding of all involved disease sites locally, and a higher proportion of cases among groups known to have increased rates of extrapulmonary TB (e.g., East African and South East Asian populations) in King County than the U.S. as a whole

Smear and culture results

Of the 121 cases reported in 2008, 102 (84%) were confirmed by the results of a positive *M.tuberculosis* culture (89% of pulmonary cases were confirmed by a positive culture). Nationally, 81% of all cases were diagnosed through a positive TB culture.

In 2008, 80 cases major site of disease was reported as pulmonary. Of those 49% were sputum acid-fast bacilli (AFB) smear-positive, and 89% had positive AFB cultures. Nationwide, in 2007, 46% of pulmonary cases were smear positive and 70% were culture positive.

TB treatment

More than 90% of the 2008 King County TB cases alive at the time of diagnosis received an initial regimen consisting of four-drug therapy. Four-drug therapy is the standard recommended by the Centers for Disease Control and Prevention (CDC), the American Thoracic Society (ATS) and the Infectious Disease Society of America

(IDSA),. Use of clinical judgment is also encouraged to limit the number and type of drugs initially prescribed given the patient’s liver function and other factors. Treating TB with a combination of drugs prevents the occurrence of drug resistance and facilitates curing the disease in a timely manner. Five cases (4%) died of non-TB related causes at, or prior to, diagnosis and received one day or less of TB medication.

People completing therapy

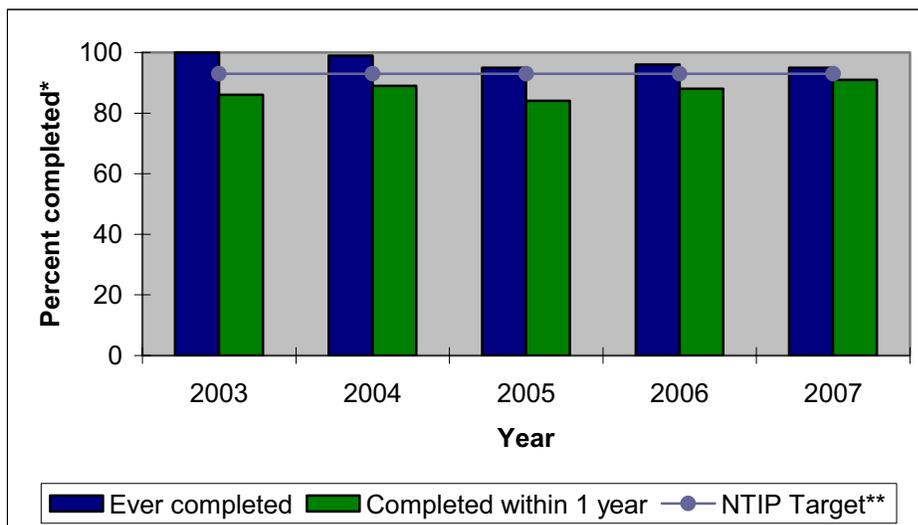
Overall treatment completion rates in King County remain at 95% or greater over the past five years (2008 data incomplete as some people require more than 12 months of treatment). King County exceeds The Healthy People 2010 target of 90%.

The most common reasons for not completing treatment are moving out of King County (5% of cases 2005-2006; efforts were made to ensure treatment continuation and completion after the person moved to a different jurisdiction) or death (6% percent of cases from 2005-2006). The percentage of cases ever completing treatment has remained steady over the past few years, and the percent completing within one year has fluctuated between 84% and 91% over the last five years (Figure 6).

Factors contributing to non-completion of treatment within one year include drug intolerance, non-adherence with TB treatment regimen, drug resistance, and TB affecting bone/joint and central nervous system that requires prolonged TB treatment (See Previous Section: Disease Characteristics). Furthermore, TB treatment guidelines (published by CDC/American Thoracic Society/Infectious Disease Society of America in 2003) recommend prolonging TB treatment for those with pulmonary cavities and delayed microbial response.

