Global and U.S. Tuberculosis Epidemiology and Principles of Control

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Centers for Disease Control and Prevention

SAFER • HEALTHIER • PEOPLE

Outline

- **Global epidemiology**
- **U.S. epidemiology**
- **U.S. principles of control**
- **Global TB control strategy**

Global Importance of TB

Top 10 Global Causes of Death (2004)

World	Deaths in millions	% of deaths
Coronary heart disease	7.20	12.2
Stroke and other cerebrovascular diseases	5.71	9.7
Lower respiratory infections	4.18	7.1
Chronic obstructive pulmonary disease	3.02	5.1
Diarrhoeal diseases	2.16	3.7
HIV/AIDS	2.04	3.5
Tuberculosis	1.46	2.5
Trachea, bronchus, lung cancers	1.32	2.3
Road traffic accidents	1.27	2.2
Prematurity and low birth weight	1.18	2.0

Global TB Burden: 2009 WHO Estimates (1)

- **9.4 million new cases**
  - **Rate 137 per 100,000**
- **1.7 million deaths**
- **85% of cases are in Southeast Asia, Africa and Western Pacific**
- **11% of TB cases are HIV-infected**
 - **Africa accounts for 80% of HIV-infected cases**

Global TB Burden: 2009 WHO Estimates (2)

- **22 high-burden countries account for 81% of cases**

- **Five countries with highest incidence**
  - **India (2 million)**
  - **China (1.3 million)**
  - **South Africa (490 thousand)**
  - **Nigeria (460 thousand)**
  - **Indonesia (430 thousand)**

Estimated TB incidence rates, by country, 2009
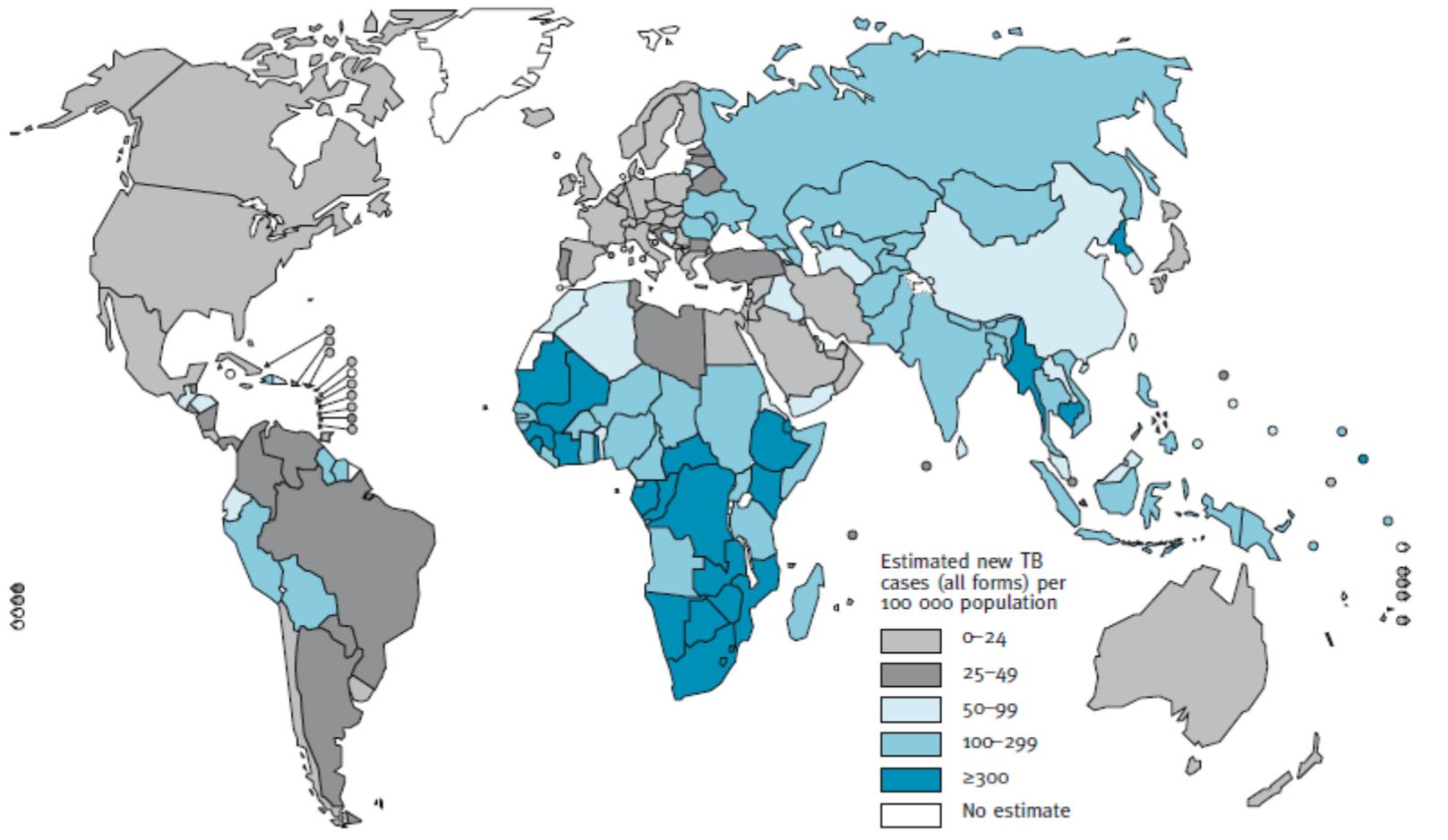
Estimated HIV prevalence in new TB cases, 2009

HIV prevalence
in new TB cases,
all ages (%)

0–4
5–19
20–49
≥50
No estimate
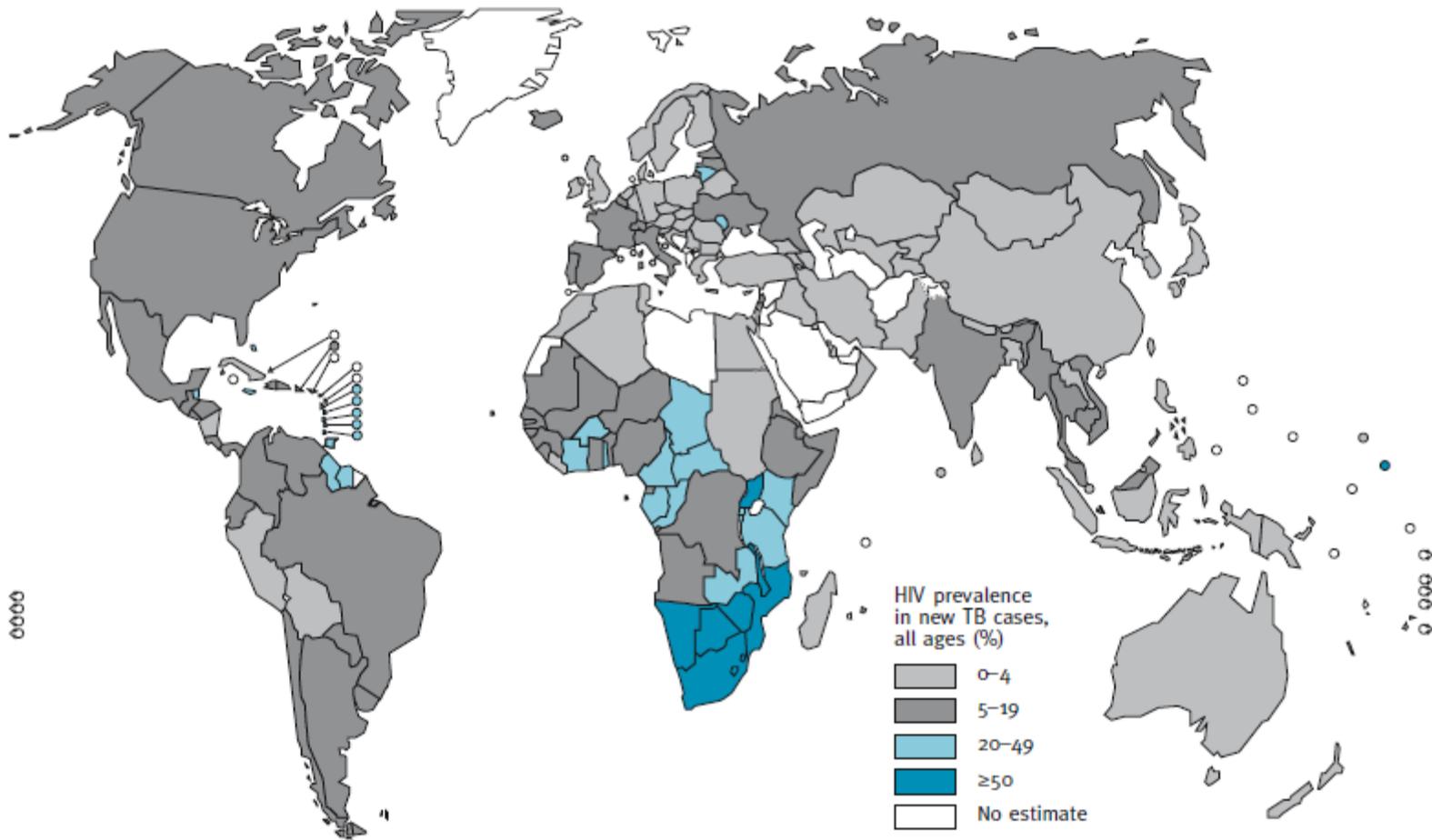
Global TB Trends

- **Incident cases slowly increasing**
- **Incidence rate is slowly decreasing (about 1%) per year**
  - **Population increasing faster than TB cases**
- **Mortality also decreasing (about 1/3 since 1990)**

Drug-Resistant TB

- **Multidrug-resistant (MDR) TB: resistant to isoniazid and rifampin**

- **Extensively drug-resistant (XDR) TB: MDR TB plus resistance to a fluoroquinolone and any second-line injectable (amikacin, kanamycin, capreomycin)**

Mechanisms of Drug-Resistant TB

- **Primary: transmission of drug resistant strain from one person to another**

- **Secondary (acquired): susceptible strain becomes resistant because of improper treatment**

Global MDR TB Estimates: 2008

- **New cases MDR TB: 440,000**
- **3.3% of all new cases**
- **50% of new MDR TB cases are in China and India**
- **Highest prevalence in Eastern Europe and Central Asia**
- **150,000 deaths from MDR TB**
- **Much higher in retreatment cases (acquired)**
  - **As high as 61% in some countries**

MAP 3 Distribution of proportion of MDR-TB among new TB cases, 1994–2009

Legend:
- 0–<3
- 3–<6
- 6–<12
- 12–<18
- ≥18
- No data available[a]
- Subnational data only
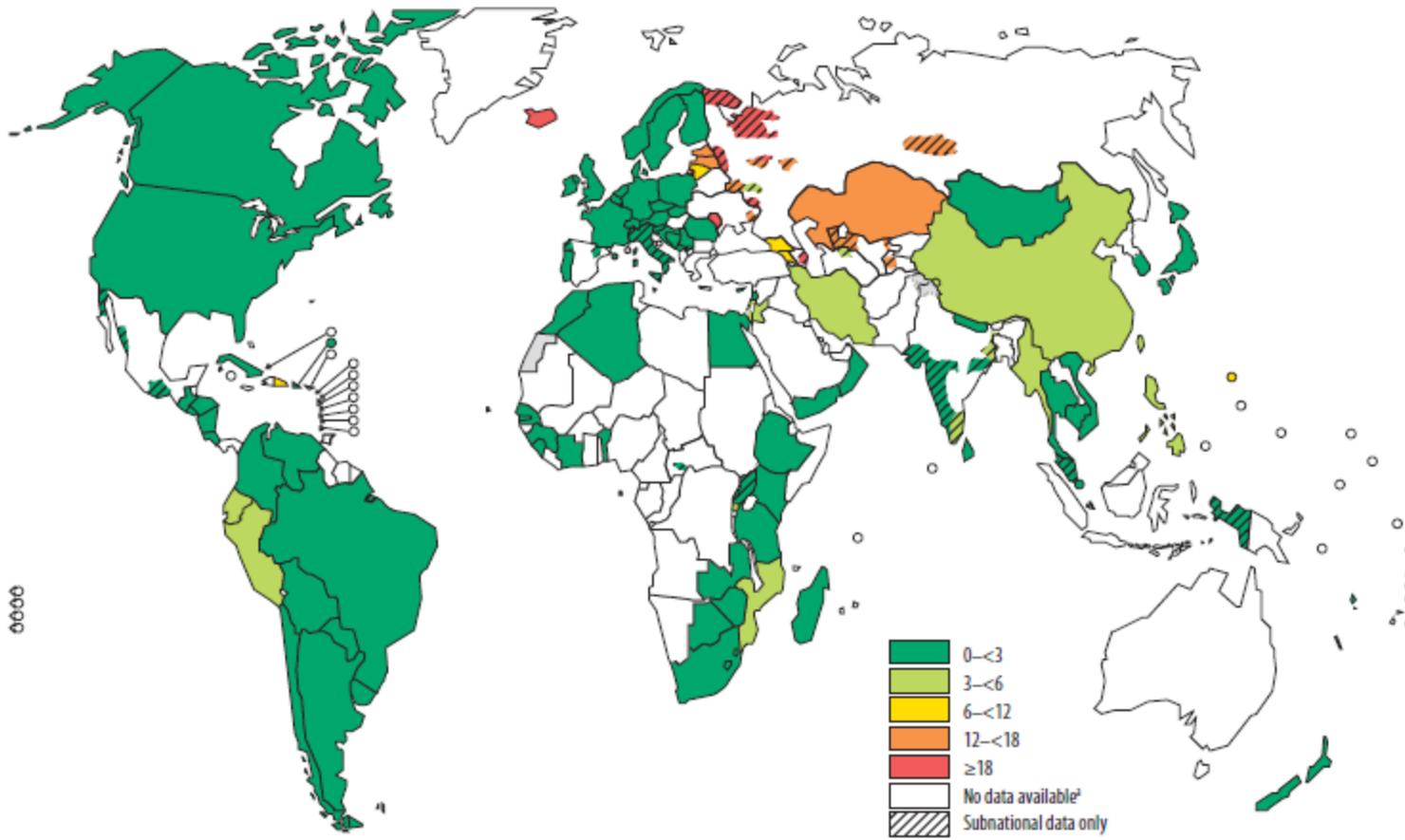
[a] Australia, Democratic Republic of the Congo, Fiji, Guam, New Caledonia, Solomon Islands and Qatar reported data on combined new and previously treated cases.

