SOURCES OF DATA FOR IMPROVED SURVEILLANCE OF HIV/AIDS IN CHINA

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Abstract. The objective of this paper is to describe the evolution of human immunodeficiency virus/acquired immunodeficiency syndrome surveillance in mainland China, with a focus on reviewing the sources of data being used for improved surveillance of HIV/AIDS. We review the development of HIV/AIDS surveillance and its multiple data sources to monitor the dynamics of HIV/AIDS in China. The surveillance system for HIV/AIDS in China was initiated in 1986. It has evolved in three stages: (1) passive surveillance, (2) HIV sentinel surveillance with co-existing active surveillance and passive surveillance, and (3) comprehensive surveillance. In parallel with the evolution of the surveillance system itself, the HIV epidemic in China has gone through increasing stages of complexity, through an Introduction Phase, a Spreading Phase, and a Rapidy Spreading Phase. More reliable data from improved surveillance suggest that the HIV/AIDS epidemic is expanding in China. HIV infections among 2005 estimates remain concentrated among injection drug users (IDUs), those buying and selling sex, and men who have sex with men. Better HIV/AIDS surveillance synthesizes multiple data sources to provide a more accurate picture of the dynamics of specific HIV/AIDS circumstances in different areas of China. Improved surveillance is meaningful insofar as data are used to implement more effective HIV prevention programs in China. Support for surveillance and strategic analyses can enable policy decision makers to make more effective program choices and mobilize adequate resources to contain HIV.

INTRODUCTION

China has the world's largest population with over 1.3 billion people, 62% of whom live in rural areas (China Census Bureau, 2001). Surveillance experts believe the human immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS) epidemic in China is still growing, as are rates of other sexually transmitted diseases (STD)(Chen *et al,* 2000; Yang *et al,* 2005; Lu *et al,* 2006; MOH, UNAIDS, WHO, 2006; Zarocostas, 2006). Improved HIV data collection and a better estimate of the "at-risk populations" guide the most recent estimates. As of the end of 2005, there were an estimated 650,000 people living with HIV/AIDS in China (likely range: 540,000 to 760,000), lower than the 2003 estimates of 830,000 (650,000-1,020,000). These statistics exclude Taiwan and the two Special Administrative Regions of Hong Kong and Macao that have surveillance systems that are independent of the China Center for Disease Control and Prevention (China CDC) (Macao SAR Government Department of Health, 2000; Lau and Tsui, 2003; Twu *et al*, 2004; Lu *et al*, 2006; MOH, UNAIDS, WHO, 2006; Wong *et al*, 2006). The WHO/UNAIDS Workbook methods were

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adapted to meet the needs of China both in 2003 and 2005 (Lu *et al,* 2006; Lyerla, *et al*, 2006); however, the newer estimates were based on a much wider range of surveillance data as well as mass screening of former plasma donors in central China. For the 2005 estimates, data were available at the more decentralized prefecture level. Greater generalization from high prevalence provincial surveillance sites had led to past estimates that are now believed to have been too high (Lu *et al,* 2006; MOH, UNAIDS, WHO, 2006).

New infections outpaced deaths in 2005 such that the HIV epidemic in China was still growing. Since China's multicultural and multiethnic characteristics accompany wide geographic and socio-demographic variations in high risk activities, many challenges exist in tracking and understanding the dynamics of HIV transmission through surveillance. We present the development of HIV/AIDS surveillance in China and review the sources of data and the approaches being taken to improve surveillance of HIV/AIDS in China.

MATERIALS AND METHODS

China initiated the surveillance system to monitor the status of HIV/AIDS in 1986. It has evolved through three stages (Zheng *et al*, 1989; MOH and China CDC, 1996; Sun, 1999; Zheng, 2001; Lu *et al*, 2002; Zhang and Ma, 2002): (1) passive surveillance from 1986 to 1994; (2) HIV sentinel surveillance with coexisting active surveillance and passive surveillance from 1995 to 1998, and (3) the comprehensive surveillance stage from 1999 to the present (2006).

