

The truth about HIV/AIDS

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The Human Immunodeficiency Virus (HIV) is one of the most dangerous sexually transmitted diseases ever encountered. There have been many attempts to eradicate the virus (by drugs and vaccines), but the only success has been suppression of the virus. There are currently 33 million people worldwide infected by HIV, of whom 2.7 million were infected in 2007 (Steinbrook 2008). Sub-Saharan Africa has the largest population of seropositive individuals mainly caused by their societal belief that men are superior to women and children, the extremely high number of rape cases, and the lack of education for all men, women and children. Antiretroviral drugs have decreased the number of infected individuals by diminishing the viral load levels in infected individuals. Unfortunately, the costs of the antiretroviral drugs limit the number of HIV-positive individuals in poor countries that can efficiently take therapy. This paper presents a brief description of HIV, some of the reasons it has not yet been eradicated, and ways that could in theory eliminate the disease.

The first case of AIDS was noted in the 1980's. HIV is a disease that is accompanied by depletion in the number of CD4 T cells, and can be transmitted by blood or other body fluids. HIV was spread to humans by chimpanzee's *Pan troglodytes* (Janeway *et al.* 2006). The number of years it takes the Human Immunodeficiency Virus to cause a large depletion in T cells and create AIDS (Acquired Immunodeficiency Syndrome) varies between individuals but is approximately 10 to 12 years.

HIV is an enveloped retrovirus that contains two copies of an RNA genome which are reverse transcribed into DNA in the infected cell and then integrated into the host chromosome (Janeway *et al.* 2006). In order for the virus to enter the cell, specific receptors must bind. HIV enters a cell by binding two glycoproteins gp120 and gp41, and by binding with a co-receptor. The RNA transcripts produced from the integrated viral DNA serve both as mRNA to direct the synthesis of the viral proteins and later as the RNA genomes of new viral particles. New virions escape from the cell by budding from the plasma membrane, each in a new individual membrane envelope. The virus is carried in infected CD4 T cells, dendritic cells, and macrophages. It is also a free virus in blood, semen, vaginal fluids and breast milk. HIV is most commonly spread by sexual intercourse, contaminated needles used for drug injections, and from mother to foetus. Mothers who breast feed with HIV transmit HIV 40% of the time (Janeway *et al.* 2006). This disease is a worldwide pandemic, and all individuals in the world must be informed and take precautions when putting themselves into contact with HIV/AIDS.

Infection with HIV leads to an immune response similar to that of any other virus. One of the few differences is that during the primary infection, HIV infects the immune CD4 T cells, most of which are necessary for an immune response, thereby decreasing them. Antibodies are formed after infection, and this is the main method used to identify positive HIV patients. A problem is what while being tested during the primary stages, an individual may be misdiagnosed because it takes approximately 3-4 weeks for antibodies to be produced (Janeway *et al.* 2006). This can cause the virus to spread since

seropositive individuals do know their status. The normal CD4 T cell count is approximately $1200 \text{ cells } \mu\text{l}^{-1}$, but after an initial infection it drops to approximately $800 \text{ cells } \mu\text{l}^{-1}$. Once an individual reaches $200 \text{ cells } \mu\text{l}^{-1}$, they are now considered an AIDS patient (Janeway *et al.* 2006). The period of clinical latency ends, and opportunistic infections begin to appear. A patient with AIDS lives, on average, for 1-2 years.

The following will briefly describe the importance of continuously developing new drugs and analysing their use. An infected individual has the chance to live a more prolonged life because of antiretroviral therapy. One of the problems with antiretroviral therapies such as HAART is that it inflicts major side effects which deter patients from taking their drugs. The use of antiretroviral drugs reduces the viral load in a patient which in turn reduces the chance of spreading the disease. It is well known that the result of imperfect adherence creates an increase in drug resistance. Studies have shown that patients must have 95% adherence to drug therapy in order to prevent biological resistance (Bartlett 2002). They also show that 40-60% of patients are less than 90% adherent to their drugs, and adherence decreases over time (Bartlett 2002). Drugs such as reverse transcriptase inhibitors and protease inhibitors will either stop the virus from infecting CD4 T cells, or stop new infectious virions from being produced (Lipsky 1996). The reverse transcriptase inhibitors (RTI) aim to stop the viral reverse transcriptase which is required for synthesis of the provirus. The protease inhibitors (PI) aim to stop the viral protease which cleaves polyproteins to produce the virion proteins and viral enzymes. The PIs act at a very late maturation of the virus where virions are still produced but are non-infectious. Since CD4 memory T cells carry integrated provirus, these are very long-lasting reservoirs of the infection and these cells are resistant to drug therapy for HIV. This is one of the many reasons the immune system cannot completely eliminate HIV. On a positive note, the infection of HIV from mother to child is very preventable by simply taking the drug zidovudine or nevirapine (Janeway *et al.* 2006). Therefore, it is important for all HIV patients to take therapy with perfect adherence in order to reduce transmission.