Global XDR TB Estimates: 2008

- 5.4% of MDR TB cases
- Has been reported in 69 countries
- Estimates based on very limited data

Global distribution of countries reporting at least one XDR-TB case by March 2011
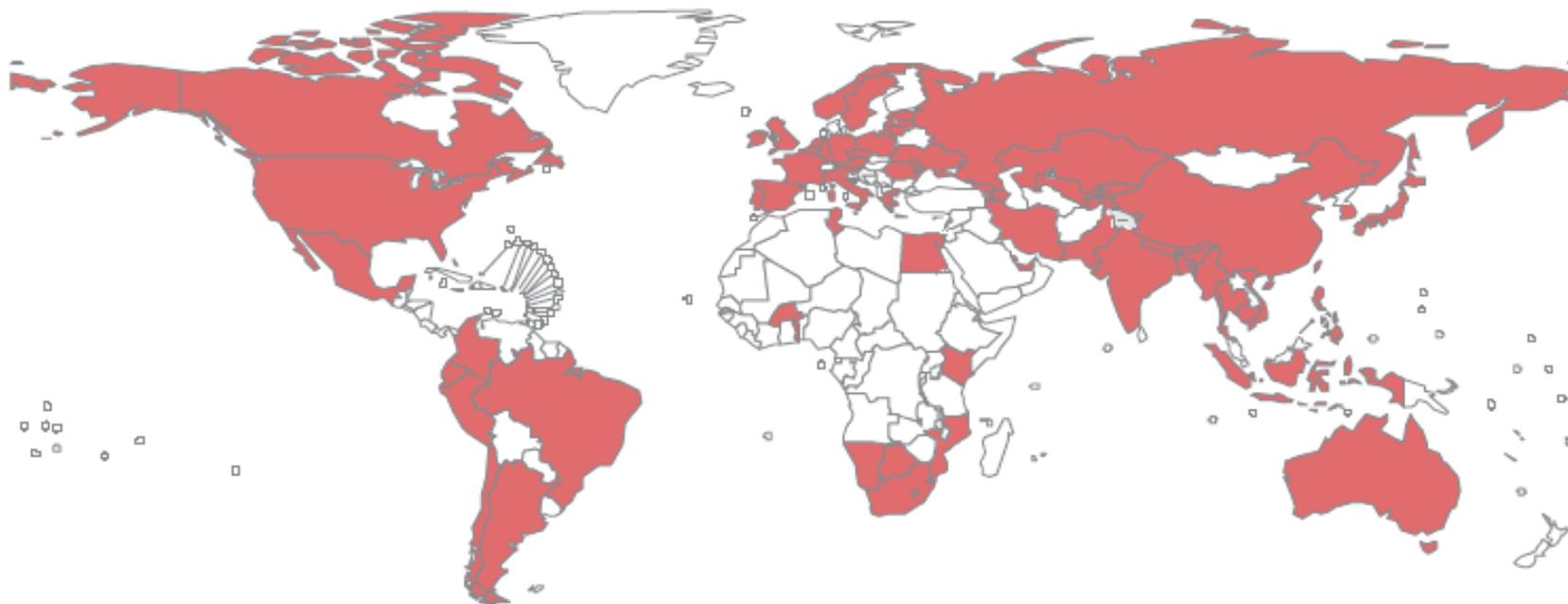
U.S. Epidemiology
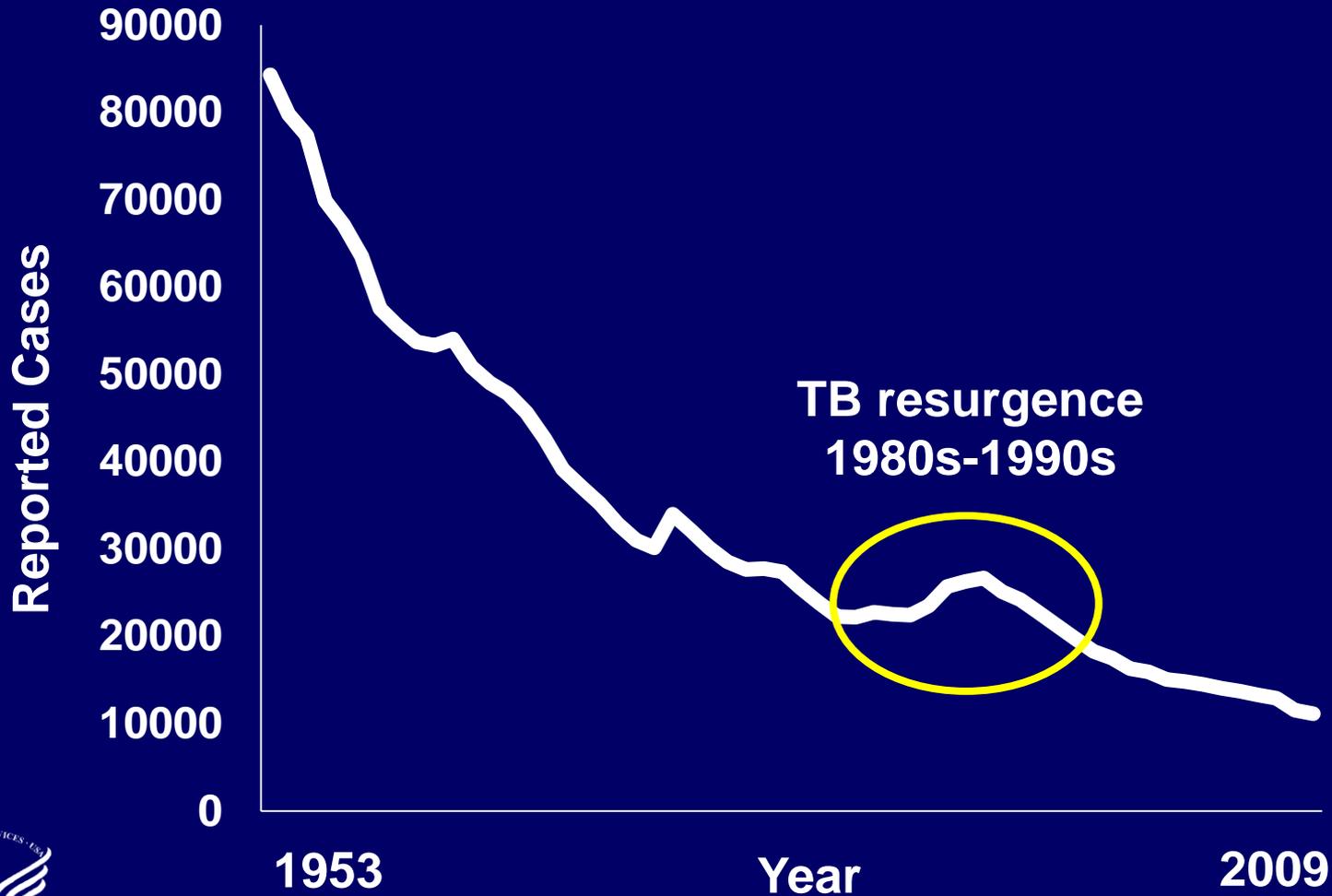
Reported TB Cases*
United States, 1982–2009

No. of Cases (y-axis: 10,000 to 28,000)

Year (x-axis: 1982 to 2009)

Resurgence

National response
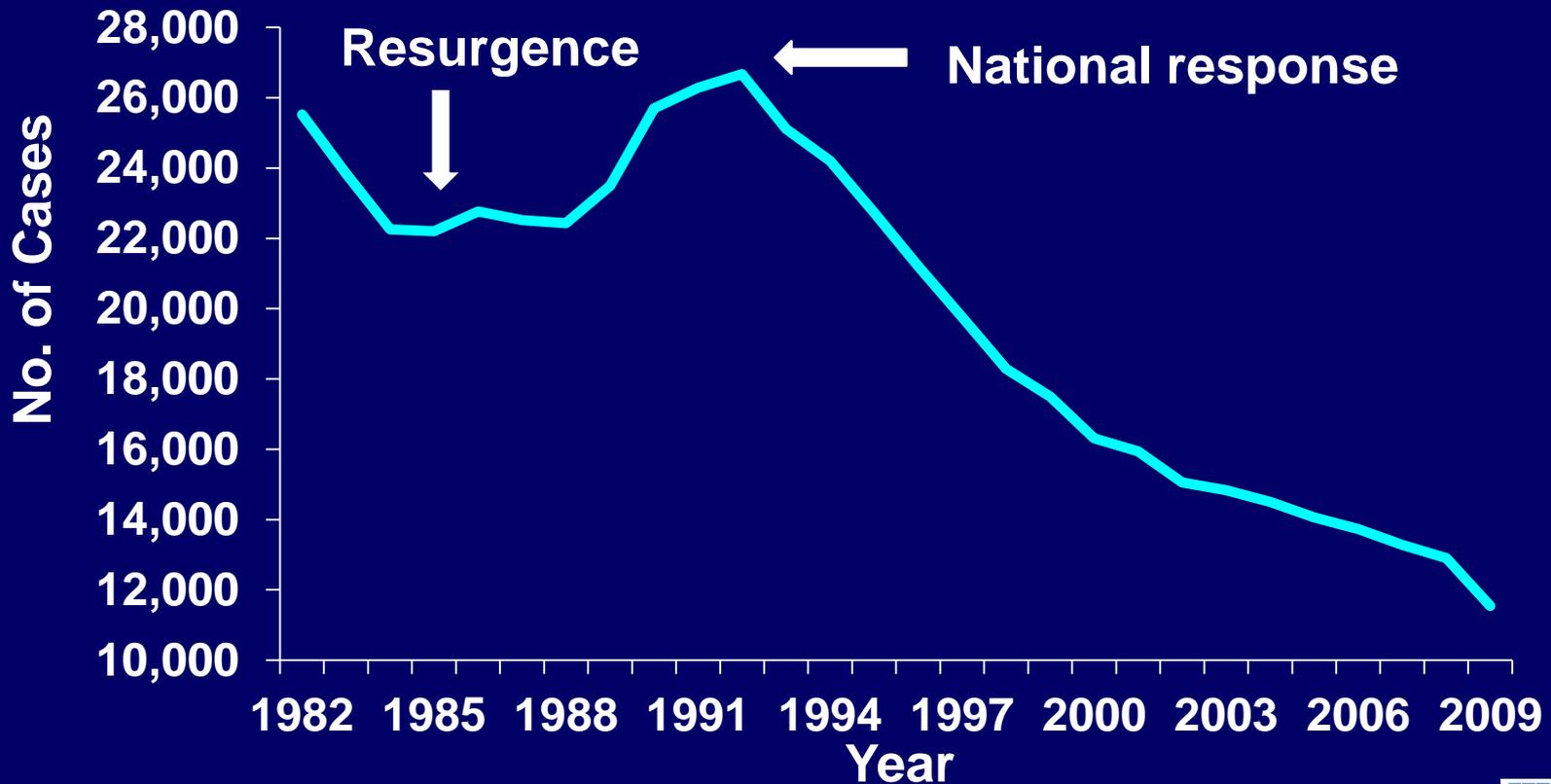
*Updated as of July 1, 2010.

Factors Associated with Resurgence of TB in 1980s-1990s

- **HIV epidemic**
- **Poverty and homelessness**
- **Drug abuse**
- **Migration from high prevalence countries**
- **Emergence of drug-resistant TB**
- **Decline of HCW expertise**
- **Decline of public health infrastructure**

TB Morbidity
United States, 2003–2009

Year	No.	Rate*
2003	14,836	5.1
2004	14,499	4.9
2005	14,064	4.8
2006	13,734	4.6
2007	13,280	4.4
2008	12,906	4.2
2009	11,545	3.8

*Cases per 100,000, updated as of July 1, 2010.

TB Case Rates,* United States, 2009

● D.C.