The most recent national data available is about people who initiated treatment in 2005: 83% of patients for whom one year or less of treatment was indicated completed therapy within one year.

FIGURE 6. COMPLETION OF TB TREATMENT, 2003-2007, KING COUNTY, WASHINGTON



*Per CDC National Tuberculosis Indicators Project (NTIP), this includes all TB patients, for whom 12 months of treatment or less is recommended, alive at diagnosis, initiated treatment with one or more drugs, and counted in the year of interest. Patients with any rifampin-resistant TB or meningeal TB, and children aged 14 or younger with disseminated TB are excluded. Disseminated TB is defined by having "miliary" checked in RVCT form as a major site of disease or a positive blood culture. Patients who died during treatment are excluded.

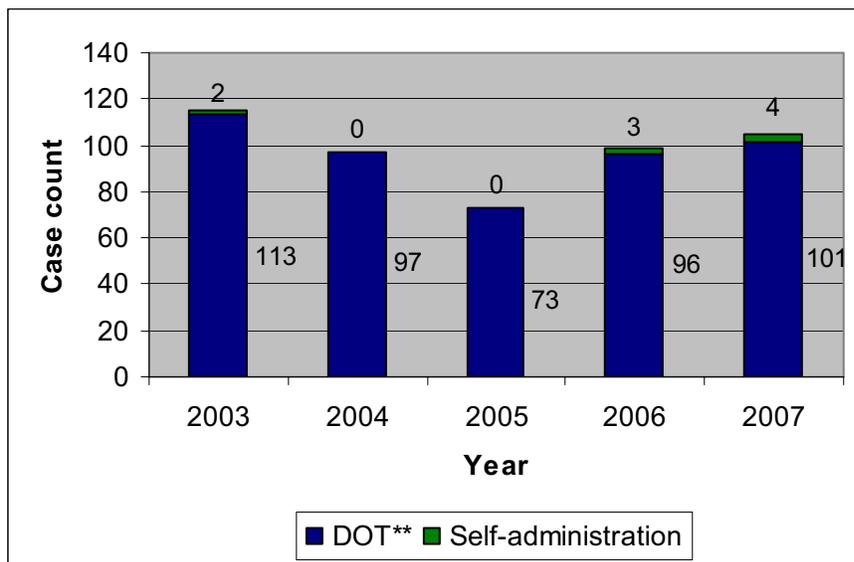
**NTIP 2015 goal is 93% completion within one year or less.

Mode of TB treatment

Among the cases from 2007 who already completed treatment (144 cases), 91% were treated with directly observed therapy (DOT) only or a combination of DOT and self-administered therapy. The proportion of cases treated with DOT has decreased slightly over the past few years as our program has prioritized pulmonary cases, given limited resources (Figures 7 and 8). Nationally, 88% of cases were on DOT or a combination of DOT and self-administered therapy (2005 data).

In 2007, people treated using DOT (information available on 133 people at time of this report), received an average of 29 weeks (median of 28 weeks).