HIV has a rapid replication rate of about 10^9 to 10^{10} new virions every day coupled with a mutation rate of approximately 3×10^{-5} per nucleotide base cycle of replication which leads to the generation of many variants of HIV in a single infected patient in the course of a day (Janeway *et al.* 2006). Since HIV is highly variable, it rapidly develops resistance to antiretroviral drugs. Some reverse transcriptors require only one or two mutations in order for HIV to build resistance towards the drug whereas other protease inhibitors such as ritonavir need 7-9 mutations meaning these will take much longer for the virus to be resistant towards it (Maplanka 2007). Also the reverse transcriptase inhibitor zidovudine (AZT) – first drug created –, needs only 3-4 point mutations in the viral genome to become resistant and this only takes a few months (Maplanka 2007). On November 30th 2007, CBC News reported that a new drug is being used in Canada for HIV/AIDS patients. The integrase inhibitor raltegravir works by blocking integrase (enzyme used by virus to insert DNA into the host cell's chromosome). This drug travels in the blood stream much faster which may cause an increase in CD4 T cells at a more rapid rate. New antiretroviral drugs are being tested, all of which help to increase the number of years HIV/AIDS patients can live and are a serious attempt at eradicating the disease due to the ever increasing triggers to different sites. The scientists are therefore

doing an excellent job at preventing the spreading of the disease. If all HIV infected individuals were able to afford the expensive drugs, there would be a decrease of the transmission of HIV. Unfortunately, there are few people who can access or afford the drugs in places such as Africa. This therefore prevents the eradication of HIV and increases the chance of spreading the disease.

Research on HIV is continuously being funded in order to eliminate the disease. In January 2008, a paper was published saying that if you were a seropositive individual not suffering for any other STDs and following a drug therapy with perfect adherence then you would not and could not transmit HIV (Vernazza *et al.* 2008). It fails to mention that certain antiretroviral drugs are unable to enter the male and female genital tracks, and since the disease is spread by sexual intercourse, this causes major problems. The use of antiretroviral drugs will lower the number of virus particles in the peripheral blood and in the genital track, but will not eliminate the HIV (Hart *et al.* 1999, Wilson *et al.* 2008). This paper causes a lot of controversy because uninformed individuals may believe this study and think they can practice unsafe sex. The paper was actually written because an HIV-positive individual had sexual intercourse with an uninfected person and did not disclose that he was positive. The paper was written after she was infected in order to avoid jail for the infected individual to prove he was not a murderer. Any infected individual not disclosing their serostatus is essentially killing another person because the seronegative individual is not informed. There are thousands who will never understand that this paper should have stated that by following their criteria the chances of transmitting HIV decreases nevertheless you **can** still transmit HIV. These facts increase the level of unprotected sex and thus further the spread of HIV. This study should be seen as another way to reduce the spread of HIV while taking other measures; it should not be seen as a prevention.

Another issue that arises with HIV is the number of people who aren't being tested for the disease. According to CDC (Centres for Disease Control), there are approximately 25% of people in the US who are HIV-positive, but unaware of their status since there are few side effects once initially infected with HIV. These results are for the United States, which only have over one million people infected with HIV (Marks *et al.* 2006). Africa has approximately 22 million HIV positive individuals on the Continent - imagine how many people don't know their serostatus. The effect of not being tested increases the chance of a seronegative individual being infected, since his/her partner is unaware of their status. If more individuals infected with HIV had knowledge of their disease and disclosed their status to potential partners, this would decrease the spread of HIV and help eradicate the disease.

Further spreading is caused by laws that prevent disclosure. When an HIV-positive patient gets tested, he or she is not legally forced to disclose their status. The doctors testing these patients are also bound by confidentiality. If an HIV-positive patient is not willing to tell his/her partners about having the disease, it should be the doctor who is obligated to tell the partners as when if a patient tells a doctor they are planning on committing murder, the doctor is obliged to contact the police. There have been many topics raised about confidentiality between doctor and patient and how fewer people will

get tested if doctors start disclosing their serostatus (Odunsi 2007). It is important to inform non-infected individuals so they are able to decide about taking the risk of being with an infected patient. It should always be the seronegative individual who makes the decision since it is their life that could be affected.