☐ (white)	≤ 3.5 (year 2000 target)
☐ (cyan)	3.6–3.8
☐ (magenta)	> 3.8 (national average)
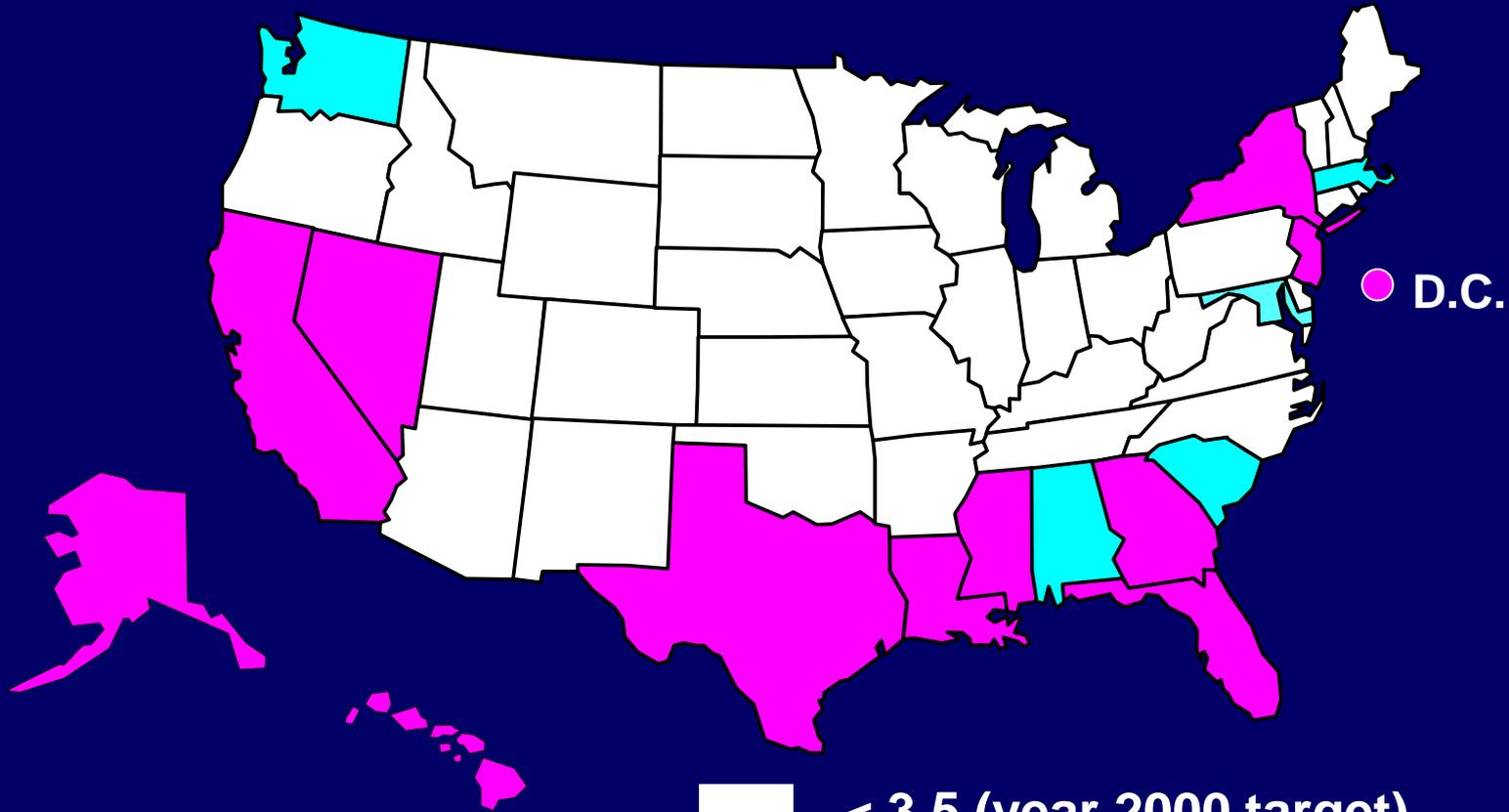
*Cases per 100,000.

TB Case Rates* by Age Group United States, 1993–2009

Cases per 100,000

20.0
15.0
10.0
5.0
0.0

1993 1995 1997 1999 2001 2003 2005 2007 2009

Legend: ◆ <15   ■ 15-24   ▲ 25-44   ■ 45-64   ■ ≥65

Age Group (years)

*Updated as of July 1, 2010.

Reported TB Cases by Age Group, United States, 2009

- <15 yrs (6%)
- 15–24 yrs (11%)
- 25–44 yrs (34%)
- 45–64 yrs (30%)
- ≥65 yrs (20%)
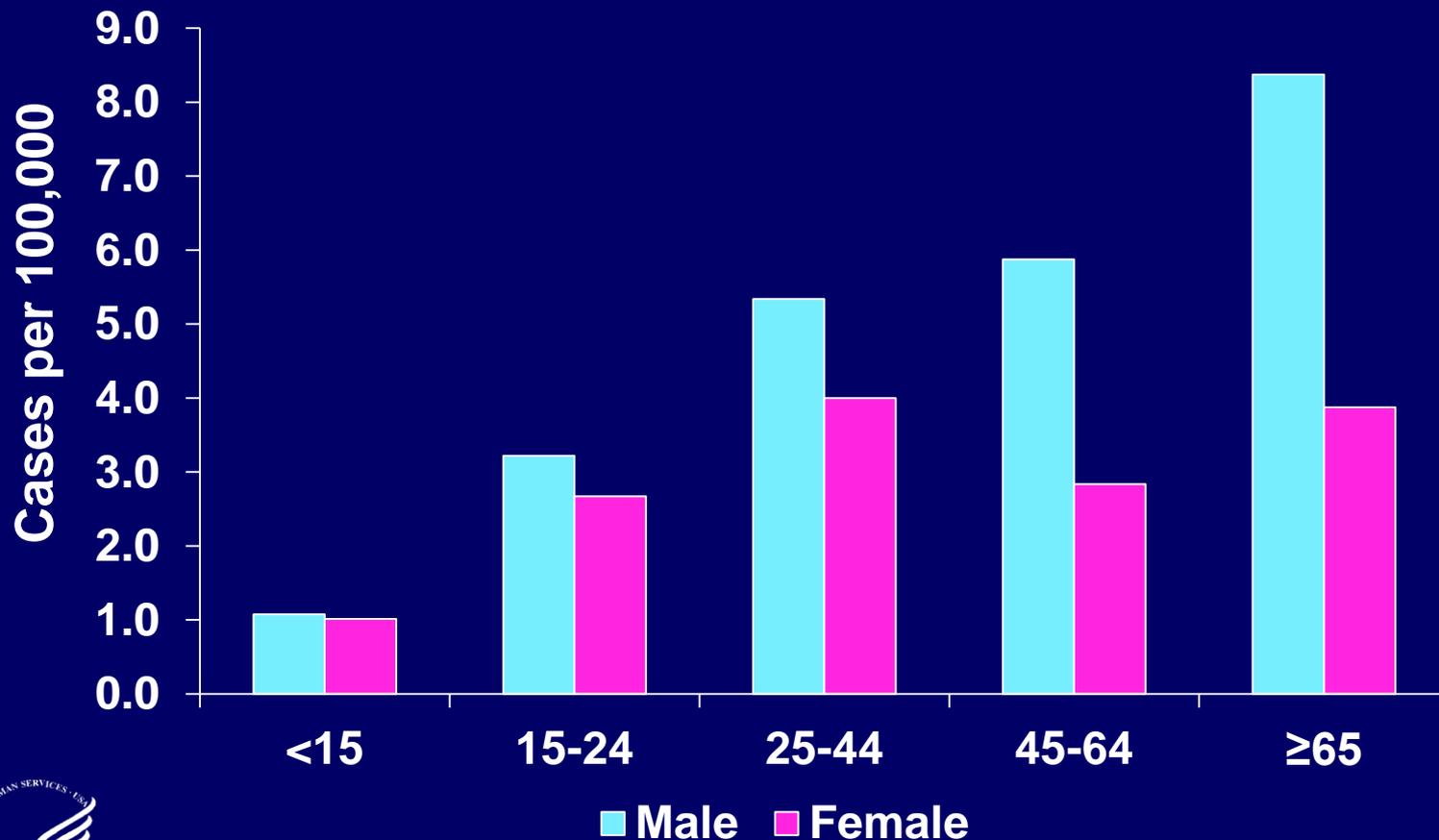
TB Case Rates by Race/Ethnicity* United States, 1993–2009**

Cases per 100,000

- Asian/Pacific Islander
- American Indian/Alaska Native
- Black or African-American
- White
- Hispanic
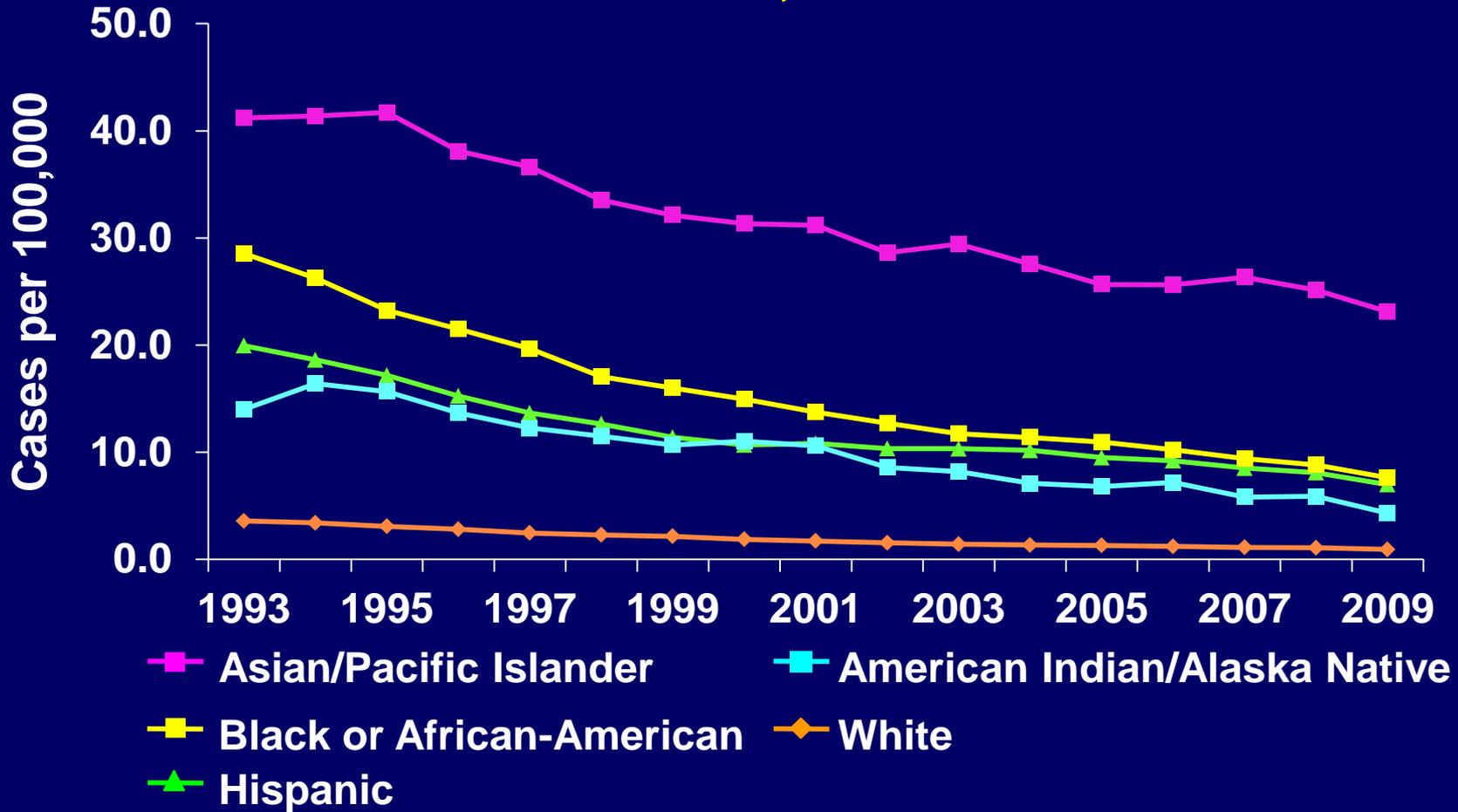
*All races are non-Hispanic. In 2003, Asian/Pacific Islander category includes persons who reported race as Asian only and/or Native Hawaiian or Other Pacific Islander only.
**Updated as of July 1, 2010.