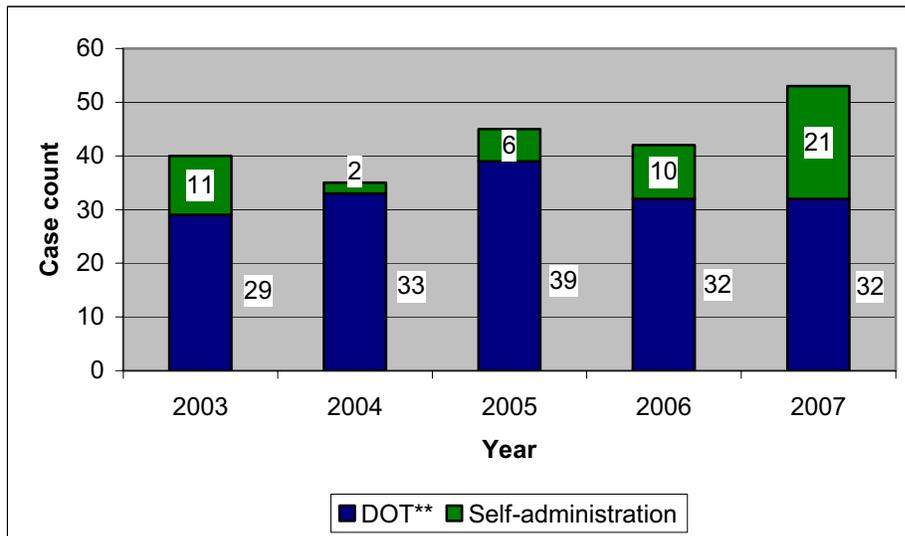
FIGURE 7. PULMONARY* TB CASES BY TREATMENT METHOD, 2003-2007, KING COUNTY, WASHINGTON



*Includes patients with only a pulmonary site of disease or pulmonary and extra-pulmonary sites of disease

**Includes patients treated with DOT only and a combination of DOT and self-administered therapy.

FIGURE 8. EXTRAPULMONARY* TB CASES BY TREATMENT METHOD, 2003-2007, KING COUNTY, WASHINGTON



*Includes patients with only an extra-pulmonary site of disease

**Includes patients treated with DOT only and a combination of DOT and self-administered therapy.

Genotyping

TB genotyping identifies links between TB culture isolates from different TB patients. If two TB patients have isolates with non-matching genotypes, they are unlikely to have been involved in the same chain of recent transmission. If isolates have matching genotypes, then genotyping, when combined with epidemiologic data, helps to distinguish TB patients who may be involved in the same chain of recent transmission, or whose disease is the result of reactivation of a remote TB infection.

Routine genotyping includes spoligotyping and mycobacterial interspersed repetitive unit analysis (MIRU). Upon request, restricted fragment length polymorphism (RFLP) analyses are also conducted to further differentiate clusters.

Genotyping of specimens has taken place at a CDC or CDC-affiliated laboratory since 2000. However, until the start of Universal Genotyping (UG) in 2004, only a partial sample of culture-positive specimens were submitted for genotyping. Since UG was implemented in 2004, all culture-positive specimens have been submitted to the CDC-affiliated laboratory in Berkeley, California for genotyping.

The following table summarizes the results of all specimens tested from King County (Table 5).

TABLE 5. GENOTYPE SUMMARY

Year	No. Culture-positive	No. of isolates*	No. clustered	Proportion clustering	No. of unique clusters	Mean isolates/cluster
2003		73	63	86%	26	2.4
2004	114	112	52	46%	19	2.7
2005	113	101	58	57%	27	2.1
2006	122	113	48	42%	30	1.6
2007	127	118	63	53%	34	1.9
2008	101	99	40	40%	26	1.5
2004-2008	577	543	271	50%	83	3.3

*Genotyping was not performed on all culture-positives

The clustering trends from this table should be interpreted with caution as the majority of samples sent in 2000-2003 were sent specifically due to linked epidemiological information and a heightened alert for outbreaks (hence specimens were, by definition, more likely to cluster).

Large clusters were identified and investigated further. Meetings were held to discuss each of the clustered cases, with additional social networking information used to supplement demographic and medical information obtained from the patient chart and from the Tuberculosis Information Management System (TIMS) database. We continue to monitor the trend of incidence of strains, as an increasing trend of a particular strain may represent undiscovered ongoing transmission.