Women's rights have always been a worldwide issue. Certain progress has been made, but these issues still continue today. It is unfortunate that certain societies in Africa do not permit women to protect themselves against men. Of the 30 million people in Africa who are affected by HIV, 58% are women, and if you narrow it down, there are ten million people infected with HIV from the ages 15-34, and 78% are women and girls (Lewis). In certain countries in Africa, the women have no rights to ask their partners to wear a condom even if they know the men are infected. Marriage is one of the worst ways to spread HIV in Africa. A wife may be faithful to her husband, but the man is allowed to have several wives, and will not be punished for cheating. This unfaithfulness increases the spread of any disease because the husband is probably not using protection. It also increases the spread of sexually transmitted diseases such as chlamydia and gonorrhea which are known to severely increase the chance of transmission to a seronegative individual (Laga *et al.* 1993, Ho *et al* 1995, McGowan *et al* 2004).

Rape increases the spread of HIV in Africa. Women and children are being raped by men everyday because of the power men have over women. There are no laws or consequences involved for such a crime. There are even cases in South Africa where men rape female children with the mistaken belief that sex with a virgin will cure the HIV-infected person (Meel 2003). The society these people live in has so many myths that it is causing serious problems. Rape, including child rape, is increasing at shocking rates in South Africa. Sexual violence against children, including the raping of infants, has increased 400% over the past decade (Dempster 2002). According to a report by BBC news, a female born in South Africa has a greater chance of being raped in her lifetime than learning how to read (Dempster 2002). When South Africa became a democracy in 1994, there were already 18,801 cases of rape per year, but by 2001 there were 24,892 (Dempster 2002). The University of South Africa reports that 1 million women and children are raped there each year (Meier 2002). It may take years to change a society's beliefs, but this is certainly required to prevent women from continuously being infected. If children and women are raped and contract HIV, then the mothers will die leaving no one to care for the children.

A new HIV prevention strategy is now in the development stage. Vaginal microbicides is a cream applied inside the vagina that prevents the spread of HIV and prevents pregnancy. It would be important that this cream has no colour or scent since women would be free to use it without the man's knowledge. A study was done in South Africa showing that if developed, 82% of men preferred a vaginal microbicide to a condom (Smith & Magnet 2007). The downside is that the microbicides do not have as high of an efficacy as using a condom or birth control pills. A condom is 87% effective for the prevention of HIV (Davis & Weller 1999), so if a less effective microbicide is introduced in a country, it would decrease the use of condoms and this might increase the spread of HIV. The microbicides would be expensive again posing a problem with its availability and use.

Clearly being able to use both the condom and the cream would achieve the best prevention results.

Another form of eradicating HIV which targets men has been male circumcision. In 2006, BBC news talked about two African trials that showed male circumcision can cut the rate of HIV infection in heterosexuals by 50% (Weiss *et al* 2000, Quinn *et al.* 2000).

It is not only women who are discriminated against, but the gay community as well. There shouldn't be anything wrong with an individual wanting to have sexual intercourse with anyone he or she wants. HIV started as a 'gay disease', and this mistaken belief stood for many of years. One way HIV can enter a body is by contact with mucosal epithelia. When coming into contact with the epithelial cell lining in the vagina, penis, cervix and anus, the disease can spread since each of these areas have several layers of epithelial cells (Janeway 2006). Male-to-female heterosexual transmission of HIV is two to eight times more efficient compared to female-to-male, with a male-to-female *per* contact infectivity estimated to be 0.0009, whereas receptive anal intercourse results in an estimated *per* contact infectivity of 0.0082 (Cummins & Dezzutti 2000). The reason for the increased rate of infection from penile-anal sex compared to penile-vaginal sex may be due to the differences in the architecture of the rectum/colon and vagina/cervix. The rectum/colon is lined with simple columnar epithelial cells that are involved in transportation and adsorption of molecules, secretion, and protection (Cummins & Dezzutti 2000). Since the easiest way for the virus to enter a body is by the anus, more gay men are infected by HIV. *Herek and Glunt (1988)* explains how in the early years of infection, the stigma of only gay people having HIV increased the spread of the disease since heterosexuals were not educated enough to know that HIV could be spread by vaginal-penile intercourse. He brings up the fact that a Republican columnist says 'There is one, only one, cause of the AIDS crisis – the wilful refusal of homosexuals to cease indulging in the immoral, unnatural, unsanitary, unhealthy, and suicidal practice of anal intercourse, which is the primary means by which the AIDS virus is being spread through the gay community, and, hence, into the needles of IV drug abusers – and to others' (Herek & Glunt 1988). The discrimination towards gay men and women is still an issue in society, and unless these issues can be resolved, it will always be difficult to not only accept the gay community, but also to eradicate HIV since without knowledge of any disease, the general population think they are not prone to catching HIV – which is a mistaken belief. In 2003, *Parker and Aggleton* describe the stigma and issues that arise from the gay community and how these problems are still in the society years after the initial infection of HIV. Some ways to prevent the spread of HIV through the gay community has been by using condoms and creating bath houses which are houses geared towards men having sex with men but concentrating on safe sex. The houses are filled with condoms and may be hated by many, but it surely prevents the spread of HIV since sex these houses is always protected.