Reported TB Cases by Race/Ethnicity* United States, 2009
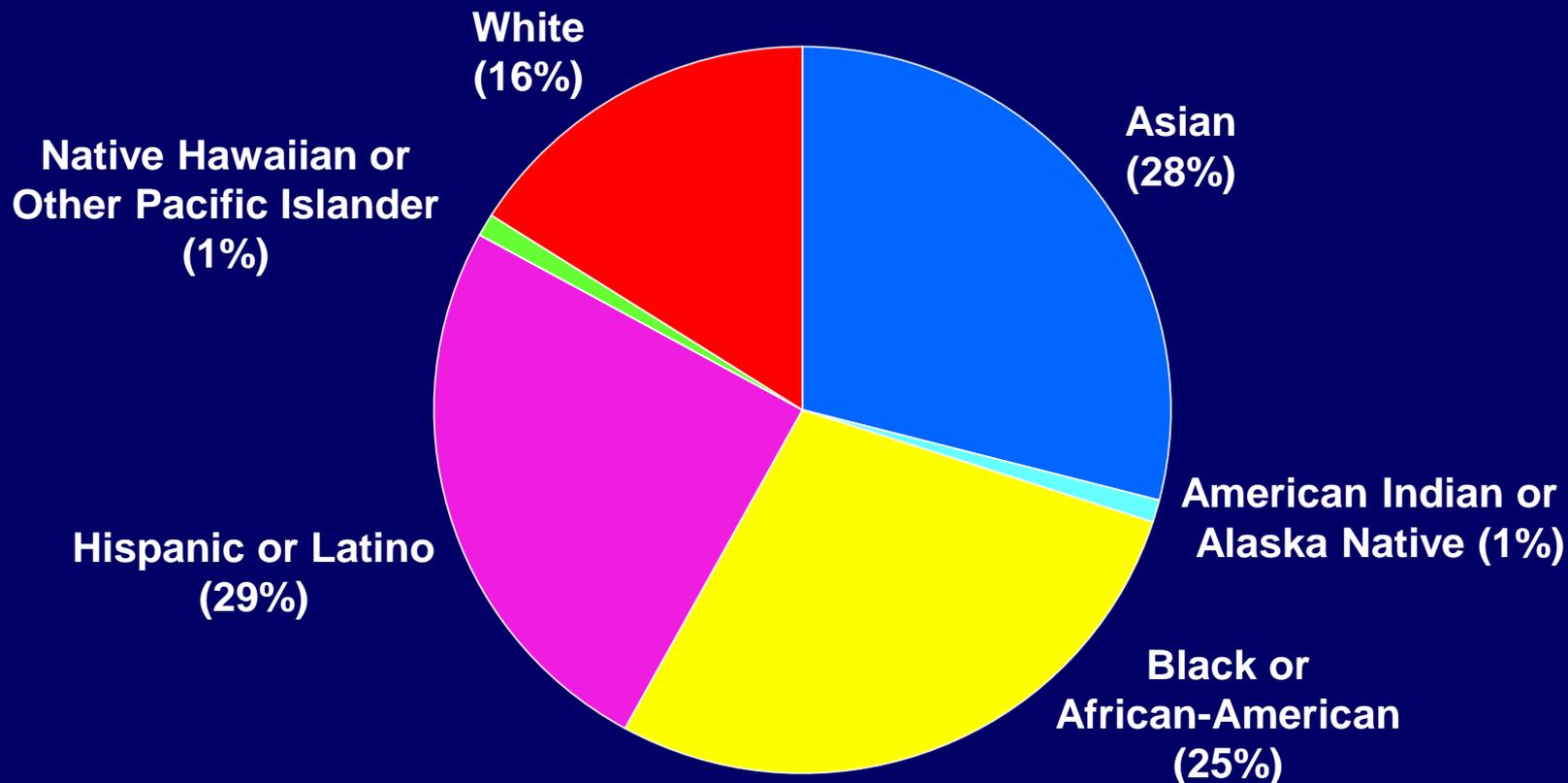
White (16%)

Native Hawaiian or Other Pacific Islander (1%)

Asian (28%)

American Indian or Alaska Native (1%)

Hispanic or Latino (29%)

Black or African-American (25%)

*All races are non-Hispanic. Persons reporting two or more races accounted for less than 1% of all cases.

# Number of TB Cases in U.S.-born vs. Foreign-born Persons United States, 1993–2009*
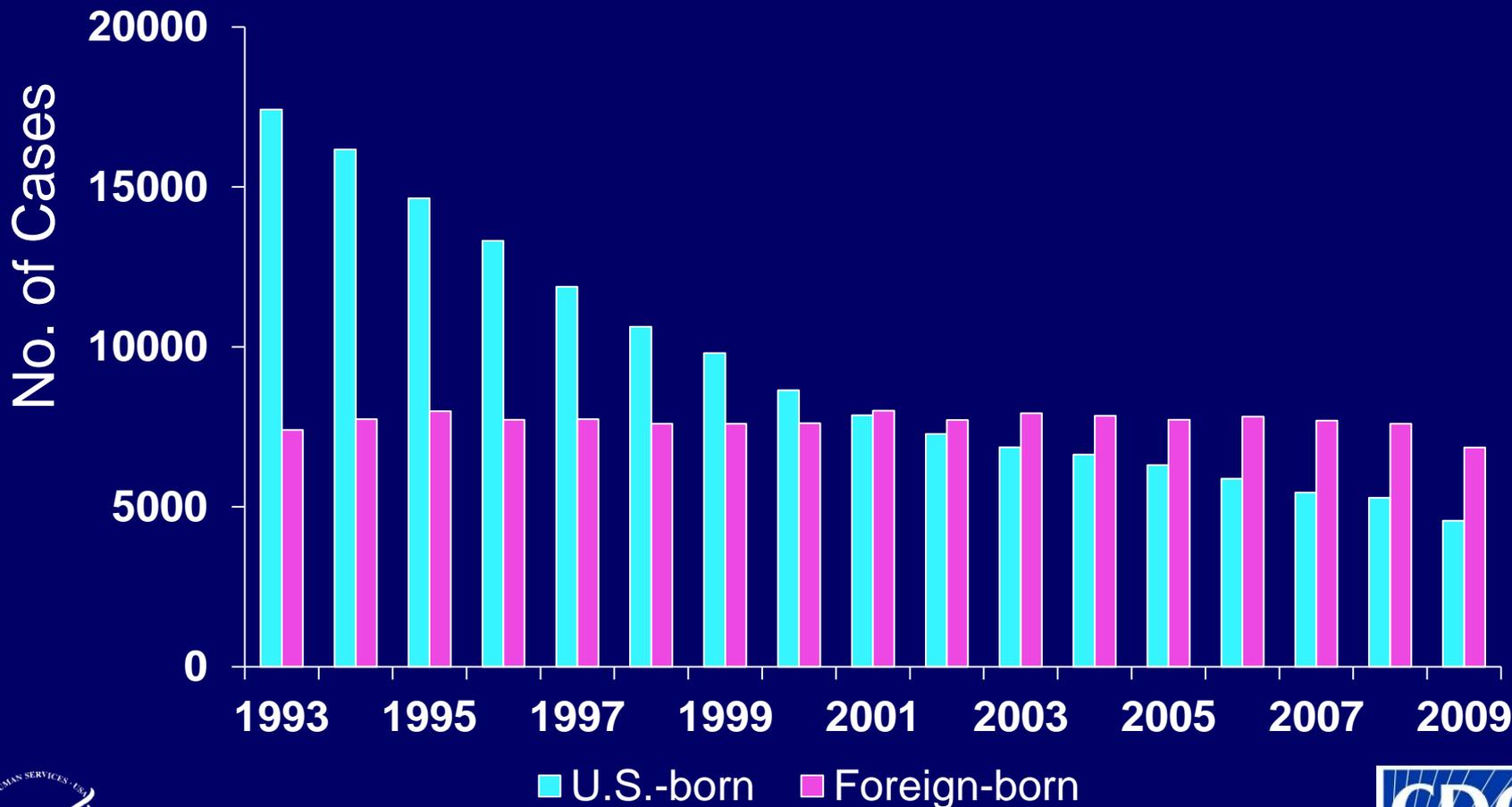
*Updated as of July 1, 2010.

Trends in TB Cases in Foreign-born Persons, United States, 1989–2009*

No. of Cases
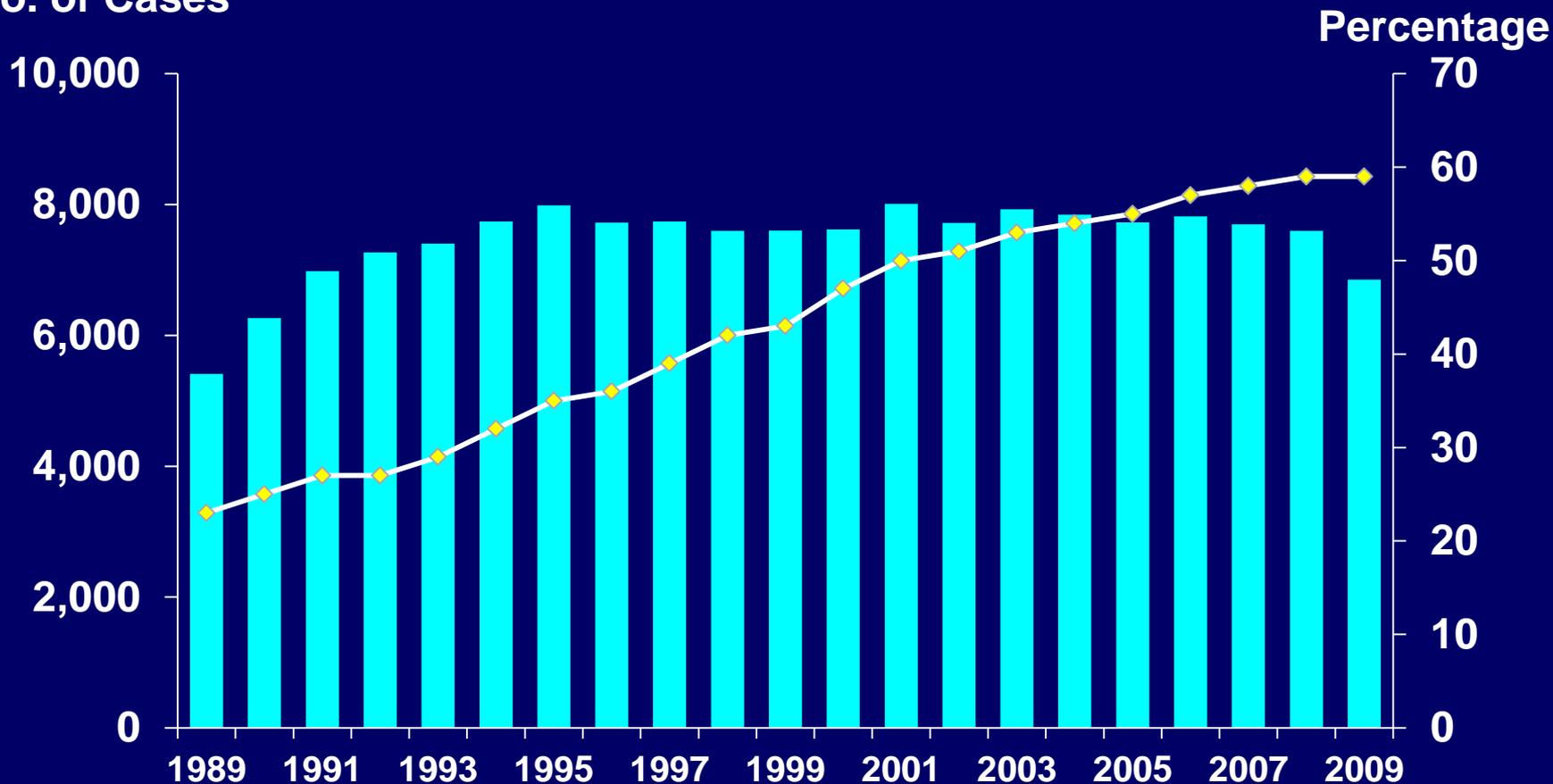
Percentage

No. of Cases   Percentage of Total Cases

*Updated as of July 1, 2010.