The passive surveillance stage (1985-1994)

The HIV/AIDS surveillance system in China was initiated in 1986 after a foreign visitor was recognized as the first AIDS case in 1985 (Zheng *et al,* 1989; Zheng, 2001; Lu *et al*, 2002). HIV/AIDS was reportable through three theoretically complementary but practically overlapping components: (1) The HIV/AIDS Reporting System, coordinated by the Division of Epidemiology, National Center for AIDS/STD Prevention and Control (NCAIDS) of the Chinese Academy of Preventive Medicine (CAPM) (Zheng *et al*, 1989; MOH and China CDC, 1996; Sun, 1999; Zheng, 2001; Lu *et al*, 2002; Zhang and Ma, 2002), (2) The Communicable Diseases Reporting System, coordinated by the Division of Epidemiology, Institute of Infectious Disease Control and Prevention, CAPM (includes 35 notifiable infectious diseases) (Zheng *et al*, 1989; China CDC and US CDC, 2002; China CDC, 2006), and (3) The National STD Surveillance System, coordinated by the Nanjing STD Center of the Chinese Academy of Medicine (data on eight STDs including HIV) (Zheng *et al*, 1989; China CDC and US CDC, 2002; China CDC, 2006). Through these three systems, HIV/AIDS case reports flowed from the health facilities or clinics as follows: (1) to the local district, county, or county-level city, (2) to the prefecture or prefecture-level city, (3) to the provincial health departments, and (4) to three separate national agencies. The HIV/AIDS reporting system coordinated by the National Center for AIDS/STD Control and Prevention (NCAIDS) of CAPM served as the principal component of the HIV/AIDS surveillance system (Fig 1).

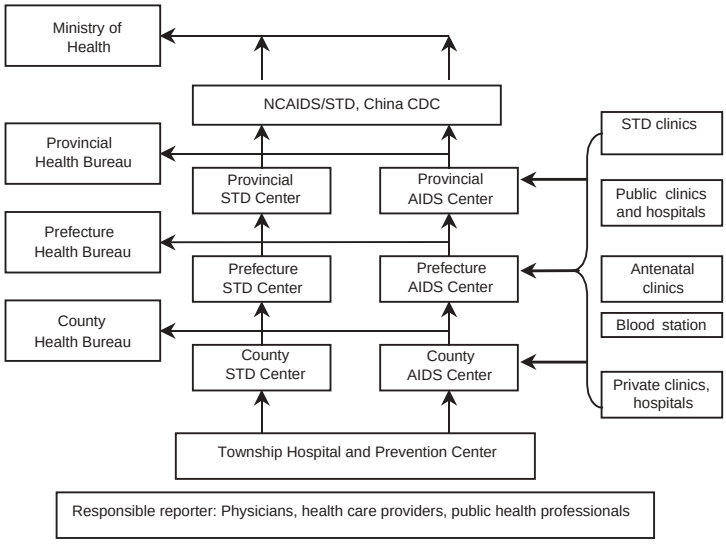
The sentinel surveillance development stage (1995-1998)

In 1995, the China Ministry of Health, in conjunction with local government health authorities, implemented an expanded surveillance system with three complementary elements: (1) passive HIV/AIDS case reporting, (2) active HIV sentinel surveillance (HSS), and (3) special epidemiological studies focusing on high risk groups. With the assistance of the World Health Organization (WHO), 42 national sentinel sites were established in 23 of the 31 provinces in 1995 (Note that our use of "provinces" includes the following entities: 22 provinces, 5 autonomous regions, and 4 munici-

palities, all of which are considered similarly in the Chinese political system, analogous to states in the United States) (MOH and China CDC, 1996; Qu *et al*, 1998, 2000; Zheng, 2001). At that time, the target groups for HSS included injection drug users (IDUs), patients attending STD clinics, commercial sex workers (CSWs), and long-distance truck drivers (Qu *et al*, 1998, 2000). Since 1997, women attending antenatal clinics have been included in the sentinel surveillance efforts. Former blood plasma donors were recruited by HSS in 1998-2001, but not in the later years (Qu *et al*, 2000). Subsequently, more than 100 provincial HSS sites were established and sponsored by local provincial governments as complementary to the national HSS. HSS continues to serve as a principal component of HIV surveillance in China (Sun, 1999; Lu *et al*, 2002).

