The global epidemiology of HIV/AIDS

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In this paper, the ways in which HIV is transmitted and factors facilitating transmission are described, although we still do not fully understand why the HIV epidemic has spread so heterogeneously across the globe. Estimates of HIV prevalence vary in quality but give some idea of trends in different countries and regions. Of all regions in the world, sub-Saharan Africa is the hardest hit by HIV, containing around 70% of people living with HIV/AIDS. There are, however, recent signs of hope in Africa due to a slight reduction in the number of new HIV cases in the year 2000. Most countries in Asia have not seen explosive epidemics in the general population up to now but patterns of injecting drug use (IDU) and sex work are conducive to the spread of HIV so there is no room for complacency. Unpredictable epidemics among IDU in the former Soviet Union have the potential to spread into the general population. Some countries in Central America and the Caribbean have growing HIV epidemics with adult prevalences second only to sub-Saharan Africa. Reductions in morbidity and mortality through the use of highly active antiretroviral therapy are at present limited to high-income and some Latin American countries. Both the cost of these therapies and the poor health care delivery systems in many affected countries need to be addressed before antiretrovirals can benefit the majority of people living with HIV/AIDS.

In 1981, the Centers for Disease Control and Prevention reported unusual clusters of Pneumocystis carinii pneumonia and Kaposi’s sarcoma in gay men in parts of the US. These were the first reported cases of Acquired Immune Deficiency Syndrome (AIDS). Twenty years later, the global HIV/AIDS epidemic has killed an estimated 21.8 million people and another 36.1 million are living with HIV infection. Around 95% of these people live in non-industrialised countries with few financial resources to deal with the HIV/AIDS epidemic and where hard won social and economic development is most vulnerable to the heavy burden that HIV/AIDS puts upon it. Over 90% of people living with HIV/AIDS do not know they are infected and even if they did antiretroviral therapies (ART) are not at present an option for them. Most people living with HIV/AIDS are in the economically productive age-group supporting children and elderly relatives and most will receive...
minimal care when they finally develop AIDS-related illness. From many aspects the global HIV/AIDS epidemic is an enormous tragedy for humankind.

**HIV transmission**

The estimated 57.9 million people who have been infected with HIV since the pandemic began have, with a few exceptions, caught the virus by one of three modes of transmission: sexual, parenteral and mother-to-child. HIV-1 is the virus type responsible for the global pandemic. HIV-2 is less easily transmitted than HIV-1 and is confined mainly to West Africa. There is at present no convincing evidence to suggest that different HIV-1 subtypes have different transmission probabilities.

**Sexual transmission of HIV**

Sexual transmission is by far the most common mode of transmission globally. Obviously the probability of a person being infected via sexual intercourse depends on the likelihood of unprotected sex with an infected partner, so sexual behaviour patterns and the background prevalence of HIV are of major importance. Interventions to change sexual behaviour (mainly partner reduction) and to promote condom use are, therefore, a vital component of any HIV control programme and have been shown to be effective in individual studies and at the national level.

The chance that a person becomes infected with HIV during one particular sexual contact varies greatly and depends on many factors. Male to female penile-vaginal transmission appears to be 2–3 times more efficient than female to male transmission and there is some evidence that first sexual intercourse for females may be associated with particularly high transmission probabilities. Receptive anal intercourse appears to be more risky than receptive vaginal intercourse with obvious implications for spread amongst men who have sex with men (MSM). Cases of infection by oral sex have been reported but this mode of transmission is believed to be much less risky than penile-vaginal or penile-anal sex.

Sexual transmission of HIV also depends greatly on the infectiousness of the infected partner. Higher viral loads in the later stages of the disease are associated with increased probability of transmission but infectiousness has also been shown to be higher around the time of seroconversion. ART, which reduces infectiousness, therefore has implications for transmission of HIV as well as affecting the morbidity and mortality of those living with HIV/AIDS.
Sexual transmission of HIV is enhanced by the presence of another sexually transmitted infection (STI), especially an ulcerative one such as chancroid, syphilis or herpes simplex virus 2 (HSV2)\textsuperscript{17,18}. STI control programmes are, therefore, an important component of HIV prevention programmes and have been shown to be effective in reducing incidence of HIV in the early stages of an HIV epidemic where a substantial proportion of STIs are treatable\textsuperscript{19}. However, there is some doubt about their effectiveness for HIV control in areas where the HIV epidemic is mature and transmission probabilities are dominated by viral load and infections which are difficult to treat in non-industrialised countries, such as HSV2 and bacterial vaginosis\textsuperscript{20,21}.