Reported TB Cases by Origin and Race/Ethnicity,* United States, 2009

U.S.-born
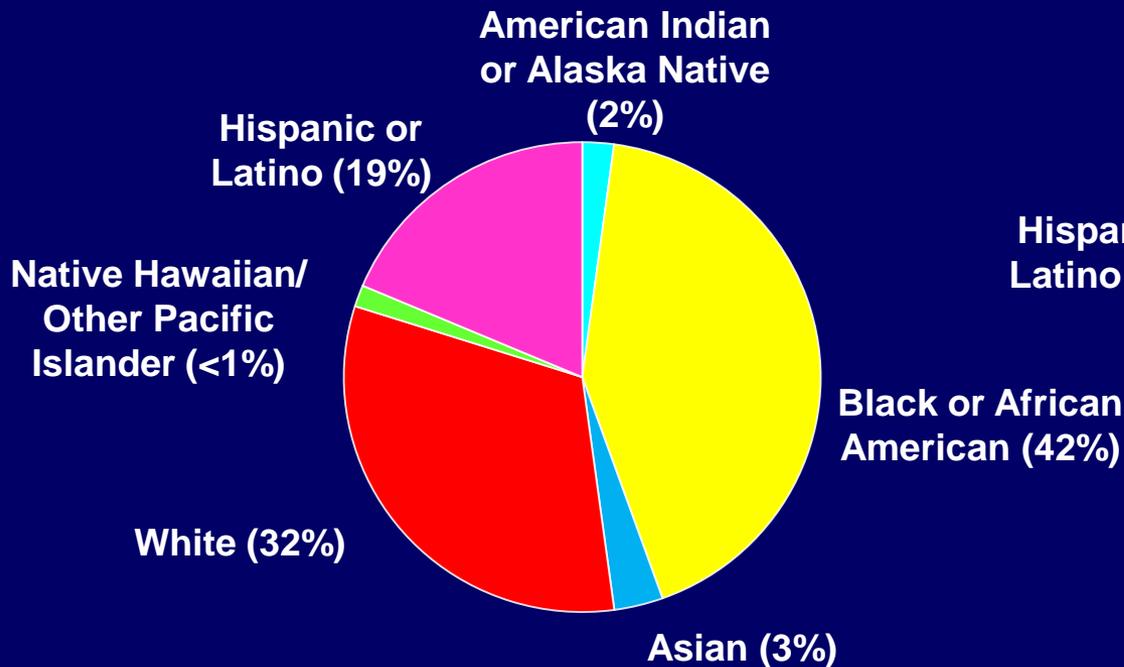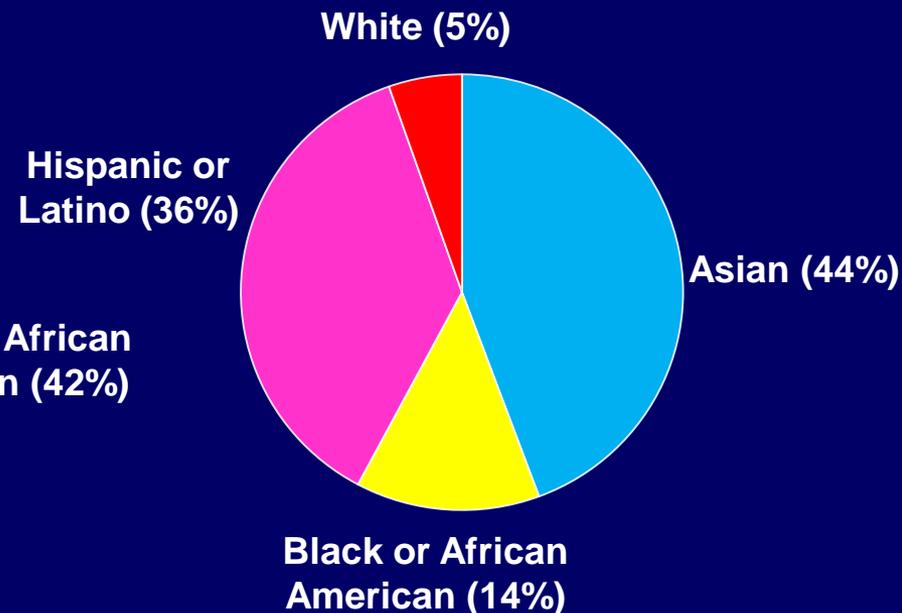
- American Indian or Alaska Native (2%)
- Hispanic or Latino (19%)
- Native Hawaiian/ Other Pacific Islander (<1%)
- White (32%)
- Black or African American (42%)
- Asian (3%)

Foreign-born

- White (5%)
- Hispanic or Latino (36%)
- Asian (44%)
- Black or African American (14%)

*All races are non-Hispanic. Persons reporting two or more races accounted for less than 1% of all cases.

**American Indian or Alaska Native and Native Hawaiian or Other Pacific Islander accounted for less than 1% of foreign-born cases and are not shown.

Percentage of TB Cases Among Foreign-born Persons, United States*

1999

2009

DC

DC

- ≥50%
- 25%–49%
- <25%
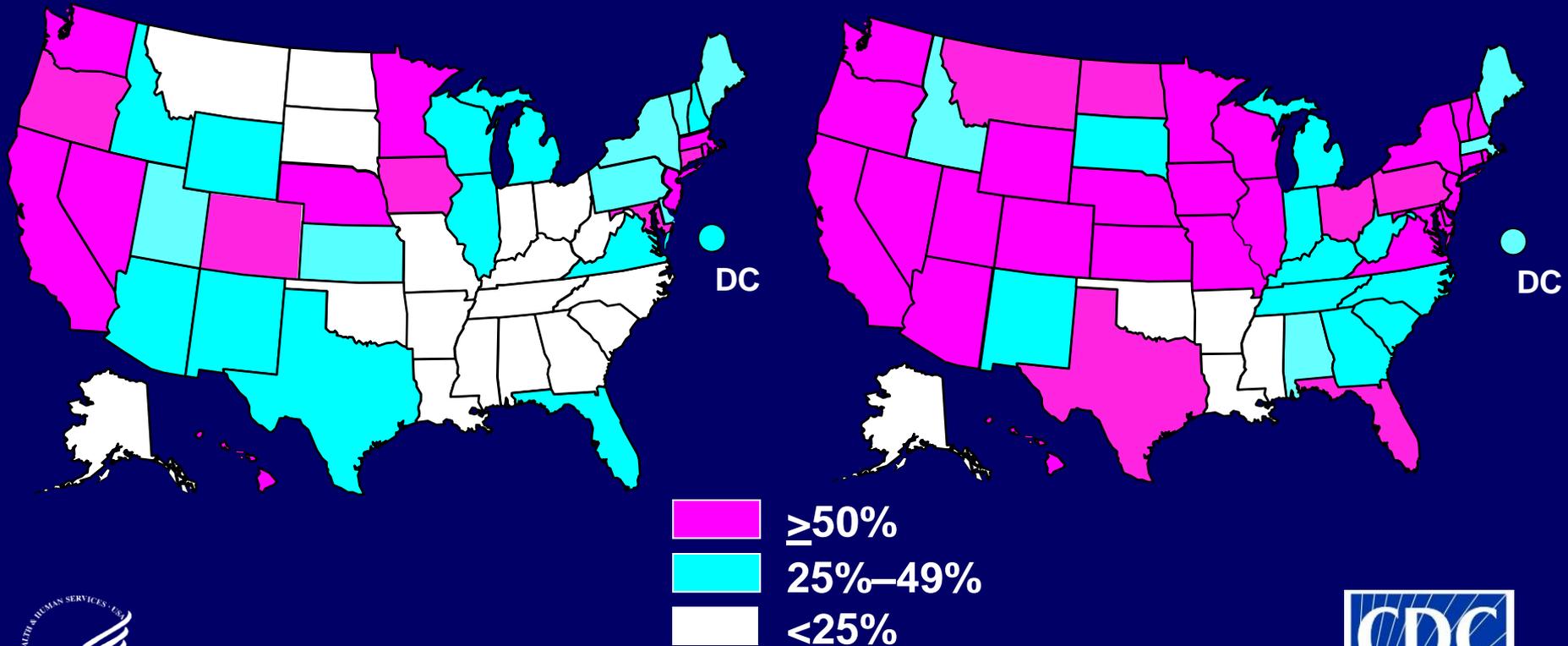
*Updated as of July 1, 2010.

TB Case Rates in U.S.-born vs. Foreign-born Persons United States, 1993–2009*
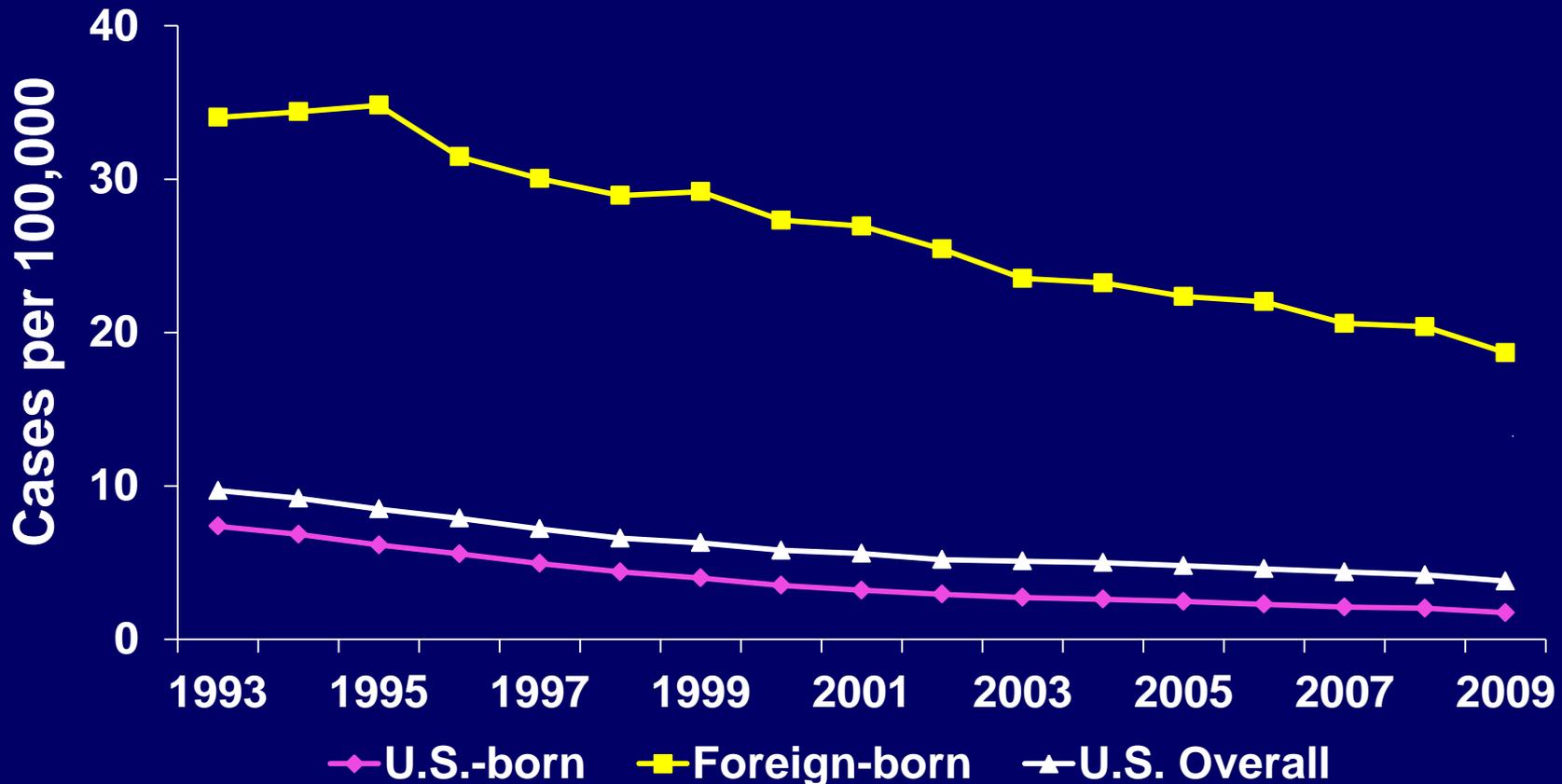
Countries of Birth of Foreign-born Persons Reported with TB United States, 2009

Pie chart data:
- Mexico (23%)
- Philippines (12%)
- India (8%)
- Vietnam (8%)
- China (5%)
- Guatemala (3%)
- Haiti (3%)
- Other Countries (38%)
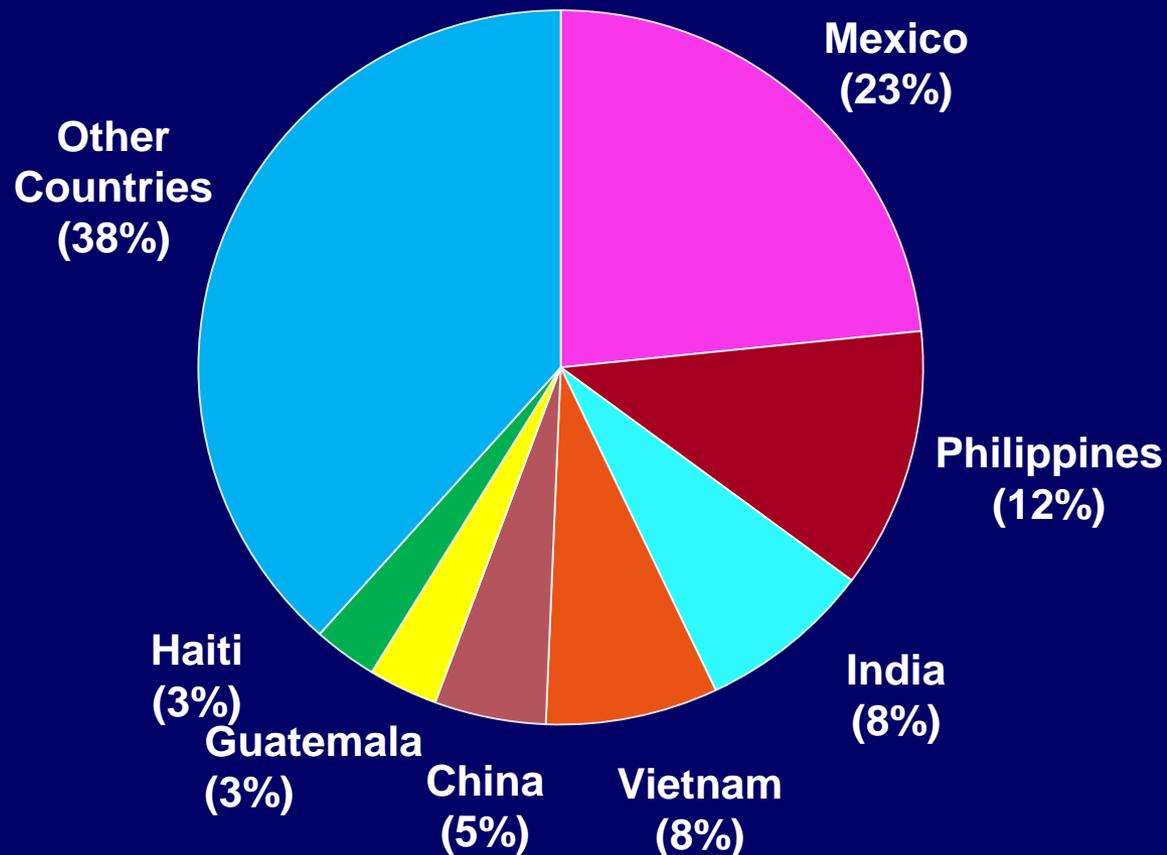
Percent of Foreign-born with TB by Time of Residence in U.S. Prior to Diagnosis, 2009