The comprehensive surveillance development stage (1999 to 2006)

From 1999, the surveillance system was strengthened further with specific epidemiological studies, a web-based HIV/AIDS reporting system, and an increase in the number of national and provincial HSS sites (China CDC and US CDC, 2002). National HSS sites had been established in 158 locations in all 31 provinces by 2002. The number of national HSS sites was increased to 194 by 2003, 247 by 2004, and 329 by 2005 (Table 1) (Lu *et al,* 2006). Men having sex with men (MSM) were targeted for surveillance in 2003. In addition, there were 420 provincial HSS sites established by 2005 to provide provincial level data with the support of local funds (Table 1). There were 57 confirmatory laboratories and 3,756 screening laboratories supporting screening among key populations in 2005. There were 2,850 Voluntary Counseling and Testing (VCT) clinics providing free counseling and testing services by 2005. The creation of the China CDC (from the CAPM) in 2002 brought together the different agencies within the MOH responsible for HIV/AIDS surveillance. This united the three separate case-reporting systems in an effort to integrate, simplify, and



STD: Sexually transmitted diseases

The National Center for AIDS and STD Control and Prevention (NCAIDS) at the China Center for Disease Control and Prevention (CDC) leads surveillance program management, review, and oversight of HIV/AIDS case-reporting.

Fig 1–Case reporting system of HIV/AIDS surveillance in China.

strengthen the HIV/AIDS reporting system (Fig 1) (Sun, 1999; Lu *et al*, 2002). Since then, China CDC has led surveillance program management, review, and oversight of HIV/AIDS case-reporting.

Since 1998, Chinese experts have developed the HIV/AIDS/STD Comprehensive Surveillance concept based on the characteristics of the epidemic in China and have incorporated the WHO "second generation surveillance" (WHO and UNAIDS, 2000; China CDC, 2002). Based on the existing HIV/AIDS and STD surveillance systems, the HIV/AIDS/STD Comprehensive Surveillance System combines HIV/AIDS surveillance with STD surveillance (biological markers for high risk behavior) and combines biological surveillance with behavioral surveillance. China initiated the National HIV/AIDS/STD Comprehensive Sentinel Surveillance (NHCSS) system in 2003, delayed in implementation by one year due to the diversion of public health staff to address the epidemic of coronavirus-associated severe acute respiratory syndrome (Table 2) (China CDC, 2004). NHCSS was established in 42 sentinel sites from 19 provinces to assess behavioral trends of high risk sub-groups (IDUs, CSWs, MSM, and STD patients), vulnerable groups (long distance truck drivers), and selected sub-groups of the general population (students age 14-25 years). In order to capture the diversity of HIV risks and to track and explain changes over time, NHCSS combines biological and behavioral surveillance strategies within a "second generation" surveillance system, both population-based and facility-based. A two-stage-cluster sampling method was applied; probability proportional to size sampling was used for target populations of known sizes and equal probability techniques were used when there was an unknown size of the target population in the first stage. Specialized methods were used in the second stage, including, simple random sampling, systematic sampling, snowball sampling of CSWs and IDUs, and total population surveys for willing truck drivers through their companies. Data were used for program planning, to concentrate resources for care and prevention in areas of greatest need. The NHCSS provides an earlier warning of epidemic spread than does HIV/AIDS reporting, can help regional and national health officials design focused interventions and is used in program evaluations (China CDC, 2006).

Additional surveys were integrated into the HIV/AIDS/STD Comprehensive Surveillance system in 1999 (China CDC, 2006).