TB CONTACT INVESTIGATIONS

The TB Control Program uses a concentric circle approach to conduct contact investigations; contacts are prioritized based on their duration/intensity of exposure and personal medical characteristics, and those at highest risk are tested first. Depending on the results from this closest circle of contacts, the investigation may be expanded to the 'second tier' contacts, and so on. Additional factors which determine the scope of contact investigations include: characteristics of the case (i.e., relative infectiousness and duration of "infectious period"), vulnerability and immunocompetence of the exposed population, and the environmental features of the setting where exposure occurred (ventilation, room size, etc.). The TB Control Program evaluates all contacts with a symptom review, a medical-risk assessment, and a skin test. If necessary, contacts are encouraged to obtain a chest x-ray and treatment if they are found to have latent TB infection or TB disease. In addition, contacts with latent TB infection are eligible to be enrolled in the TB Trials Consortium clinical research study (see online supplement for more information).

Following a large outbreak among the homeless in King County in 2002-2003, a section was formed consisting of an outbreak coordinator, epidemiologists and disease intervention specialists. The primary goals for this section are to conduct contact evaluations in congregate settings and provide assessment of the contact investigation process. This assessment is used to determine how investigations can be improved and whether to expand to the next concentric circle of contacts.

The coordinator and epidemiologists organize screenings, process and analyze exposure data and produce summary reports; disease intervention specialists interview index cases, locate contacts, and conduct skin tests for congregate setting TB screenings. Additionally, the team conducts environmental assessments to analyze possible transmission.

Prioritization of activities depends on case characteristics, cumulative exposure, exposure risk based on environmental characteristics, and available resources. This specialized section assists heavily-burdened nurse case managers who generally carry 15-25 cases at any given time. The section coordinates the development of procedures to ensure treatment for latent TB infection is successfully initiated and completed by infected contacts.

In 2008, 251 individuals were identified as close contacts to infectious TB cases at these settings. 214 (85%) of these contacts were located and screened for both active and latent TB.

Table 6 summarizes the congregate setting contact-investigation activities for 2008.

TABLE 6. CONGREGATE SETTING INVESTIGATION SUMMARY, 2008

Investigation	Contacts Identified	Prior Positive Skin Tests	Received a Skin Test	Skin Test Positive (% positive)±
Nursing/Medical facilities*	71	16	54	22 (41%)
Schools/Universities	128	3	95	6 (6%)
Worksite/Other Institution#	52	2	44	15 (34%)
Total	251	21	193	43 (22%)

±Excluding prior positive skin tests

*Excluding hospitals

Excluding homeless shelters and services

TB IN KING COUNTY: 10 YEAR SUMMARY

The 121 cases of active TB reported in King County in 2008 represents a 15% increase over the number of cases reported ten years prior in 1999 (105). The 2008 case rate (6.5 cases per 100,000 population) represented a 7% increase over the case rate in 1999 (6.1 cases per 100,000 population). This shows that while there was a slight increase in the cases per capita, the large part of the increase in case numbers over this ten year period is due to population growth.

Gender

TB case count and incidence (per 100,000 population) was consistently higher in males than in females in King County during the past 10 years. At the height of outbreak among the homeless in 2003, case count and incidence peaked in males, while the peak of case count and incidence for females peaked in 2002 (Tables 7 and 8).

TABLE 7. TB CASE COUNTS BY GENDER AND YEAR, 1999-2008, KING COUNTY, WASHINGTON

	Male	Female	Total
1999	58	47	105
2000	68	59	127
2001	84	55	139
2002	91	67	158
2003	103	52	155
2004	78	56	134
2005	78	47	125
2006	88	57	145
2007	99	62	161
2008	62	59	121

TABLE 8. TB INCIDENCE (PER 100,000 POPULATION) BY GENDER AND YEAR, KING COUNTY, WASHINGTON, 1999-2008

	Male	Female
1999	6.8	5.4
2000	7.9	6.8
2001	9.6	6.2
2002	10.3	7.5
2003	11.6	5.8
2004	8.8	6.2
2005	8.7	5.2
2006	9.6	6.2
2007	10.7	6.6
2008	6.6	6.2

Race and ethnicity

TB case rate (per 100,000 population) has fluctuated over the last 10 years. In most racial groups, however, case rate stayed mostly consistent in individuals who identify as White (Table 9). The case rate in American Indians/Alaska Natives peaked during the

outbreak among homeless people in 2002 and 2003, and in 2008 subsequently decreased to the lowest rate in the past eight years. Case rate in Asians was just over half of its 2001 level in 2008. The case rate among Blacks has shown an increase over the past ten years with a peak of 43.2 cases per 100,000 population in 2007. Over the past ten in the rate among Latinos has risen to 15.7 compared to the 8.9 per 100,000 seen in 1999.