Legend: Missing*, <1 year, 1-4 years, ≥5 years

Categories: Mexico, Philippines, India, Total
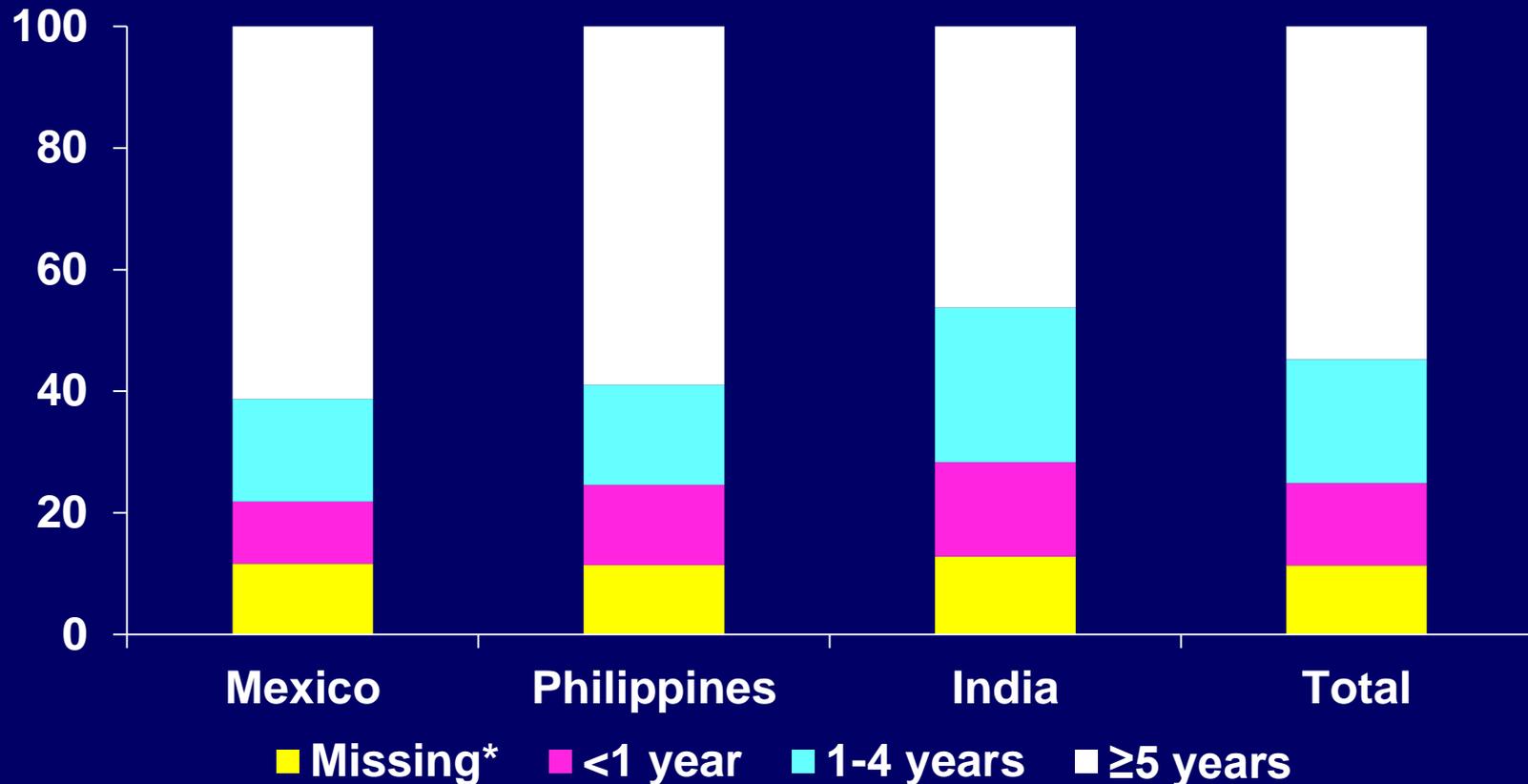
* Foreign-born TB patients for whom information on length of residence in the U.S. prior to diagnosis is unknown or missing.

Primary MDR TB
# United States, 1993–2009*
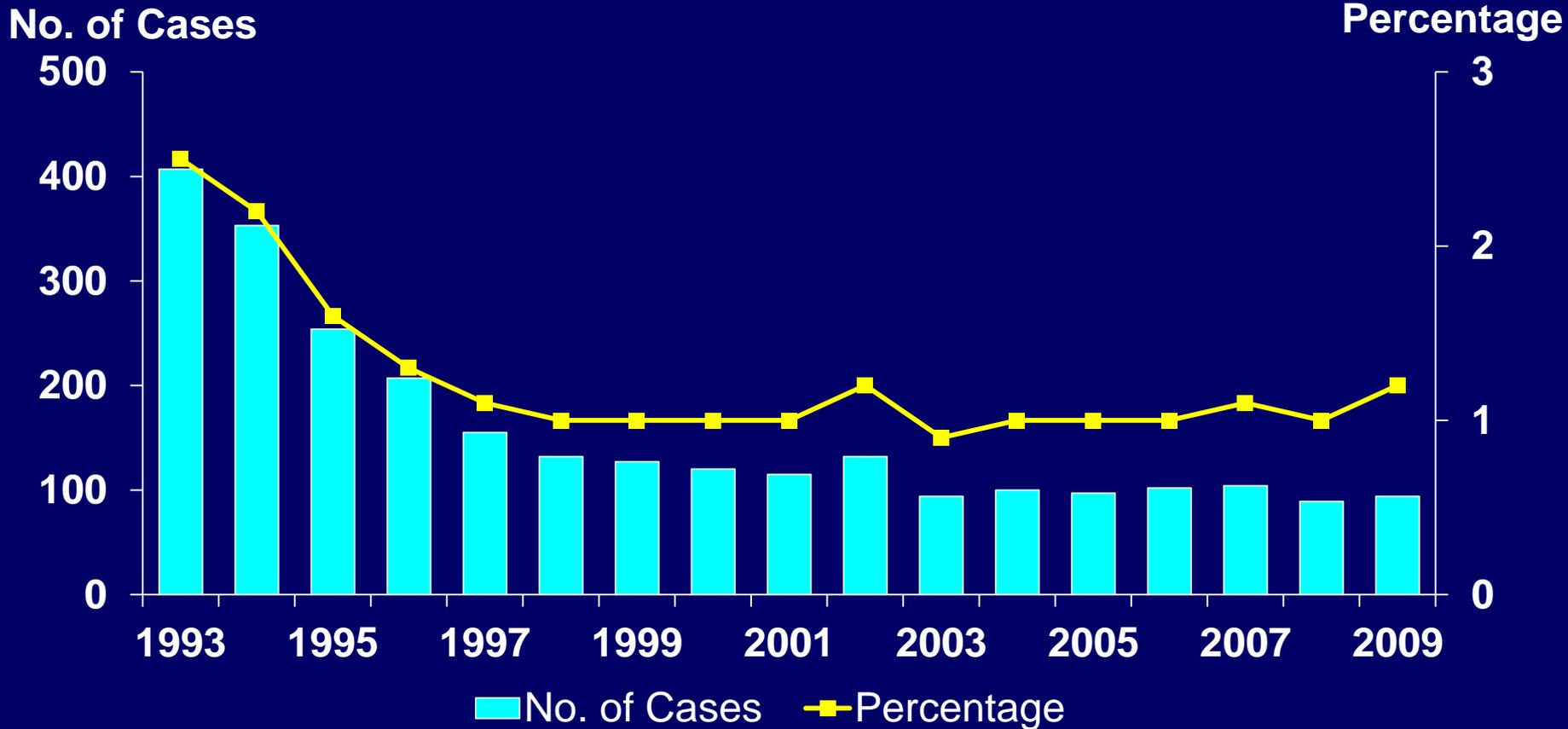
No. of Cases

Percentage

*Updated as of July 1, 2010.

Note: Based on initial isolates from persons with no prior history of TB.
MDR TB defined as resistance to at least isoniazid and rifampin.

# Primary MDR TB in U.S.-born vs. Foreign-born Persons, United States, 1993–2009*
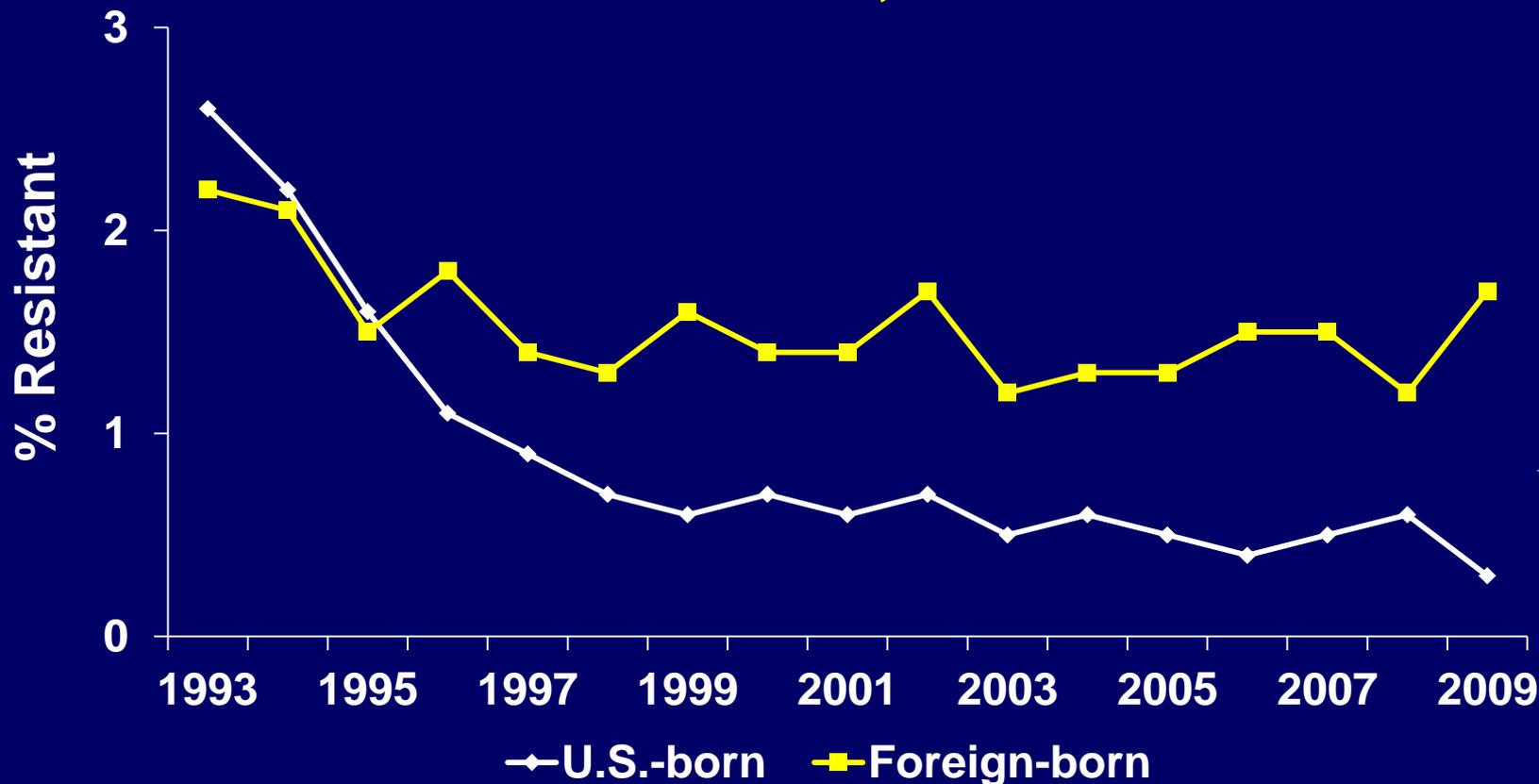
*Updated as of July 1, 2010.

Note: Based on initial isolates from persons with no prior history of TB.
MDR TB defined as resistance to at least isoniazid and rifampin.