The first Behavioral Surveillance Survey was conducted in Xinjiang, Guangxi, Fujian, and Shanxi, supported by a World Bank Loan Project. Behavioral surveillance surveys target high-risk groups, vulnerable groups, and the general public. In 2001, the China-United Kingdom HIV Prevention and Care Project carried out a behavioral surveillance study in Yunnan and Sichuan, providing information about the context of high-risk behavior and condom use among CSWs and the general male population. These were followed in 2002 by special surveys in 22 provinces among high risk groups (Lu *et al*, 2002; China CDC, 2006).

The first Nationwide HIV Seroprevalence Survey was completed in June 2004. This methodologically rigorous survey was conducted to improve HIV/AIDS surveillance, to better measure HIV prevalence among high-risk sub-groups, to estimate the population size of each sub-group, and to guide prevention efforts and efficient allocation of resources. Stratified random sampling was applied in the selection of 80,000 people, including IDUs, CSWs, blood plasma donors, MSM, STD clinical patients, hospital patients, and the general population (China CDC, 2006).

Another important data source is the National Surveillance Survey, a comprehensive annual survey of available nationwide data of varying quality. The first national surveillance

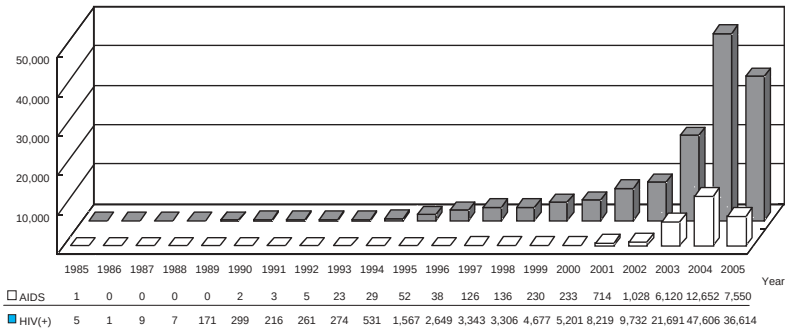
survey was carried out in 2002 and is now an annual routine for province-level CDCs. National Surveillance Survey data include estimated HIV prevalence among high risk subgroups and selected general population subgroups based on estimates from local provincial experts. These include the estimated size of the subgroup populations at risk and the general population, documentation of the estimation procedures used, a report on the estimated number of STDs, and summaries of local epidemiological studies, both published and unpublished (China CDC, 2006).

Laboratories that conduct Routine HIV Serologic Testing Programs provide summary reports quarterly to provincial CDCs and then to China CDC. The scope of this testing varies considerably by province; groups that are tested include couples applying for marriage licenses, pregnant women, occupational groups, such as restaurant and night-club workers, health care workers, persons returning from overseas, and high-risk persons, including drug users and CSWs in detention/re-education centers (China CDC, 2006). In summary, the web-based HIV/AIDS reporting system, the HSS, the NHCSS sentinel sites, the Nationwide HIV Seroprevalence Survey, the National Surveillance Survey, routine HIV serologic testing programs, and specific epidemiological studies and surveys have formed a more effective and comprehensive surveillance system in China.

RESULTS

National surveillance data suggested that the HIV epidemic in China had gone through an Introduction Phase (1985 to September 1989), then a Spreading Phase (October 1990 to 1994) (Fig 2). The small number of AIDS cases in 1985-1988 from coastal cities represented foreigners or Chinese people who had traveled overseas. For example, four patients with hemophilia infected with HIV through imported Factor VIII were reported from Zhejiang Province. Only 193 infected people had been reported with HIV/AIDS by the end of 1989, of whom 41 (21.2%) were foreigners.

The Spreading Phase of the epidemic was recognized in October 1989 with the identification of autochthonous HIV infection in 146 IDUs in Southwest Yunnan. Subsequent HIV outbreaks among IDUs were confirmed in several counties and cities in Dehong Prefecture, Yunnan Province, which is on the Myanmar border. Reported HIV/AIDS cases among STD patients, CSWs, and Chinese people returning from overseas increased steadily in several regions. The cumulative number of HIV/AIDS cases by the end of 1994 was now dominated by Chinese nationals who represented 90% of the cumulative reported cases. Of



National surveillance data demonstrated that the HIV epidemic in China had gone through an introduction phase (1985 to September 1989), a spreading phase (October 1990 to 1994) and a rapidly spreading phase (1995 to present, 2006).