TABLE 9. TB INCIDENCE (PER 100,000 POPULATION) BY RACE OR ETHNICITY AND YEAR, KING COUNTY, WASHINGTON, 1999-2008

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
American Indian/Alaska Native	*	*	29.7	69.5	86.6	63.2	17.1	16.8	27.6	11.1
Asian	*	*	29.4	32.5	33.0	24.9	25.8	33.6	29.5	15.9
Black	24.7	31.5	33.0	36.9	28.2	35.9	29.6	24.8	43.2	34.2
White	2.0	2.6	2.7	2.5	2.5	2.0	2.1	2.6	2.1	1.6
Native Hawaiian/Pacific Islander	*	*	*	*	*	*	*	*	*	--
Latino	8.9	13.6	12.5	12.7	15.5	8.2	10.0	17.0	18.6	15.7

*Population data not available

Age

Since 1999, TB case rates stayed consistent in most age groups, with slight year-to-year fluctuations in all age groups. Case rate in the 25-44 age group increased 12% from 1999 to 2008 (Table 10).

TABLE 10. TB INCIDENCE (CASES PER 100,000 POPULATION) BY AGE GROUP AND YEAR, KING COUNTY, WASHINGTON, 1999-2008*

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
15-24	7.7	7.6	9.1	11.1	8.4	12.1	7.0	7.2	11.9	7.5
25-44	6.9	8.8	9.3	11.1	9.4	6.9	6.2	9.4	9.7	7.8
45-64	6.0	8.0	7.9	8.3	10.3	7.2	8.1	7.8	8.4	4.5
65+	11.6	12.7	11.4	12.9	14.4	14.8	15.6	15.3	9.5	11.6

* Case counts for age groups 0-4 and 5-14 have been under 10 cases per year during the past ten years, and thus case rates in these groups do not meet the threshold for statistical stability and are not reported.

Age and place of birth

The age distribution of TB cases in King County from 1999-2008 differs significantly by place of birth (foreign-born or US-born) and mirrors the trends observed in other parts of the US and in the US as a whole (Figure 9). Sixty-one percent of foreign-born cases were under 45 years of age while only 46% of US-born cases were under 45 (Table 10). Foreign-born cases tend to be younger than US-born cases for two primary reasons. Firstly, foreign-born individuals are more likely than US-born individuals to be exposed to TB infection thereby increasing their likelihood of contracting latent TB infection. Secondly, US-born people born before the mid-20th century when TB was more prevalent in the US are more likely to have been exposed to TB than US-born individuals born in the latter part of the 20th century. Therefore US-born individuals with active TB tend to be older.