XDR TB Case Count defined on Initial DST[†] by Year, 1993–2009*
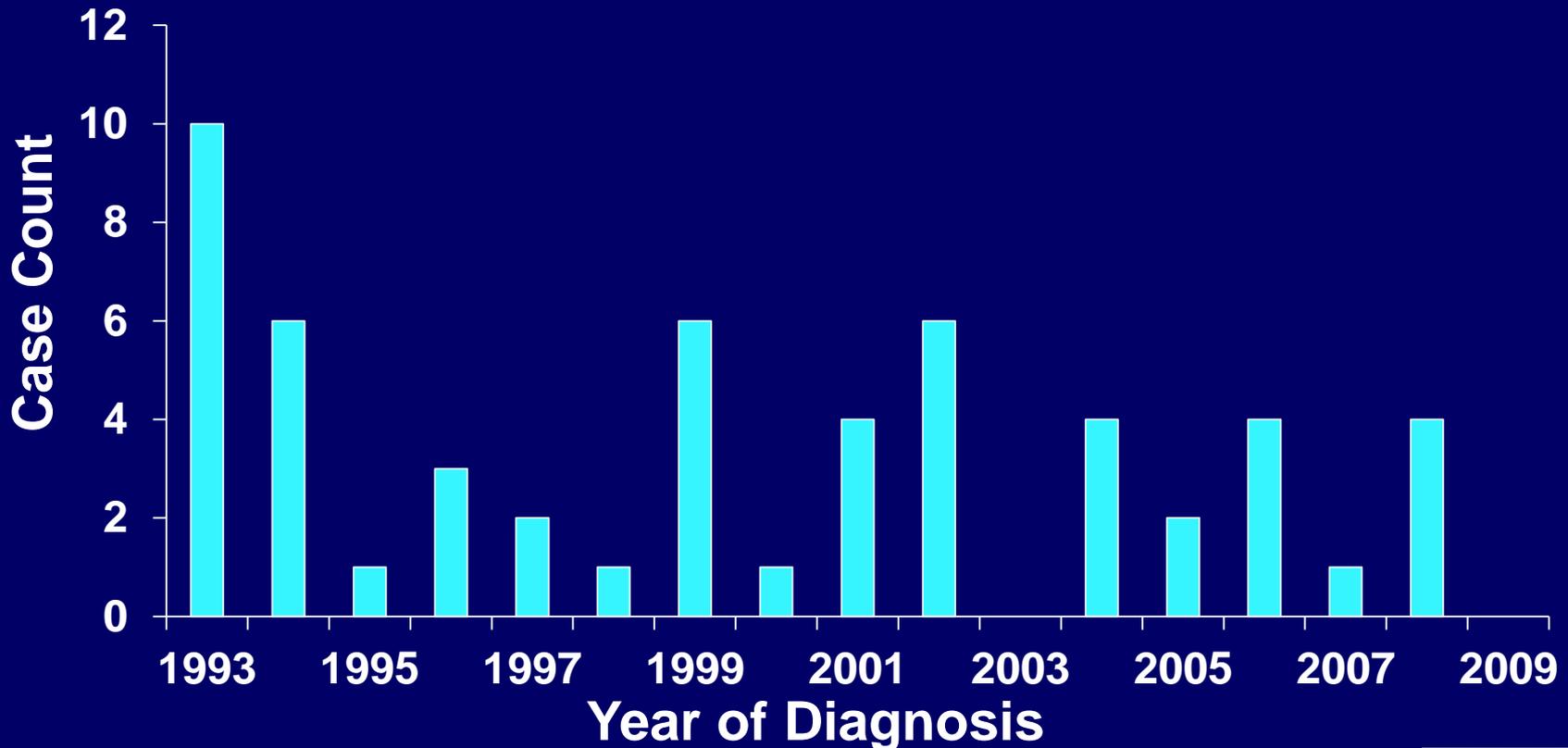
[†]Drug susceptibility test.
*Reported incident cases as of July 1, 2010.
Extensively drug-resistant TB (XDR TB) is defined as resistance to isoniazid and rifampin,
plus resistance to any fluoroquinolone and at least one of three injectable second-line anti-TB drugs.

Estimated HIV Coinfection in Persons Reported with TB, United States, 1993–2009*

Legend: Aged 25-44, All Ages
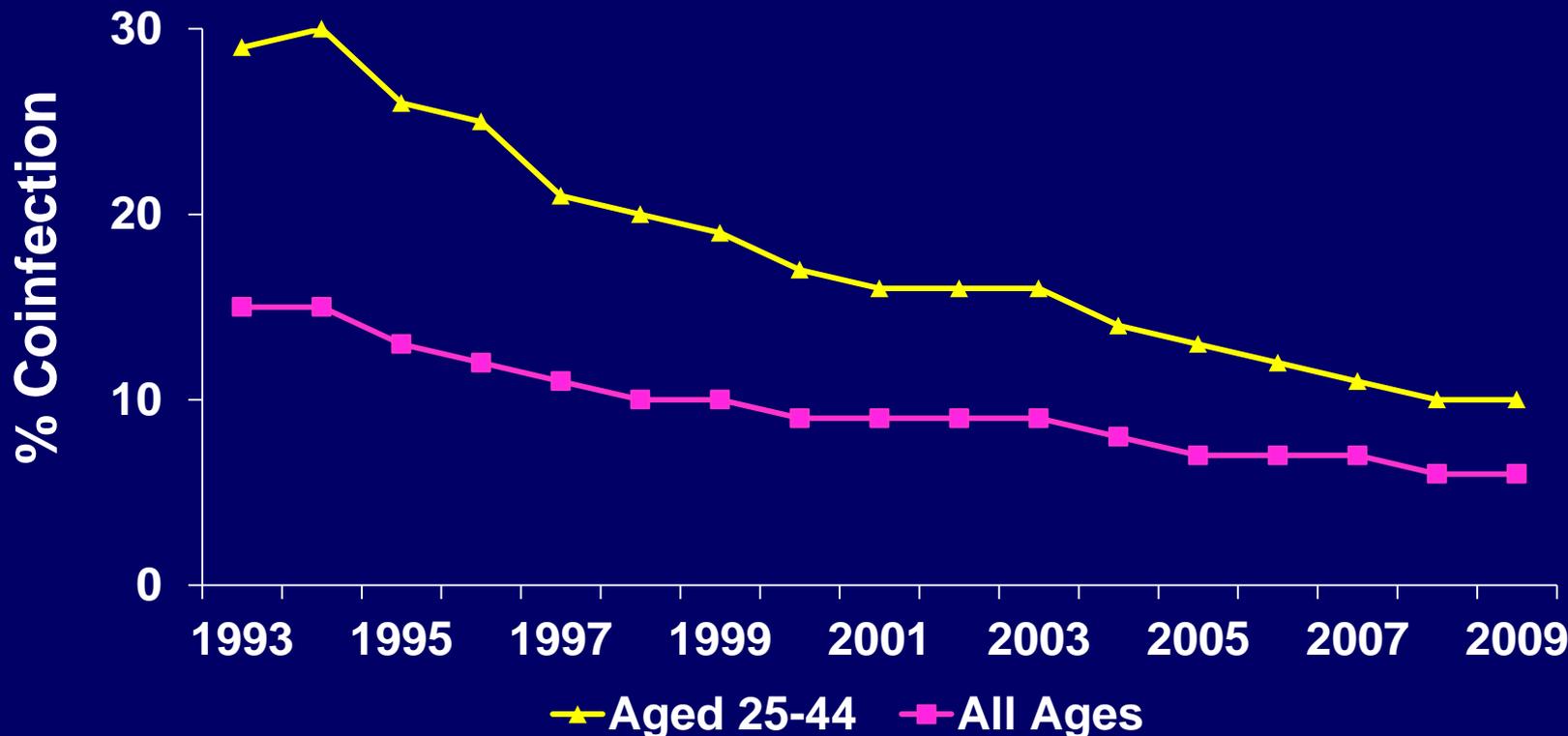
*Updated as of July 1, 2010.

Note: Minimum estimates based on reported HIV-positive status among all TB cases in the age group.

Associated Conditions for 2009 TB Cases

- HIV infected: 6.1%
- Homelessness: 5.3%
- Correction facility: 4.2%
- Injection drug use: 1.4%
- Non-injection drug use: 7.8%
- Excess alcohol use: 13.0%

Other Associated Conditions Not Currently Available in U.S. Surveillance Data

- Organ transplantation
- Chronic renal failure/dialysis
- Diabetes melitus
- Treatment with TNF-α antagonists
- Treatment with glucocorticoids
- Silicosis
- Head and neck cancer
- Cigarette smoking

Principles of TB Control in the United States

How is TB Transmitted?

- Airborne: droplet nuclei containing TB bacilli are coughed into the air by a person with active TB and inhaled by susceptible host