Fig 2–Annual report HIV/AIDS cases in China (1985-2005). A total of 175,321 cumulative confirmed HIV cases had been reported, including 28,942 AIDS cases, as of reports received through April 2006 for 1985-2005 inclusive.

Table 1
Sentinel surveillance sites contributing data to national HIV estimates in 2003 and 2005[a].

Different types of sentinel sites	2003	2005		
	National	National	Provincial	Total
Commercial sex workers	43	67	57	124
Drug users/injection drug users	49	77	92	169
Sexually transmitted disease clinics	72	120	147	267
Men who have sex with men	1	3	0	3
Antenatal clinics	18	37	45	82
Long distance truck drivers	11	25	23	48
Others	-	-	56	56
Total	194	329	420	749

[a]This table indicates the number of HIV sentinel surveillance (HSS) sites for each at-risk population with data available in the 2003 and 2005 estimate process. The national HSS expanded to 329 sites, compared with 194 in 2003. In addition, data from 420 HSS provincial sites were included for 2005 estimates compared to only 194 national HSS sites available for 2003 estimates.

Table 2
National HIV/STD Comprehensive Sentinel Surveillance Sites in 2004-2005[a].
Comprehensive sites are defined as those that include both biological and behavioral surveillance and testing for sexually transmitted infections.

Province, municipality, or autonomous region (n=19)	CSWs	Drug users	MSM	STD	LDTR	Students	Total
Guangdong	2	1		1			4
Yunnan and Xinjiang	1	1				1	6
Guangxi and Sichuan	1	1			1		6
Guizhou	1	1		1			3
Shandong	1		1	1			3
Anhui, Jiangsu	1			1			4
Henan, Hubei, and Fujian	1	1					6
Shanxi	2						2
Liaoning	1		1				2
Hainan	1					1	2
Hunan, Shanghai, Ningxia, and Jilin	1						4
Total	21	9	2	5	2	3	42

[a]National HIV/STD Comprehensive Sentinel Surveillance (NHCSS) was established with 42 sites in 19 provinces to assess behavioral trends of at-risk subgroups, including drug users, commercial sex workers (CSWs), men who have sex with men (MSM), sexually transmitted disease (STD) patients, blood plasma donors, long distance truck drivers (LDTDs), and students.

1,839 cumulative HIV/AIDS cases reported through the end of 1994, only 3.7% had clinically defined AIDS, reflecting the relatively recent spread of HIV.

The surveillance data from 1995 to the present (2006) suggested that the HIV/AIDS epidemic began a Rapid Spread Phase in 1995 (Fig 2). The epidemic expanded rapidly

Table 3
Serological testing results for different investigated groups from National HIV/STD Comprehensive Sentinel Surveillance in 2004[a].

Groups	Sites	Participants	Serospecimens	HIV+ (%)[a]	Syphilis+ (%)[a]
Drug users	9	2,321	2,118	374 (17.7%)	66 (3.1%)
Female sex workers	21	5,462	4,878	3 (0.1%)	137 (2.8%)
STD patients	5	1,716	1,667	1 (0.1%)	147 (8.8%)
MSM	2	150	90	1 (1.1%)	14 (15.6%)
LDTDs	2	756	740	0	0
Students	3	1,508	817	0	0
Total	42	11,913	10,310	397[b]	364[b]

[a]A total 11,913 participants were interviewed from six different groups including drug users, female sex workers, men who have sex with men (MSM), sexually transmitted disease (STD) patients, blood plasma donors, long distance truck drivers (LDTDs), and students, at National HIV/STD Comprehensive Surveillance sites. A total of 10,310 (96%) serospecimens were drawn and examined for HIV status by the enzyme-linked immunosorbent assay (ELISA) and syphilis by rapid plasma reagin (RPR) test.
[b]We do not present an overall % positivity since the total is not representative of any given population.

