

COST-BENEFIT ANALYSIS OF ANTI-RETROVIRAL THERAPY (ART) FOR HIV/AIDS TREATMENT AND ITS ECONOMIC IMPLICATIONS IN NIGERIA

BASSEY E. NDEM, CHRISTIAN E. BASSEY AND OTU CHRISTOPHER

(Received 22 September, 2011: Revision accepted 14, November 2011)

ABSTRACT

Antiretroviral therapy (ART) means treating retroviral infections like HIV with drugs. These drugs though do not kill the virus but slowed down the growth of the virus. When the virus is slowed down, Human Immunodeficiency Virus (HIV) disease is also slowed down. ART drugs are referred to as ARV and ARV therapy is referred to as ART. From the chi square analysis, this study contends that the cost of treating HIV/AIDS is high and that is why most patients cannot access HIV/AIDS treatment even though these drugs are supposed to be free. It was also discovered that HIV/AIDS disease reduces labour force and productivity of the affected country and also affect individual income which in turn reduces savings rate and low level of school enrollment. The researcher therefore suggests that bay centers should be opened in rural areas for easy accessibility by people who suffer from HIV/AIDS leaving within these areas.

KEYWORDS: Antiretroviral Therapy, Human Immunodeficiency Virus, Acquire Immune Deficiency Syndrome, Cost and Benefit.

1.1 INTRODUCTION

AIDS means acquired immune deficiency syndrome. It is a condition caused by a virus called HIV. This virus attacks the immune system of the body. That is the "security force" that fights off infections. When the immune system breaks down, the body loses protection and can develop several other deadly infections and cancers. That is why it is called "opportunistic infections (OIs)" because they take advantage of the body's weakened defenses. AIDS does not kill. What do is the opportunistic infections.

However, HIV (human immunodeficiency virus) is the cause of AIDS that is acquired immunodeficiency syndrome. HIV is a type of virus called a retrovirus, which infects humans when it comes in contact with tissues such as those that line the vagina, anal area, mouth, or

eyes, or a break in the skin. It is a type of virus that is wrapped up in protein, sugar and fat. HIV mostly affects CD4 cells sometimes call T cells, or T-helper cells. These cells coordinate the immune system to fight diseases in the body. When this virus enters the cells, they start producing millions of little ones which eventually kill cells and further infect it. Hence, any drug administer for cure only interfere the process.

HIV is transmitted via infectious agent such as saliva, air, cough, fecal-oral route, surfaces, blood, needles, blood transfusions, sexual contact, mother to fetus, to mention a few. Over the years, there had been antiretroviral therapy to reduce the negative effects of AIDS. Antiretroviral therapy however, means treating retroviral infections like HIV with drugs. Though these drugs do not kill the virus but it however, slows down the growth of the virus. When the

Bassey E. Ndem, Department of Economics, University of Calabar, Calabar, Nigeria.

Christian E. Bassey, Department of Economics, University of Calabar, Calabar, Nigeria.

Otu Christopher, Department of Economics, University of Calabar, Calabar, Nigeria.

virus is slowed down, HIV disease is also slowed down. Antiretroviral drugs are referred to as ARV and ARV therapy is referred to as ART.

Patients initiating antiretroviral therapy should be willing and also able to commit to lifelong treatment. He or she should also understand the benefits and risks of the therapy and the importance of adherence. Patients may choose to postpone therapy, and providers, on occasional basis, may choose to change therapy based on clinical, psychological and social factors.

Adverse effects of antiretroviral drugs vary by drug, by individual, ethnicity, and by interaction with other drugs, including alcohol. Hypersensitivity to some drugs may also occur in some individuals.

However, standard antiretroviral therapy (ART) consists of the use of at least three antiretroviral (ARV) drugs to maximally suppress the HIV virus to stop the progression of HIV disease. Huge reductions have been seen in rates of death and suffering when use is made of a potent antiretroviral regimen.

However, despite the level of achievement by government in reducing death rate among patients with HIV/AIDS, there are still much to be done to capture larger population with HIV/AIDS. Many patients living within the rural areas hardly access treatment centers, if they do is not without huge cost since treatment centers are located within the urban areas, specifically (General Hospitals). Moreso, most of those HIV/AIDS patients in rural areas fall within the middle and low income brackets. Therefore, accessing treatment are usually done with some constraint.

This study evaluates the cost incurred by patient with HIV especially those from rural areas and the benefit derived in the process of accessing antiretroviral therapy in Nigeria. It also analyzed some of the economic implications. Consequently, desired policy frame work is suggested to guide government in dispensing this therapy. This will help to reduce if any, the constraint faced by patient in the process of receiving treatment.