FIGURE 9. HISTOGRAM OF AGE AT REPORT OF TB BY PLACE OF BIRTH, KING COUNTY, WASHINGTON, 1999-2008

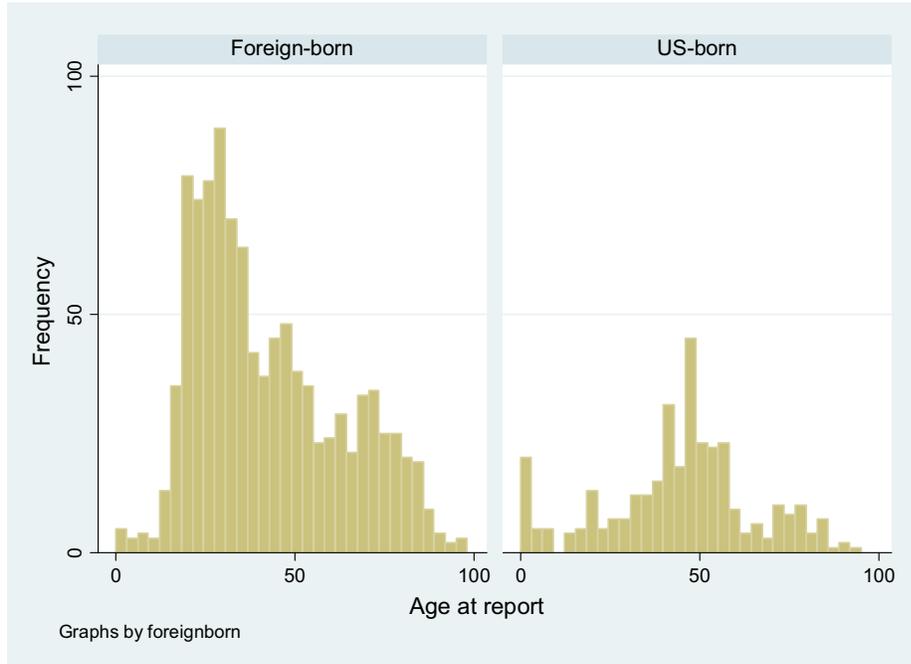


TABLE 10. TB CASES BY PLACE OF BIRTH AND AGE GROUP, KING COUNTY, WASHINGTON, 1999-2008.

	Foreign-born	US-born	Total
Under 5	5	22	27
5-14	21	11	32
15-24	190	24	214
25-44	409	97	506
45-64	213	131	344
65 and over	195	52	247
Total	1033	337	1370

Area of residence

TB incidence (per 100,000 population) has remained consistent over the past few years, with increases in 2002 and 2003 in Seattle due to the homeless outbreak, except for South King County. South King County has seen a significant upward trend in TB case rates from 1999 to 2008 (Table 11).

TABLE 11. TB CASES BY REGION OF RESIDENCE IN KING COUNTY AND YEAR, KING COUNTY, WASHINGTON, 1999-2008

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
East	2.0	3.8	3.9	3.9	3.8	2.1	3.5	4.1	4.7	2.4
North	2.9	4.3	1.4	6.3	3.5	4.2	2.8	3.4	3.4	0.0
Seattle	7.9	9.6	10.2	14.2	14.7	13.1	9.9	12.1	10.4	7.9
South	2.7	6.0	6.9	6.3	5.8	5.5	6.0	6.1	9.5	7.6

Income

The poverty threshold is the minimum level of income deemed necessary to achieve an adequate standard of living in a given country. In the United States, poverty thresholds vary by family size, and Alaska and Hawaii use a threshold different from that used by the 48 contiguous states and the District of Columbia.

For the past ten years, TB case rate (per 100,000 population) has consistently been highest in individuals with an income greater than or equal to 20% below Federal Poverty Level (FPL) and lowest in individuals with an income less than 5% below FPL (Table 12). Case rate (per 100,000 population) peaked in the lowest income group in 2002 and 2003 at the height of the homeless TB outbreak in King County.

TABLE 12. TB CASES BY POVERTY LEVEL AND YEAR, KING COUNTY, WASHINGTON, 1999-2008.*

FPL*/year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
>=20% below FPL	11.16	16.98	13.06	34.52	48.53	27.04	22.42	29.51	20.25	11.38
5% to 19% below FPL	5.12	7.08	8.51	9.02	7.98	8.34	7.26	8.28	10.27	7.83
<5% below FPL	1.82	4.10	3.08	3.37	2.40	2.06	2.79	2.59	3.00	1.77

FPL= Federal Poverty Level

*Categorization based on estimation of income level using geographical location of individuals at TB diagnosis.