The evidence for a partially protective effect of male circumcision is now compelling\textsuperscript{22,23} and studies examining the acceptability and feasibility of promoting male circumcision for HIV prevention are underway\textsuperscript{24}. Other factors which may increase the transmission probability of HIV include the insertion of herbs or other substances into the vagina by some women in sub-Saharan Africa to facilitate dry and tight sex\textsuperscript{25} and use of some types of contraception\textsuperscript{7}. Recent reviews\textsuperscript{26,27} suggest that forced or coercive sex may also be associated with increased transmission probabilities for women.

**Parenteral transmission of HIV**

Parenteral transmission of HIV occurs most commonly among IDU when needles are shared. Prevention of transmission between IDU can be achieved by community outreach and needle exchange programmes\textsuperscript{5} although political reluctance to work with IDU can be difficult to overcome. Parenteral transmission can also occur by the transfusion of infected blood, so screening blood and/or reducing the unnecessary use of transfusions are necessary to minimise transmission by this route. Contaminated needles for injections and needlestick injuries among health professionals are another source of infection. Contaminated blood products (such as Factor VIII) and infected organs or semen have also been shown to transmit infection.

**Mother-to-child transmission of HIV**

Since the beginning of the epidemic, an estimated 5.1 million children world-wide have been infected with HIV. Mother-to-child transmission (MTCT) is believed to be responsible for more than 90% of these infections\textsuperscript{28}. Around two-thirds of MTCT occurs in \textit{utero} and at delivery and one-third occurs during breast feeding. Long regimens of ART have been shown to be highly effective in preventing MTCT but shorter, less
complex and cheaper regimens have also been shown to reduce MTCT by half in infants who are not breast fed. Implementing this intervention on a large scale in non-industrialised countries is complicated by the lack of safe alternatives to breast feeding, the issue of HIV testing and costs of the drug, service delivery and HIV tests.

**Core groups**

Within countries, there are sub-populations who are particularly vulnerable to HIV infection, such as sex workers and their clients, MSM and IDU. The HIV virus is often found predominantly within these subpopulations (sometimes called core-groups) at the beginning of an epidemic when prevalence is extremely low in the general population. HIV prevention activities have been found to be particularly effective when focused on these vulnerable groups at the early stages of an epidemic. If not controlled while it is predominantly within these groups, HIV can spread into the general population via, for example, wives or girlfriends of men who use sex workers or sexual partners of IDU. Subpopulations at a particularly high risk of HIV tend to be situated in urban areas so when HIV starts to spread into the general population, urban areas are usually affected before rural areas.

**Social, cultural, economic and political context**

The fact that HIV raises the culturally sensitive issues of sexuality, gender inequality, commercial sex, MSM and IDU has often led to denial of the problem and reluctance to address it, which obviously exacerbates the problem. Gender inequality means that women are often not in a position to negotiate safe sex and are put at risk of infection by husbands and partners. The development of female controlled methods of HIV prevention, such as the female condom and microbicides, are therefore particularly urgent. Migration, which separates people from their families, can result in higher levels of commercial and casual sex. The very low level of financial resources available to most affected countries make decisions about the priority of HIV control extremely difficult and also limits the general level of health services available. These are just a few examples of how the social, cultural, economic and political context have a major impact on HIV epidemics.

**The relative importance of factors driving HIV epidemics**

In addition to the factors mentioned above, the susceptibility of an individual to HIV infection may depend on genetic factors, although it
is not widely believed at present that this is a major factor driving the different HIV epidemics. A study of sexual behaviour and factors affecting transmission probabilities in four cities in sub-Saharan Africa suggests that male circumcision, prevalence of HSV2 and high levels of sexual debut at an early age for females are important in driving the HIV epidemics in sub-Saharan Africa. An analysis of more macro social and economic factors thought to affect HIV in 72 non-industrialised countries found that indicators of poverty, income inequality, gender inequality, poor economic growth, high levels of immigration and high levels of militarisation explained between a half and a third of the variation in HIV prevalences between countries. However, we are a long way from fully understanding how and why the enormous variations in the HIV epidemic seen around the world have developed.