Another major cause of the spread of HIV is the lack of education. The World Health Organization (WHO) states that levels of knowledge of safe sex and HIV remain low in many countries – even in countries with high incidence and growth of HIV. In 24 sub-Saharan countries (including Cameroon, Côte d'Ivoire, Kenya, Nigeria, Senegal and

Uganda), two-thirds or more of young women (aged 15-24 years) lacked comprehensive knowledge of HIV transmission. According to a major survey carried out in the Philippines in 2003 by the WHO, more than 90% of respondents still believed that HIV could be transmitted by sharing a meal with an HIV-positive person. This lack of education causes societies to grow without prior knowledge of certain important factors and could have major impacts on the population as a whole. For example, the South African president was just recently put on trial for raping a young woman. When the president was told the woman had HIV, he reported that it didn't matter since he had showered after intercourse. Not only does the lack of knowledge from the president affect himself, but it affects the whole country of South Africa since his people will follow his mistaken information and this leads to the spread of HIV. Also, as mentioned earlier, the misconception that if a man sleeps with a virgin he will eliminate HIV. All of these issues could be avoided by education about the disease, but it is sometimes almost impossible to transmit this information to an already sustainable society. Another way of contracting HIV is by having oral sex, which many people believe it is not possible. It may be a low risk factor, but HIV can be spread by oral sex with a population-attributable risk percentage of 0.1% (Page *et al.* 2002). It is important for individuals all over the world to understand the ways HIV may be spread, and understand the consequences involved in becoming infected. As many as one in three HIV-positive people continue unprotected sexual practices after learning that they are HIV infected (Kalichman *et al.* 2001). It is almost unbelievable to think that this happens knowing the spread of HIV can be prevented by simply using a condom. It was also proven that the intervention to reduce risk of HIV transmission (educating people on HIV) resulted in significantly less unprotected intercourse and greater condom use at follow-up (Weinhardt *et al.* 1999). Transmission-risk behaviours with non-HIV-positive sexual partners and estimated HIV transmission rates over a 1-year horizon were also significantly lower for the behavioural risk-reduction intervention group (Kalichman *et al.* 2001). This may be another prevention strategy.

It has been known that the best way to eradicate any disease is by vaccination. The cost of a vaccine is sometimes an issue, but the effects of vaccination will always cause a decrease in the spread of a disease (Emini & Koff 2004). A vaccine for HIV has not yet been created. Vaccination against HIV is an attractive solution but poses many difficulties. The main problem is the nature of the infection itself – a virus that proliferates extremely rapidly (half life of 2 days) and causes sustained infection in the face of strong cytotoxic T cell and antibody responses (Campbell & Reece 2002). Since mutation occurs in each individual differently, this escapes recognition by antibodies and by cytotoxic T lymphocytes. Furthermore, the provirus which is invisible to the immune system might prevent it to clear the virus even if a vaccine is present (Campbell & Reece 2002). Also, the main cause of HIV is still unknown, so creating a vaccine that increases the level the cytotoxic T lymphocytes for example may not be enough.

In very few cases, genetic variation in either virus or host show slower disease progression. Genetic variation in HLA type of the host modifies the disease outcome (Baltimore 1995). There are people who are infected with HIV yet remain disease free and virus negative. Some people are resistant to the virus because they have a mutation

in a cell-surface chemokine receptor which is used as a co-receptor for viral entry. Studies have been done regarding how certain people are resistant to HIV. This may help in finding a cure for HIV and finding ways to stop infection through sexual transmission or to slow down the rate of progression of the virus. Other work being done here in Ottawa is to trigger a protein contained in the virus. A protein such as *tat* does not mutate but has been proven essential for the integration of the virus in a cell (Faller *et al.* 2007). Work is being done to trigger a part of the protein genome that will hopefully inhibit its effects and thus stop the virus from entering an immune cell. This understanding and these findings will hopefully lead to one day creating a vaccine that is good enough to stop the spread of the infection.

It is sometimes hard to believe, but HIV/AIDS is a preventable disease. There are 15,000 new infections each day, meaning 6 new infections per second worldwide (Bartlett 2002). Each year, there are over 40,000 new infections which can be prevented. Condoms are the main source of prevention in the spread of HIV. Also, there are thousands of people who are infected but are too afraid to get tested. It is important to not only be informed in order to control the spread of the disease, but it is also important to know if a person is infected in order to not mistakenly infect another. Women and gay rights continue to affect the outcomes of this pandemic, and it may never be possible to completely abolish the controversies involving these rights, but it can be possible to eradicate HIV by using condoms, taking drug therapy, and hopefully creating a protection against women's health by microbicides. HIV/AIDS is a terrible disease, but every person on earth can make a difference by creating awareness and providing education about HIV.

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