among IDUs in rural border areas of Yunnan Province, where China borders Myanmar, Lao PDR, and Vietnam close to the "Golden Triangle", soon spreading to IDUs in nearby cities. It further spread to IDU communities residing along the major drug trafficking routes to Guangxi, Xinjiang, Sichuan, Guangdong, and other provinces. Surveillance data suggest the number of individuals (n=1, 567) identified with HIV infection in just one year, 1995, approached the total cumulative number (n= 1,839) from the previous decade (1985 to 1994). The number of new HIV/AIDS reports rose 70% to 2,694 in one year (1994 to 1995). Many cases of HIV infection were reported among IDUs beyond Yunnan, as well as among CSWs and blood plasma donors from various regions in the mid-1990s. By the end of 1998, HIV infection had been reported from all 31 provinces. Drug users still accounted for 60-70% of reported HIV infections through 1998, and the proportion of transmissions through heterosexual contacts increased steadily to 7%.

In 2004, 42 NHCSS sites interviewed a total 11,913 participants among risk groups (IDUs, CSWs, MSM, and STD patients), vulnerable groups (long distance truck drivers), and selected sub-groups of the general population (students age 14-25 years). A total of 10,310 (96%) participants were tested by HIV-specific enzyme-linked immunosorbent assay (ELISA) and for syphilis by the rapid plasma reagin (RPR) test. Of 10,310 participants tested, 379 (3.7%) were HIV seropositive and 364 (3.6%) were RPR seropositive (Table 3). A total of 175,321 cumulative confirmed HIV cases have been reported, including 28,942 AIDS cases (17%), as of reports received through April 2006 for 1985-2005 inclusive.

Improved surveillance programs have enabled more accurate estimates in 2005, correcting the overestimates reported in 2003. Similar estimation methods were used in 2003 and 2005, but these generated estimates of 840,000 HIV cases in 2003, but a lower estimate of 650,000 HIV cases in 2005. Deaths from AIDS do not explain this difference; rather, the data sources differed. The newer 2005 estimates used more data sources from more sentinel sites (Table1), more epidemiological studies, and more complete and representa-

tive data from national HIV screening programs and surveys, including better estimating the sizes of at-risk populations based on new behavioral surveillance data. New estimates were done at the prefecture level, providing more representative and detailed information than the province-wide estimates done in 2003. For example, a more realistic downward adjustment was made in estimating that 55,000 former blood plasma donors were living with HIV/AIDS in 2005, a difference of 144,000 compared with the 2003 estimate of 199,000; similarly 47,000 MSM were estimated to be living with HIV/AIDS in 2005, a difference of 50,000 compared with the 2003 estimate of 97,000. This experience is not unique to China. As US and sub-Saharan African surveillance systems improved, it was also noted that earlier prevalence estimates were too high due to overestimates of rural prevalence rates where surveys were scarce.

