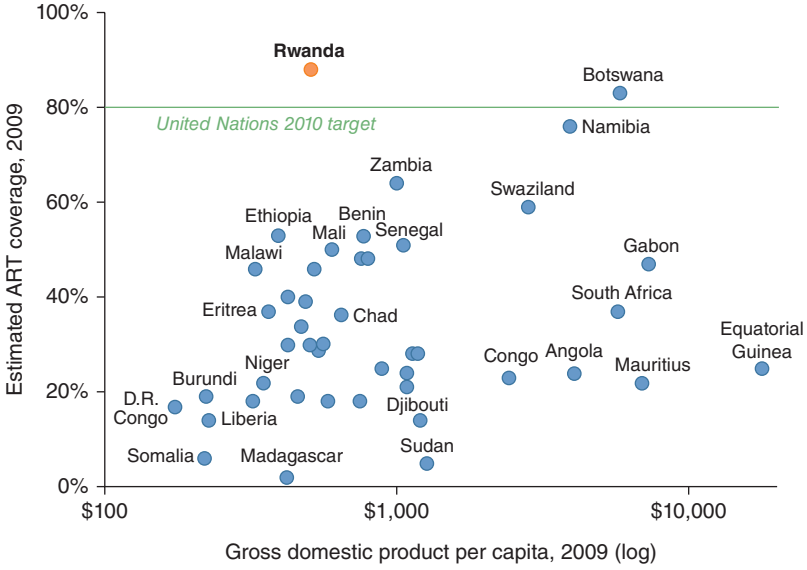


**FIGURE 2-3** **Antiretroviral therapy (ART) coverage in sub-Saharan Africa, 2009.**

registered in southern Africa is attributed to HIV co-infection. Even before the advent of HIV, however, it was estimated that fewer than one-half of all cases of TB in developing countries were ever diagnosed, much less treated. Primarily because of the common failure to diagnose and treat TB, international authorities devised a single strategy to reduce the burden of disease. In the early 1990s, the World Bank, the WHO, and other international bodies promoted the DOTS strategy (*d*irectly *o*bserved *t*herapy using *s*hort-course isoniazid- and rifampin-based regimens) as highly cost-effective. Passive case-finding of smear-positive patients was central to the strategy, and an uninterrupted drug supply was, of course, deemed necessary for cure.

DOTS was clearly effective for most uncomplicated cases of drug-susceptible TB, but a number of shortcomings were soon identified. First, the diagnosis of TB based solely on sputum smear microscopy—a method dating from the late nineteenth century—is not sensitive. Many cases of pulmonary TB and all cases of exclusively extrapulmonary TB are missed by smear microscopy, as are most cases of active disease in children. Second, passive case-finding relies on the availability of health care services, which is uneven in the settings where TB is most prevalent. Third, patients with multidrug-resistant TB (MDR-TB) are by definition infected with strains of *Mycobacterium tuberculosis* resistant to isoniazid and rifampin; thus exclusive reliance on these drugs is unwarranted in settings in which drug resistance is an established problem.

The crisis of antibiotic resistance registered in U.S. hospitals is not confined to the industrialized world or to common bacterial infections. The great majority of patients sick with and dying from TB are afflicted with strains susceptible to all first-line drugs. In some settings, however, a substantial minority of patients with TB are infected with *M. tuberculosis* strains resistant to at least one first-line anti-TB drug. A 2012 article in a leading journal reported that, in China, 10% of all patients with TB and 26% of all previously treated patients were sick with MDR strains of *M. tuberculosis*. Most of these cases were the result of primary transmission. To improve DOTS-based responses to MDR-TB, global health authorities adopted DOTS-Plus, which adds the diagnostics and drugs necessary to manage drug-resistant disease. Even as DOTS-Plus was being piloted in resource-constrained settings, however, new strains of extensively drug-resistant (XDR) *M. tuberculosis* (resistant to isoniazid and rifampin, any fluoroquinolone, and at least one injectable second-line drug) had already threatened the success of TB control programs in beleaguered South Africa, for example, where high rates of HIV infection have led to a doubling of TB incidence over the last decade. Despite the poor capacity for detection of MDR- and XDR-TB in most resource-limited settings, an estimated 630,000 cases of MDR-TB were thought to occur in 2011. Approximately 9% of these drug-resistant cases were caused by XDR strains. It is clear that poor infection control in hospitals and clinics is associated with explosive and lethal epidemics due to these strains and that patients may be infected with multiple strains.

## TUBERCULOSIS AND AIDS AS CHRONIC DISEASES: LESSONS LEARNED

Strategies effective against MDR-TB have implications for the management of drug-resistant HIV infection and even drug-resistant malaria, which, through repeated infections and a lack of effective therapy, has become a chronic disease in parts of Africa (see "Malaria," below). As new therapies, whether for TB or for hepatitis C infection, become available, many of the problems encountered in the past will recur. Indeed, examining AIDS and TB as chronic diseases—instead of simply communicable diseases—makes it possible to draw a number of conclusions, many of them pertinent to global health in general.

First, the chronic infections discussed here are best treated with multidrug regimens to which the infecting strains are susceptible. This is true of chronic infections due to many bacteria, fungi, parasites, or viruses; even acute infections such as those caused by *Plasmodium* species are not reliably treated with a single drug.

Second, charging fees for AIDS prevention and care poses insurmountable problems for people living in poverty, many of whom are unable to pay even modest amounts for services or medications. Like efforts to battle airborne TB, such services might best be seen as a *public good* promoting public health. Initially, a subsidy approach will require sustained donor contributions, but many African countries have set targets for increased national investments in health—a pledge that could render ambitious programs sustainable in the long run, as the Rwanda experience suggests. Meanwhile, as local investments increase, the price of AIDS care is decreasing. The development of generic medications means that ART can now cost <$0.25 per day; costs continue to decrease.

Third, the effective scale-up of pilot projects requires strengthening and sometimes rebuilding of health care systems, including those charged with delivering primary care. In the past, the lack of health care infrastructure has been cited as a barrier to providing ART in the world's poorest regions; however, AIDS resources, which are at last considerable, may be marshaled to rebuild public health systems in sub-Saharan Africa and other HIV-burdened regions—precisely the settings in which TB is resurgent.

Fourth, the lack of trained health care personnel, most notably doctors and nurses, in resource-poor settings must be addressed. This personnel deficiency is invoked as a reason for the failure to treat AIDS in poor countries. In what is termed the *brain drain*, many physicians and nurses emigrate from their home countries to pursue opportunities abroad, leaving behind health systems that are understaffed and ill equipped to deal with the epidemic diseases that ravage local populations. The WHO recommends a minimum of 20 physicians and 100 nurses per 100,000 persons, but recent reports from that organization and others confirm that many countries, especially in sub-Saharan Africa, fall far short of those target numbers. Specifically, more than one-half of those countries register fewer than 10 physicians per 100,000 population. In contrast, the United States and Cuba register 279 and 596 doctors per 100,000 population, respectively. Similarly, the majority of sub-Saharan African countries do not have even half of the WHO-recommended minimum number of nurses. Further inequalities in health care staffing exist *within* countries. Rural–urban disparities in health care personnel mirror disparities of both wealth and health. For instance, nearly 90% of Malawi's population lives in rural areas, but more than 95% of clinical officers work at urban facilities, and 47% of nurses work at tertiary care facilities. Even community health workers trained to provide first-line services to rural populations often transfer to urban districts.

One reason doctors and nurses leave sub-Saharan Africa and other resource-poor areas is that they lack the tools to practice their trade there. Funding for "vertical" (disease-specific) programs can be used