The study area covers three General Hospitals in Cross River State, Rivers State and Akwa Ibom State. To effectively carry out this research, it is organized in the following: 1.1 introduces the course of study, 2.1 discussed the literature review, 2.2 analyzed theoretical issues, 3.1 explains some of the economic implications of HIV/AIDS in Nigeria, 4.1 projects some research questions, 5.1 detailed the research

hypotheses, 6.1 formulate the research methodology, 7.1 discussed the research findings, 8.1 gives some recommendations and 9.1 concludes the study.

2. LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1 HISTORY AND IDENTIFICATION OF AIDS

In May 1983, Medical team led by Dr. Luc Montagnier's of the Pasteur Institute in France reported that they had isolated a new retrovirus from lymphoid ganglions that they believed was the cause of AIDS. The virus was later named lymphadenopathy-associated virus (LAV) and a sample was sent to the U.S. Centers for Disease Control, which was later passed to the National Cancer Institute (NCI).

However, in May 1984 a team led by Robert Gallo of the United States confirmed the discovery of the virus, but they renamed it human T lymphotropic virus type III (HTLV-III).

In January 1985 a number of more detailed reports were published concerning LAV and HTLV-III, and by March it was clear that the viruses were the same, from the same source, and were the etiological agent of AIDS. Then in May 1986, the International Committee on Taxonomy of Viruses ruled that both names should be dropped and a new name, HIV (Human Immunodeficiency Virus), be used.

According to genetic studies Proceedings of 2008, by the National Academy of Sciences study, a team led by Robert Shafer at Stanford University School of Medicine discovered that Gray Mouse Lemur has an endogenous lentivirus in its genetic makeup. This means that lentiviruses have existed for at least 14 million years, much longer than the currently known existence of HIV. Lemurs later developed immunity to the virus strain and survived an era when the lentivirus was widespread among other mammalia.

In 2010, researchers reported that Simian Immunodeficiency Virus (SIV) had infected monkeys in Bioko for at least 32,000 years. Now monkeys lived without having the effects. The question is will there be a time when man will live with AIDS without the negative symptoms just as the monkeys and Lemur?

Another identification was found on a Canadian airline steward named Gaëtan Dugas who was also referred to as "Patient 0" in an early AIDS study by Dr. William Darrow of the Centers for Disease Control. People believed that

Dugas brought HIV to North America. The idea was rejected because HIV was discovered long before Dugas began his career. This false claim began with a book titled 'And the Band Played On' written by Randy Shilts in 1987 and a followed up movie in which Duga was referred to as 'Patient Zero'. He was acclaimed Patient Zero because at least 40 out of 248 people known to be infected by AIDS in 1983 had had sex with him, or with someone who had sexual intercourse with him.

The AIDS epidemic officially began on June 5, 1981, when the U.S. Centers for Disease Control and Prevention in its Morbidity and Mortality Weekly Report newsletter reported unusual clusters of Pneumocystis pneumonia (PCP) caused by a form of Pneumocystis carinii now recognized as a distinct species of Pneumocystis jirovecii in five homosexual men in Los Angeles.

18 months later, more PCP clusters were discovered among healthy men in cities throughout the country, along with other opportunistic diseases such as Kaposi's sarcoma and persistent, generalized lymphadenopathy, common in immunosuppressed patients.

In June 1982, a report of a group of cases amongst gay men in Southern California proved that a sexually transmitted infectious agent might be the etiological agent, and the syndrome was initially termed "GRID", or gay-related immune deficiency. By August 1982, the disease name was changed from CDC-coined name to Acquired Immune Deficiency Syndrome (AIDS).

It was later realized that nearly half of the people identified with the syndrome were not homosexual men. This same infections were also reported among hemophiliacs, heterosexual intravenous drug users, and Haitian immigrants.

2.2 THEORETICAL ISSUES/REVIEW OF LITERATURE

Horowitz 2001, unearthed some stunning scientific documents that chimpanzees, contaminated with accidental oral polio vaccine (OPV) partially derived from live polio viruses in monkey kidney cells contaminated with cancer viruses such as SV40, that is, the 40 monkey virus, was used to produce hundreds of hepatitis B vaccine. This vaccine was administered to central African Blacks along with homosexual men in New York City at precisely the same time Dr. Myers and colleagues claim the origin of HIV.

However, Cribb et al 2001, protested that too little attention is given by drug-industry-

influenced medical journals, and the mainstream media, to controversial truths in science regarding the origin of HIV and AIDS. As a result, documents such as those published by Horowitz 2001, and others, showing that AIDS was apparently derived from contaminated hepatitis B vaccines was criticized, they concluded that HIV's origin, and AIDS, was not likely to have come from polio vaccine transmissions as chimpanzees were not proven to have been used during the manufacture of this vaccine.