cough

TB bacteria

healthy lung

TB patient

Pathogenesis of TB

< 30% **5-10%**
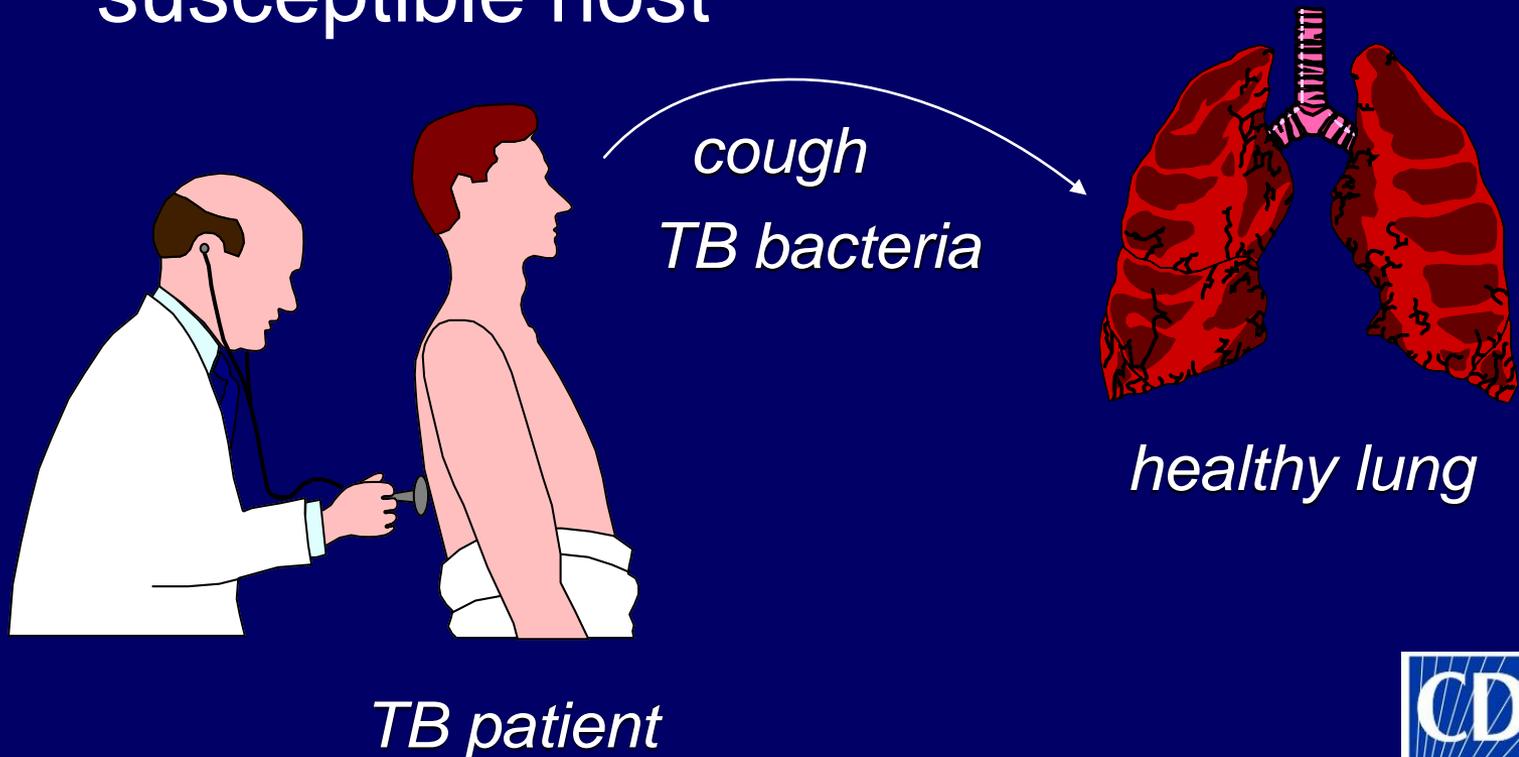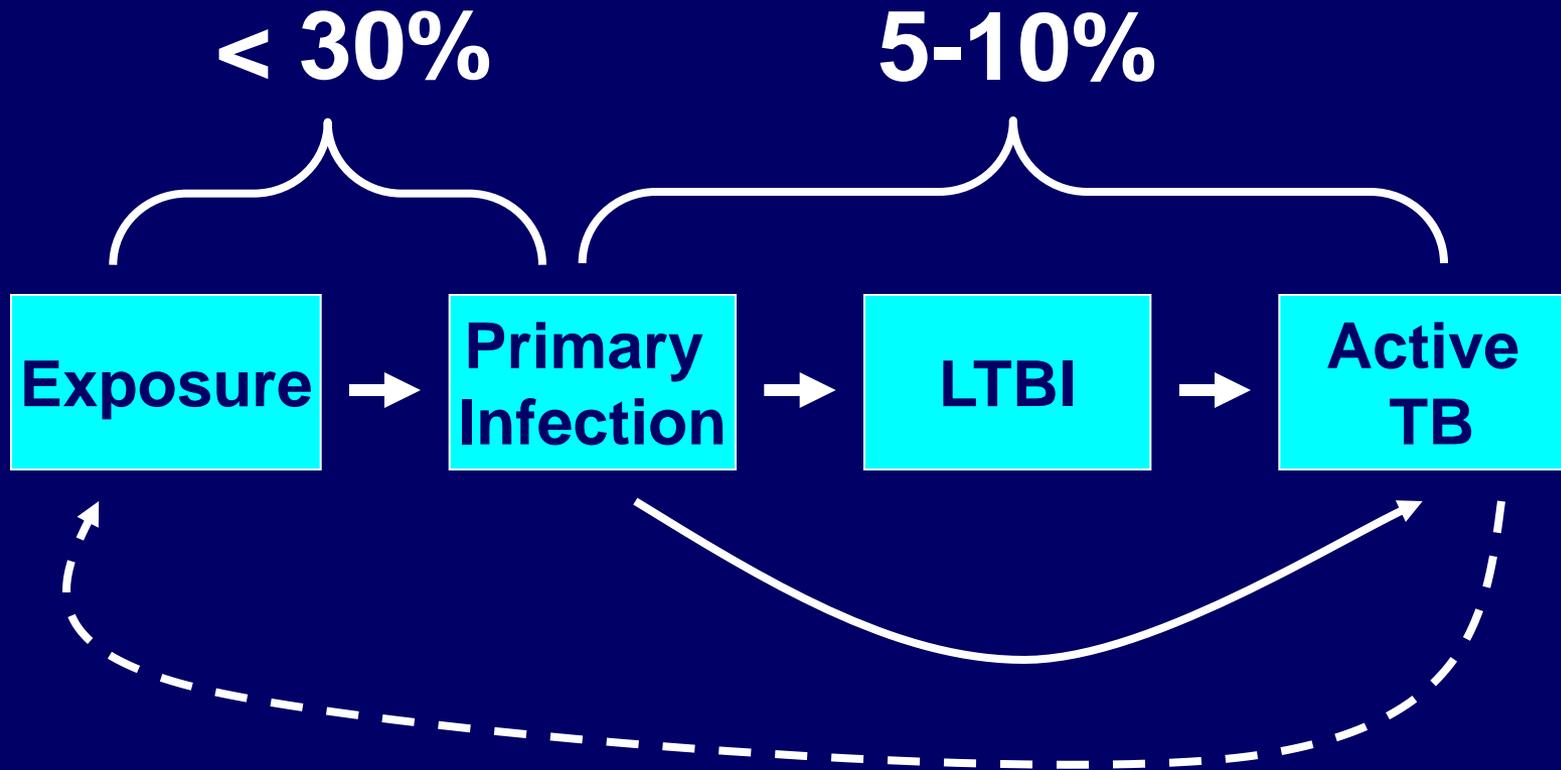
| Exposure | → | **Primary Infection** | → | **LTBI** | → | **Active TB** |
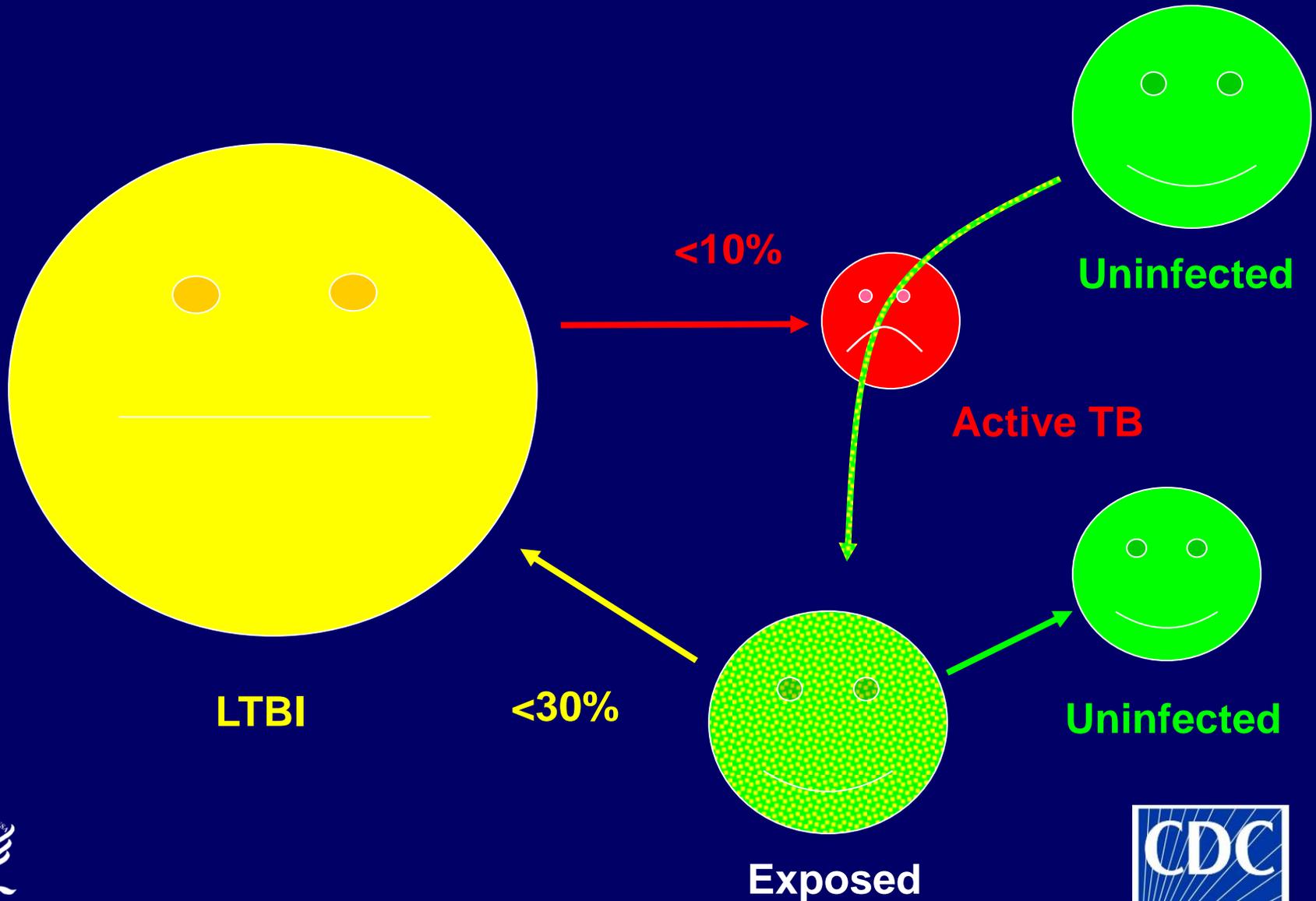
Interventions to Control Spread of TB

2) "Window prophylaxis" (reserved for high-risk persons: HIV, young children)

3) LTBI treatment (preventive therapy)

| Exposure | 🚫 | Primary Infection | → | LTBI | 🚫 | Active TB |
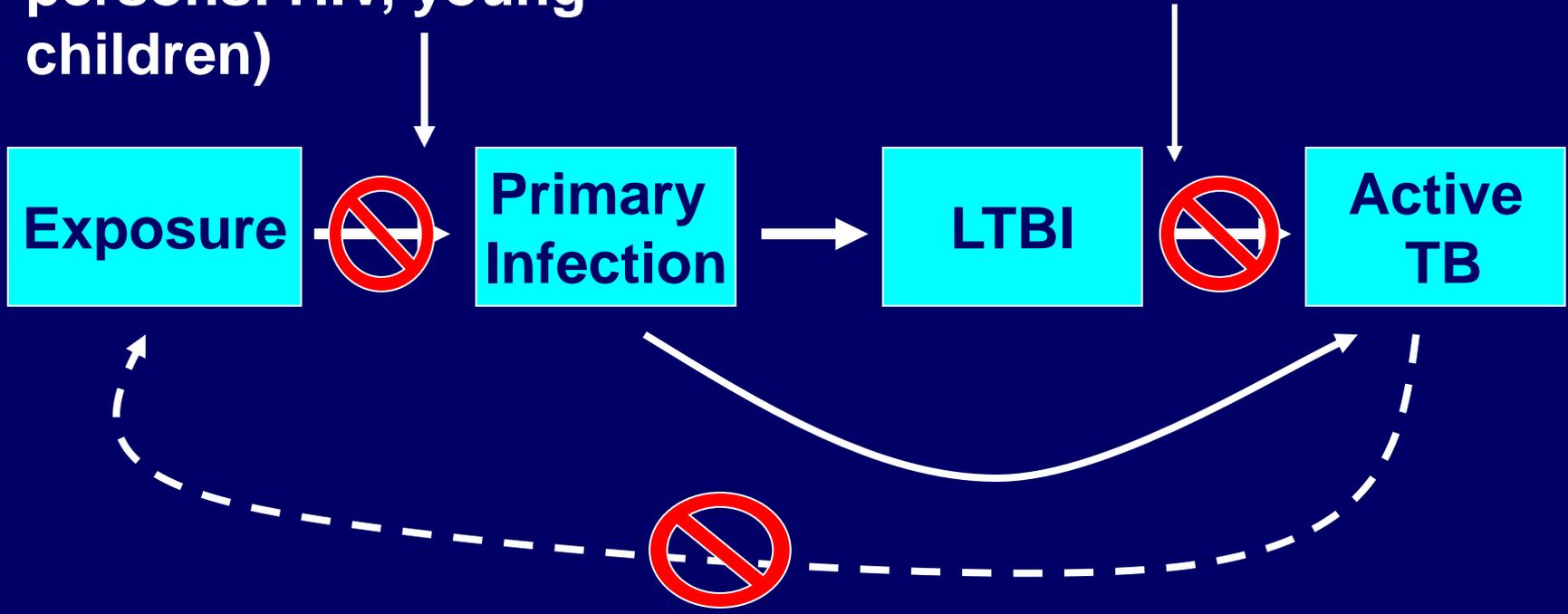
1) Isolate and treat active cases

U.S. TB Control Priorities

1) **Diagnose and treat all persons with active TB**

   – **Isolate until no longer infectious**

2) **Conduct contact investigations of persons with infectious TB**

   – **Detect secondary cases**

   – **Detect newly infected persons and treat for LTBI**

3) **Targeted testing and treatment of persons with LTBI at risk for progression to active TB**

Table 1 Risk factors for the development of active tuberculosis among persons infected with *Mycobacterium tuberculosis*

Risk factor	Estimated risk for TB relative to persons with no known risk factor	References
High risk (testing and treatment for LTBI recommended for all ages[†])		
AIDS	110–170	[9,10]
HIV	50–110	[11,12]
Transplantation (related to immune-suppressant therapy)	20–74	[13–16]
Silicosis	30	[17,18]
Chronic renal failure requiring hemodialysis	10–25	[19–22]
Carcinoma of head and neck	16.0	[23]
Recent TB infection (<2 years)	15.0	[24,25]
Abnormal chest x-ray—with upper lobe fibronodular disease typical of healed TB infection	6–19	[26–28]
TNF-alpha inhibitors	1.7–9.0	[29–32]
Moderate risk (testing and treatment for LTBI recommended if age <65 years[†])		
Treatment with glucocorticoids	4.9	[33]
Diabetes mellitus (all types)	2–3.6	[34–37]
Young age when infected (0–4 years)	2.2–5	[38]
Slightly increased risk (testing and treatment for LTBI recommended if age <50 years[†])		
Underweight (<90% ideal body weight; for most persons, this is a BMI ≤ 20)	2–3	[39]
Cigarette smoker (1 pack/day)	2–3	[40,41]
Abnormal chest x-ray—granuloma	2	[27,42]
Low risk (testing and treatment for LTBI recommended if age <35 years[†])		
Infected person, no known risk factor, normal chest x-ray ('low-risk reactor')	1	[43]
Very low risk (treatment of LTBI not usually recommended)		
Person with positive two-step (booster), no other known risk factor, and normal chest x-ray	0.5	Extrapolated from [43] and [44]

Core Strategy: DOTS

- **Developed for low-income, high-burden countries**
- **Focused on detection and treatment of most infectious cases**
  - **Use of smear microscopy and standardized treatment regimens**
  - **Culture and drug-susceptibility testing not routinely done**
- **Has limitations especially for HIV/TB and MDR TB**

Revised Stop TB Strategy

- **Expand and enhance high quality DOTS**
- **Scaling up of integrated TB/HIV activities (e.g., intensified case find, preventive therapy, antiretroviral therapy)**
- **Scaling up of MDR TB diagnosis and treatment**
- **Strengthen infection control measures**
- **Address needs of TB contacts**
- **Implementation is highly variable from country to country**

Questions?