Estimating the magnitude of the epidemic

Where HIV has spread into the general population, ongoing HIV surveillance in women attending antenatal care can give a good indication of trends within a population. In addition, community-based surveys give estimates of prevalence, and sometimes incidence, in the general population and aid interpretation of antenatal surveillance data. STI clinic attendees are often included in HIV surveillance to give an idea of prevalence in high risk groups. However, access to many high risk groups for surveillance is difficult, so estimates in countries where HIV is still mainly restricted to these groups are usually less reliable. There is great variation between countries in the effort to gather data on HIV. Some countries have carried out widespread surveillance since the 1980s, whilst in others coverage is patchy or barely existent. UNAIDS takes estimates available from published studies and combines them with unpublished data, which is collected as part of AIDS control programmes in many countries, to produce national estimates of prevalence and deaths. Obviously, these estimates are only as good as the data on which they are based but they are the most comprehensive available. UNAIDS reports for the year 2000 will be drawn on heavily in the following sections describing regional trends around the world.

Global trends in the HIV pandemic

Sub-Saharan Africa

Sub-Saharan Africa has been devastated by the HIV/AIDS epidemic. While only 10% of the world’s population lives in sub-Saharan Africa,
an estimated 70% of all HIV infected adults and children are found there (Table 1). Heterosexual sexual transmission is predominant and sub-Saharan Africa is the only region where more women than men are infected. Patterns of sexual behaviour whereby young women have sex with older men, in combination with high susceptibility to infection in very young women, has resulted in extremely high infection rates in young women in some parts of Africa. The inaccessibility of antiretroviral treatment in this region means that the vast majority of HIV infected people die around 8–10 years after infection, with tuberculosis being the most common AIDS-related illness. In the year 2000, 2.4 million adults and children were estimated to have died from AIDS in sub-Saharan Africa.

The first area to experience high prevalences of HIV was East Africa with countries in this area now experiencing adult prevalence rates of

### Table 1 Regional HIV/AIDS statistics and features at the end of 2000

<table>
<thead>
<tr>
<th>Region</th>
<th>Epidemic started</th>
<th>Adults and children living with HIV/AIDS</th>
<th>Adult prevalence rate&lt;sup&gt;a&lt;/sup&gt;</th>
<th>% of HIV positive adults who are women</th>
<th>Main mode of transmission&lt;sup&gt;b&lt;/sup&gt; for adults living with HIV/AIDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sub-Saharan Africa</td>
<td>Late 1970s, early 1980s</td>
<td>25.3 million</td>
<td>8.8%</td>
<td>55%</td>
<td>Hetero</td>
</tr>
<tr>
<td>North Africa and Middle East</td>
<td>Late 1980s</td>
<td>400,000</td>
<td>0.2%</td>
<td>40%</td>
<td>Hetero, IDU</td>
</tr>
<tr>
<td>South &amp; South-East Asia</td>
<td>Late 1980s</td>
<td>5.8 million</td>
<td>0.56%</td>
<td>35%</td>
<td>Hetero, IDU</td>
</tr>
<tr>
<td>East Asia &amp; Pacific</td>
<td>Late 1980s</td>
<td>640,000</td>
<td>0.07%</td>
<td>13%</td>
<td>IDU, Hetero, MSM</td>
</tr>
<tr>
<td>Latin America</td>
<td>Late 1970s, early 1980s</td>
<td>1.4 million</td>
<td>0.5%</td>
<td>25%</td>
<td>MSM, IDU, Hetero</td>
</tr>
<tr>
<td>Caribbean</td>
<td>Late 1970s, early 1980s</td>
<td>390,000</td>
<td>2.3%</td>
<td>35%</td>
<td>Hetero, MSM</td>
</tr>
<tr>
<td>Eastern Europe &amp; Central Asia</td>
<td>Early 1990s</td>
<td>700,000</td>
<td>0.35%</td>
<td>25%</td>
<td>IDU</td>
</tr>
<tr>
<td>Western Europe early 1980s</td>
<td>Late 1970s,</td>
<td>540,000</td>
<td>0.24%</td>
<td>25%</td>
<td>MSM, IDU</td>
</tr>
<tr>
<td>North America</td>
<td>Early 1980s</td>
<td>920,000</td>
<td>0.6%</td>
<td>20%</td>
<td>MSM, IDU, Hetero</td>
</tr>
<tr>
<td>Australia &amp; New Zealand</td>
<td>Early 1980s</td>
<td>15,000</td>
<td>0.13%</td>
<td>10%</td>
<td>MSM</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>36.1 million</strong></td>
<td><strong>1.1%</strong></td>
<td><strong>47%</strong></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup>The proportion of adults (15–49 years of age) living with HIV/AIDS in 2000.  
<sup>b</sup>Hetero, heterosexual transmission; IDU, transmission through injecting drug use; MSM, sexual transmission among men who have sex with men. Source UNAIDS.
around 8–10%. Rates in two of these countries, Kenya and Somalia, appear to be still rising. West Africa has been relatively less affected by HIV with adult prevalence rates in most countries still estimated as less than 3%. However, there are worrying signs in two of the largest countries in West Africa with prevalences of 11% in Côte D’Ivoire and 5% in Nigeria. The most shocking statistics are from southern Africa where adult HIV prevalences have risen rapidly in the last few years to around 20%, with a staggering 35% prevalence in Botswana. South Africa is now the country with the highest number of people with HIV/AIDS in the world. However, there is some good news. After a strong HIV prevention programme in Uganda, adult prevalence has decreased from 14% in the early 1990s to around 8% in 2000. Also while the number of children and adults living with HIV/AIDS in sub-Saharan Africa increased during 2000, the increase (3.8 million) was slightly less than in 1999 (4.0 million). However, if rates start rising rapidly in some of the more populous countries, such as Nigeria, this trend could easily be reversed.