Sources and notes for this report

This report primarily presents data for verified 2008 TB cases. However, where unavailable, summaries from previous years have been presented.

Since TB is a reportable disease, all 2008 cases are assumed to have been included in this report.

All case data came from the Tuberculosis Information Management System database (TIMS). This database was designed to allow counties and states to report TB surveillance data to the Centers for Disease Control and Prevention. TIMS uses data from the Report of Verified Case of Tuberculosis (RVCT) case report form that is submitted by all reporting areas.

EPI-LOG support provided by Communicable Disease Epidemiology & Immunization Section, Public Health - Seattle & King County.

All charts and tables are from TB Control Program, Public Health - Seattle & King County.

Denominator estimates are courtesy VistaPHw (Population Estimates: Population Estimates for Public Health Assessment, Washington state Department of Health, Vista Partnership, and Krupski Consulting)

Washington state data are courtesy of the Washington State Department of Health Infectious Disease and Reproductive Health Assessment Unit.

National data are from the surveillance reports at CDC's Division of TB Elimination website Reported Tuberculosis in the United States, 2007 (<http://www.cdc.gov/tb/surv/default.htm>) and from Trends in Tuberculosis-United States, 2008 (<http://www.cdc.gov/tb/>)

Some percentages may not sum to 100 percent due to rounding. Figure trends were generated in Microsoft Excel.

For more information about tuberculosis in King County:

<http://www.kingcounty.gov/healthservices/health/communicable/TB.aspx>

Appendix 1: Glossary

Acid-Fast Bacilli (AFB) smears: Smears performed on sputum or other non-respiratory specimens to detect the presence of *Mycobacterium*.

Bacille Calmette-Guerin (BCG): A vaccine for TB named after the French scientists Calmette and Guérin. BCG is not widely used in the United States, but it is often given to infants and small children in other countries where TB is common.

Cavity: A hole in the lung resulting from destruction of pulmonary tissue. TB patients with cavities on chest X-rays are generally more infectious because of high bacterial load.

Clinical Case(of TB): In the absence of laboratory confirmation of *M. tuberculosis* after a diagnostic process has been completed, persons must have all of the following criteria for clinical TB case:

- Evidence of TB infection based on a positive TB skin test

AND

- One of the following:
 - (1) signs and symptoms compatible with current TB disease, such as an abnormal, unstable (worsening or improving) chest radiograph, or
 - (2) clinical evidence of current disease (such as fever, night sweats, cough, weight loss, hemoptysis).

AND

- Current treatment with two-or more anti-TB medications.

Contact: An individual who has had some exposure to a source case. Contacts are often differentiated into 'close contacts,' that is, individuals who have shared the same air space with a person who has infectious TB disease for a prolonged time, or 'casual contacts,' those who did not have prolonged exposure.

Culture: Growth of bacteria in the laboratory, on either a liquid or solid medium, so that organisms can be identified based on species.

Directly Observed Therapy (DOT): A health care worker or other designated person who watches the TB patient swallow each dose of the prescribed drug.

DNA Genotyping: A laboratory approach that provides a description of the genetic makeup of a TB isolate.

Drug Susceptibility Testing: Tests done to determine which drugs will kill the bacteria that are causing the disease. Those bacteria killed by a particular drug are said to be susceptible to that drug, while those that grow in a drug's presence are said to be resistant to it.

Epidemiological (Epi) link: A known epi-link is defined as either: a) one of the patients naming the other as a contact during one of the patient's infectious period or b) the two patients being at the same place at the same time during one of the patient's infectious period.

Ethambutol (EMB): One of the four first-line oral drugs used for TB treatment.

Extrapulmonary TB: TB disease in any part of the body other than the lungs (for example, the kidney or lymph nodes).

Fingerprinting: Refers to TB genotyping using a specific type of RFLP analysis.