Surveillance data highlight at least seven noteworthy features of the Chinese HIV/AIDS epidemic in 2005: (1) HIV infection rates continue to increase. Serial seroprevalence surveys conducted at sentinel surveillance sites indicate the HIV prevalence among IDUs has risen from 2.0% in 1999 to 6.5% in 2005. HIV prevalence among CSWs has risen from 0.02% in 1999 to 0.9% in 2005. HIV prevalence among pregnant women has risen from 0 in 1996 to 0.26% in 2005. (2) The number of persons with high risk exposures include IDUs, CSWs and their clients. (3)There are wide geographic variations in HIV prevalence among IDUs and CSWs. HIV prevalence among IDUs exceeds 50% in some areas of Xinjiang, Yunnan and Sichuan and other provinces; while remains under 5% in other provinces, such as Hebei, Ningxia, and Shanxi. HIV prevalence among CSWs is over 1% in some local areas, but is much lower elsewhere. (4) New cases are being transmitted primarily through IDU and sex in the context of higher STD rates. Among people living with HIV/AIDS in 2005, an estimated 44.3% were infected through IDUs, 19.6% through commercial sex (CSWs and their clients), 16.7% were persons from the general population (without evident risk exposures), 10.7% through blood plasma products, 7.3% were MSM, and 1.4% through mother-to-child transmission. The male-female ratio of people living with HIV/AIDS was 2.5 to 1 in 2005, compared with 3.4 to 1 in 2003. Among the newly reported cases in 2005, 49.8% were associated with sexual transmission, 48.6% associated with injection drug use, and 1.6% associated with mother-to-child transmission of HIV. HIV has been identified in some urban areas among MSM, but this population has been stigmatized and is difficult to reach for conduct of serologic surveys or prevention outreach. (5) More people are progressing to clinical AIDS, and AIDS-related deaths are on the rise. (6) The epidemic is spreading from high-risk groups to the general population. In some areas of Yunnan, Henan, Xinjiang and other provinces, HIV prevalence rates have already exceeded 1% among pregnant women and those receiving premarital and clinical HIV testing. (7) HIV/AIDS awareness still remains unacceptably low. National surveillance data indicates that 45.5% of IDUs are sharing needles and syringes and 11% of IDUs are engaging in high risk sexual activities, thereby providing a bridge between the high risk IDU groups and the general population. A related problem is a dramatic increase in the prevalence of STDs, particularly ulcerative STDs that are known to facilitate the transmission of HIV. Mobility of people living with HIV/AIDS is another factor affecting the spread of HIV around China. In summary, surveillance-based seroprevalence surveys suggest that HIV rates will continue to rise in China.

DISCUSSION

Although an effective and comprehensive surveillance system has been developed,

China still confronts many challenges in surveillance and monitoring. Given the enormous population, there is a lack of skilled epidemiology personnel at all levels of the public health system. Many local staff have insufficient training and are poorly informed as to the purpose of surveillance activities. Despite recent improvements, the existing surveillance system is inadequate, particularly in rural areas where about 800 million Chinese live. HIV testing and clinical AIDS diagnostic services have been stretched too thin to accommodate all prefectures and counties.

Only about 20% of the persons estimated to have HIV/AIDS in China have been tested and only about 15% of those testing positive have received antiretroviral therapy (ART)(Lu *et al*, 2006; Wu *et al*, 2006). These estimates suggest that HIV/AIDS surveillance is occurring in the context of insufficient voluntary counseling and testing (VCT) and diagnostic capacity with consequent limited case finding. China, like many other developing countries, suffers from poor health information systems (Diaz *et al*, 2005). Furthermore, there are political and cultural constraints to report HIV/AIDS accurately as a cause of illness or death (China CDC and US CDC, 2002). China has adopted the "Four Frees and One Care Policy" (free ART, free prevention of mother-to-child transmission, free VCT, free schooling for children orphaned by AIDS, and care to people living with HIV/AIDS) since 2003, but the capacity lags behind the need (MOH, UNAIDS, WHO, 2006; State Council AIDS Working Committee Office, 2004). As ART is increasingly available, increased demand for VCT, may help reduce stigma (Peck *et al,* 2003). By the end of 2005, free ART had been provided to 20,453 AIDS patients in 605 counties within 28 provinces, including about 17,000 former plasma donors, 600 drug users, and 100 MSM (China CDC, 2006; Wu *et al*, 2006).

Bias and lack of representation creep into surveillance data via many routes. For example through 2003, all HSS of IDUs and CSWs had been conducted in detention centers. By limiting selection to such persons, bias is introduced because those persons in detention may have a different prevalence rate of HIV than those not in detention. In addition, conventional surveillance approaches often capture only a small fraction of the total population of some subgroups and there is no assurance that biases in coverage will remain constant over time. Thus, surveillance data can be misleading or can fail to capture significant pockets of infection that can lead to a more generalized spread of HIV if not contained (China CDC and US CDC, 2002; Magnani *et al*, 2005).