**HIV/AIDS epidemics in North Africa and the Middle-East**

HIV data from this region are very sparse. Best estimates are that around 400,000 adults and children were living with HIV in this region at the end of the year 2000 (Table 1). While adult HIV prevalence is at present low (an estimated 0.2%), recent data from Algeria and Sudan give warning signs that HIV may be spreading into the general population.

**South and South-East Asia**

Despite an overall estimated adult prevalence rate of only 0.56% (Table 1), this region contains around 16% of the total number of people in the world living with HIV/AIDS. There are enormous variations in how the HIV epidemic has spread within this region. National estimates put the prevalence at around 0.7% or less for all countries except Cambodia (4%), Myanmar (2%) and Thailand (2%). Thailand has a well-documented epidemic which showed rapid rises in HIV prevalence in the late 1980s which were reversed through a vigorous campaign to promote condom use, especially for contact with sex workers. There are hopeful signs that a similar approach by Cambodia may be limiting the spread of HIV into the general population there.

India is one of the most populous countries in the world and with a relatively low overall adult HIV prevalence of 0.7% already has the second highest number of people living with AIDS in the world. There
is wide variation within India. By 1998, Maharashtra and Andhra Pradesh states had antenatal prevalences of 2% or more while others had prevalences close to zero. National and some state governments have implemented prevention programmes to try and limit HIV infection in IDU and sex workers. They have also launched mass publicity campaigns to reduce risky sexual behaviour, especially among young men, in an effort to avert large scale infection in the general population. The success of these campaigns remains to be seen, as does the pattern of HIV prevalence in other South and South-East Asian countries which have similar patterns of risk factors but very low current HIV prevalence in the general population.

East Asia and the Pacific

Estimated adult HIV prevalence is extremely low (< 0.07%) in this region except for Papua New Guinea where it is still relatively low (0.22%). There is, however, no room for complacency because patterns of IDU and sex work in this region show a potential for the spread of HIV and mobility between and within countries is high. The most populous country in the world, China, has recently seen worrying levels of HIV among IDU and then in sex workers close to the borders of Myanmar, Thailand and Laos. An upsurge in STI rates in China after almost eradicating them in the 1960s also signals a worrying potential for HIV spread.