Foreign-born: Anyone born outside the United States; regardless of the location of their family's birth.

Genotyping: A laboratory approach used to determine if TB isolates are genetically identical.

Immunosuppression: Medical conditions that reduce the body's immune response and thus predispose a person to TB disease. Examples include HIV infection, diabetes, malnutrition and immunosuppressive therapy (such as steroids).

Incidence: The number of new cases of TB identified during a specified period of time; often expressed as a rate (per 100,000 individuals).

Index case: The first case identified.

Infectious: The stage of disease in which an individual transmits TB bacteria into the air.

Isoniazid (INH): One of the four first-line drugs used to treat TB, this drug is used either alone or in combination with other drugs as therapy for either TB disease or infection.

Latent TB Infection: Condition in which living TB bacteria are present in an individual, but do not produce clinically active disease. While the infected person usually has a positive tuberculin skin test, he/she does not have symptoms related to the infection, has a normal chest x-ray, and is not infectious. However, this individual remains at risk for developing TB disease.

Multi-Drug Resistant TB (MDR-TB): Drug resistance to both isoniazid (INH) and rifampin (RIF).

Mycobacterial interspersed repetitive unit (MIRU): A PCR-based genotyping assay performed on every isolate submitted for analysis.

Mycobacterium tuberculosis (M. tb, M. tuberculosis): The mycobacterium organism that causes TB.

Polymerase Chain Reaction (PCR): A technique that allows for identification of TB strain types. Two PCR-based techniques are currently in use, spoligotyping and MIRU analysis.

Pulmonary TB: TB that occurs in the lungs.

Purified Protein Derivative (PPD): A type of purified tuberculin preparation derived in the 1930's. The standard (Mantoux) skin test uses 5 tuberculin units of this preparation. The test is thus also known as a 'PPD,' or 'TST,' which stands for Tuberculin Skin Test.

Pyrazinamide (PZA): One of the four first-line oral drugs used for TB treatment.

Regimen: The treatment plan specifying which drugs, dosages, schedule and length of therapy to use for TB.

Resistance: The ability of some strains of bacteria to grow even in the presence of certain drugs which normally kill them.

Restriction Fragment Length Polymorphism (RFLP): A lab technique used to "fingerprint" strains of TB to track patterns of transmission. The technique is based on measuring the number and length of specific DNA fragments that are cut using specific enzymes.

Rifampin (RIF): One of the four first-line oral drugs used for TB treatment.

Screening: Evaluation for TB including skin testing of individuals or groups.

Spoligotyping: A genotyping technique based on spacer sequences found in a specified region of the TB bacteria's chromosome.

Source case: An infectious individual who has transmitted TB to other people.

Susceptible: Bacteria which can be killed by drugs used against them

Tuberculin Skin Test (TST): The test to see if someone has latent TB infection. Purified protein derivative (PPD) is injected under the skin on the lower part of your arm during a TB skin test. If you have latent TB infection, you will probably have a positive reaction to the tuberculin.
[see Purified Protein Derivative].

Tuberculosis Disease (TB): The disease that is caused by the mycobacterium *M. tuberculosis*. Diseased persons have met one of the case definition criteria, be it either a laboratory or clinical case definition (or both).

Appendix 2: TB Epidemiology Resources

Public Health - Seattle & King County: www.kingcounty.gov/healthservices/health.aspx

Public Health - Seattle & King County TB Control Program:
<http://www.kingcounty.gov/healthservices/health/communicable/TB.aspx>

Washington State Department of Health TB Services: <http://www.doh.wa.gov/cfh/tb/>

CDC Division of TB Elimination: <http://www.cdc.gov/nchstp/tb/>

TB Education and Training Resources: <http://www.findtbresources.org/scripts/index.cfm>

Francis J. Curry National Tuberculosis Center: www.nationaltbcenter.edu

WHO Stop TB Partnership: <http://stoptb.org/>
<http://www.who.int/tb/en/>