HIV prevalence rates are high in marginalized and hard-to-reach groups with high risk behaviors that are illegal (CSWs and IDUs) and/or socially stigmatized (MSM). There are challenges in sampling these groups in a representative manner. The sensitive nature of the behaviors also creates problems when trying to obtain valid responses. With improved sampling and recruitment strategies, *eg*, snowball sampling, time-location sampling, and respondent-driven sampling, behavioral surveillance can play a crucial role in identifying and monitoring behavioral changes among high risk groups. It is so new in China that its utility is just now being tested (Zhao *et al*, 2005). Understanding and monitoring the behavior of key at-risk subgroups are essential to control of spread of infection. However, the traditional HIV/AIDS reporting system and HSS in China were biological surveillance systems that did not track the risk behaviors and therefore, did not permit a full understanding of the dynamics of incident HIV and the related risky behaviors occurring over a given time and place (Magnani *et al,* 2005). The development of 42 NHCSS sentinel sites in 2004 has emphasized the integration of behavioral surveillance into traditional biological surveillance with a more

representative sampling strategy, however, the limited coverage of NHCSS sentinel sites and the challenges of quality control are of the most concern (China CDC, 2004).

Tuberculosis (TB) and HIV/AIDS surveillance systems are completely separate. About 1.3 million people develop active (contagious) TB and 150,000 die from the disease each year, ranking China the second most affected nation in terms of absolute numbers after India (WHO, 2005). HIV/AIDS spread that undermines TB achievements could be devastating in China. HIV/AIDS surveillance and TB surveillance cannot now readily identify co-infected persons. Chinese officials are working at present (2006) to cross-reference these data bases in order to identify persons listed in both and to guide the implementation of effective TB control programs to minimize HIV/AIDS and TB co-epidemics.

Surveillance systems in most regions of China suffer from lack of coverage of key populations, quality control problems, and a lack of time and capacity for integrated analysis of demographic, epidemiological, laboratory, clinical, and behavioral risk data. They also suffer from suboptimal use of their findings to guide program changes. The essential links between surveillance data and program management (*eg*, ART distribution, effective targeting of condom distribution, and expanded needle exchange and methadone treatment among IDUs) are often absent, leading to static prevention and care programs that do not match a changing epidemic.

Our review of the evolution and data sources of Chinese HIV/AIDS surveillance is the basis for six recommendations, several of which are already being improved by the China CDC (Qian *et al*, 2005). (1) The capacity of local staff who work in HIV/AIDS/STD surveillance and testing should be improved for data analysis, advocacy, the application of best practices, and strict maintenance of privacy and confidentiality. (2) Routine surveillance and HIV testing among different populations should be strengthened and continuously expanded in order to monitor the expansion of effective prevention, treatment, and care interventions, as well as to secure the implementation of the "Four Frees and One Care" Policy. (3) HIV drug resistance surveillance should be included to guide future ART policies, regarding the divergent subtypes of HIV-1 circulating in China (Zheng and Jia, 2007). (4) Improved sampling and recruitment strategies, *eg*, snowball, time-location, respondent-driven sampling, should be validated and expanded for the hard-to-reach and hidden populations in China. Research is needed in HIV/AIDS surveillance for improving sampling methods and recruitment strategies to obtain representative samples of vulnerable and hard-to-reach groups. Expanding NHCSS sites for behavioral data collection (China CDC, 2002, 2004), developing standard protocols, building consensus about eligibility and questionnaire elements, and determining adequate sample sizes and representativeness will improve the system. (5) Since methods for HIV prevalence estimates have substantial uncertainties and each estimation method has its biases, more reliable estimates can be made by synthesizing the estimates from different modeling procedures and several different sources of data (Karon *et al,* 1996, 1998). (6) Improved surveillance can guide key policy makers to mobilize adequate resources most efficiently to contain HIV. China has made major strides in improving HIV/AIDS surveillance, but further progress is needed for efficient targeting of prevention and care program investments.

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