Latin America and the Caribbean

In Latin America, the highest rates of HIV prevalence are seen in the central American countries of Belize (2%), Guatemala (1.4%), Honduras (1.9%) and Panama (1.54%) and on the Caribbean coast in Guyana (3%) and Suriname (1.3%). Transmission within these countries is predominantly through heterosexual intercourse and in many of these countries HIV is spreading rapidly. In other Latin American countries, HIV transmission tends to be among MSM and IDU and prevalence rates in the general population have remained relatively low. In Brazil, the epidemic is characterised by heterosexual sexual transmission as well as transmission among MSM and IDU. Brazil (along with Argentina and Mexico) is attempting to provide antiretroviral treatment and high standards of care for people living with HIV/AIDS. The reduction in mortality due to the impact of these treatments results in higher numbers of people living with HIV/AIDS in these countries which masks the success of vigorous campaigns to prevent new infections.
The Caribbean has been badly affected by the HIV/AIDS epidemic with an overall adult prevalence rate of 2.1% at the end of 2000 (Table 1), second worst in the world after sub-Saharan Africa. The most badly affected countries are Haiti with an adult prevalence rate of 5.2%, the Bahamas (4.1%) and the Dominican Republic (2.8%). In these countries, transmission is predominantly heterosexual and rates are particularly high amongst young women (as in sub-Saharan Africa). High HIV rates have also been seen among IDU and MSM in these regions.

**Eastern Europe and Central Asia**

HIV/AIDS was rare in this region until the mid-1990s but since then HIV prevalence has risen exponentially, although still mainly restricted to IDU. At the end of 1999, Ukraine, Belarus, Moldova and the Russian Federation were the most badly affected countries. The epidemics occurring in different populations of IDU throughout the region make the overall epidemic highly unstable and there are worrying signs of a potential for spread. Economic instability may be exacerbating drug use and sex work and there are signs that HIV may have entered the general population in Ukraine. A rapid rise in syphilis in many parts of this region during the 1990s indicated a potential for sexual HIV spread, although there are some indications that this may have peaked around 1997. More optimistically, many countries in this region are improving sentinel surveillance and implementing political and legal reforms which will facilitate HIV prevention efforts.

**Western Europe, North America and Australasia**

HIV infection in these regions is confined largely to IDU and MSM. High prevalences of HIV among IDU reflect a reluctance to implement community outreach and needle exchange programmes in many countries in these regions. MSM were hit very hard by the epidemic in the early 1980s but mobilised themselves against the disease very effectively and rates of new infections dropped after the mid-1980s. However, there are fears of complacency in the latest generation of MSM, who have not seen peers die of AIDS and who have access to highly active antiretroviral treatment (HAART).

There have been slow and steady rises in heterosexual transmission of HIV in these regions and it has become the predominant mode of transmission in some western European countries, although prevalences are still very low. Examination of HIV infections by ethnic
group in the US and UK show that many ethnic minorities are at a disproportionately high risk of HIV infection and have not benefited as much from HAART as the rest of the population.

The most striking feature of the HIV/AIDS epidemics in these regions is the marked reductions in AIDS-related illness and death seen as a result of the introduction of HAART in the mid-1990s. However, rates have now levelled out, possibly due to treatment intolerance, poor compliance, drug resistance and late diagnosis of HIV/AIDS. HAART has also substantially reduced mother-to-child transmission of HIV with most perinatal infections in these regions now occurring in women who have not sought antenatal care and/or not been diagnosed as HIV positive.

Conclusions

Although our understanding of the factors affecting the spread of HIV has increased greatly, we still do not fully understand why different parts of the globe have experienced such different HIV epidemics. Data on HIV prevalence in different countries are compiled by UNAIDS. They vary greatly in quality but gives us some idea of the magnitude of the problem and trends. Sub-Saharan Africa has been hardest hit by the HIV pandemic with extremely high prevalences currently being observed in southern Africa. There are, however, signs of hope due to a slight reduction in the number of new cases in 2000. Most countries in Asia have not seen explosive epidemics up to now, but patterns of IDU and sex work are conducive to the spread of HIV so there is no room for complacency. Unpredictable epidemics among IDU in the former Soviet Union have the potential to spread into the general population. Some countries in central America and the Caribbean have growing epidemics with prevalences second only to sub-Saharan Africa. HAART has reduced mortality and morbidity due to AIDS in high-income countries and in some countries in Latin America but it is still inaccessible to the vast majority of the world's infected population. Negotiations are taking place to provide more affordable ART to non-industrialised countries, especially for MTCT; however, the ability of the health systems to deliver ART effectively in many of these countries needs also to be addressed.

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