The most commonly accepted theory is that of the 'hunter'. In this scenario, SIVcpz was transferred to humans as a result of chimps being killed and eaten or their blood getting into cuts or wounds of the hunter. This eventually get adapted within its new human host and became HIV-1. Consequently retroviral transfer from primates to hunters is still occurring even till date.

Also the U.S. Government's chief DNA and sequence Analyst at the Los Alamos Laboratory in New Mexico, Dr. Gerald Myers, and his colleagues reported that the origin of HIV could not have begun with "cut hunters" or other single isolated cross species transmissions also known as "zoonosis". He reported that genetic sequencing studies proved that, there are some "punctuated origin of AIDS event" which took place during the mid-1970s giving rise, virtually simultaneously, to at least ten different HIV "clades" or genetic subtypes associated with ten different distinguishable AIDS epidemics in Africa alone. The most likely cause of this widespread bizarre zoonosis was some man-made iatrogenic event involving chimpanzees.

Once again, from the social changes and urbanization theorist, proposed by Hahn, Sharp, and colleagues 2001, believed that "the epidemic emergence of HIV most likely reflects changes in population structure and behaviour in Africa during the 20th century. That was after the Scramble for Africa in the 1880s. European colonial powers established cities, towns, and other colonial stations. Then largely masculine labor force was hastily recruited to work in fluvial and sea ports, railways, other infrastructures, and in plantations. This disrupted traditional tribal values, and favored sexual promiscuity. These new cities changed women thinking, they felt relatively liberated from rural tribal rules and many remained unmarried or divorced during long periods this was very rare in African traditional societies. This was accompanied by unprecedented increase in people's movements.

Worobey and colleagues 2010, observed that the growth of cities had played significant

role in the epidemic emergence of HIV. They also observed that the phylogenetic datations of the two older strains of HIV-1 groups M and O, viruses started to spread soon after the main Central African colonial cities were founded.

Heart of Darkness theory postulated by Chitnis, Rawls, and Moore 2004, proposed that HIV may have emerged epidemically as a result of harsh conditions, forced labor, displacement, and unsafe injection and vaccination practices associated with colonialism, particularly in French Equatorial Africa. The workers in plantations, construction projects, and other colonial enterprises were supplied with bushmeat, thus, contributing to increase sexual activity, and then exposures to HIV.

According to the theory of unsterile injections also known as the iatrogenic theory, Marx 2001, emphasized that medical interventions were serious causes of HIV. The massive number of injections administered in Africa after antibiotics were introduced around 1950 as being the most likely source of HIV because, around 1950-1970, antibiotic injections were highly intensified in Africa. He argued that a serial passage chain of 3 or 4 transmissions between humans is an unlikely event for massive spread of the virus. He said the probability is between 0.3% and 2%, that few people have acute SIV infection at any given time. Therefore, HIV emergence may have required the very high frequency of injections of the antibiotic era.

Gisselquist 2003, proposed that the mass injection campaigns to treat trypanosomiasis, that is, sleeping sickness in Central Africa were responsible for the emergence of HIV-1. Like Marx *et al*, Gisselquist suggested serial passage as the mechanism by which unsterile injections helped a SIV strain to adapt to humans, giving rise to a HIV.

Still stressing on the theory of unsterile injections, Pépin and Labbé 2008, on the review of colonial health reports of Cameroon and French Equatorial Africa for the period 1921-1959, opined that the incidences of the diseases is high using intravenous injections. They concluded that leprosy, trypanosomiasis, yaws, and syphilis were responsible for most intravenous injections. Schistosomiasis, tuberculosis, and vaccinations against smallpox represented lower parenteral risks.

Furthermore, Dinis de Sousa, Müller, Lemey, and Vandamme 2010, proposed that HIV became epidemic through sexual serial transmission, in nascent colonial cities of Africa and French west Africa, aided by high frequency

of genital ulcers, which is caused by genital ulcer diseases (GUD). GUD are simply sexually transmitted diseases that cause genital ulcers; examples are syphilis, chancroid, lymphogranuloma venereum, and genital herpes. These diseases increase the probability of HIV transmission dramatically, from around 0.01-0.1% to 4-43% per heterosexual act. This is because the genital ulcers provide a receptor of viral entry, and contain many activated T cells expressing the presence of CCR5 co-receptor, the main cell targets of HIV.

However, there are some discredited theories of AIDS, example, the denialism theory which argues that HIV or AIDS does not exist or that AIDS is not caused by HIV; some of its proponents believe that AIDS is caused by lifestyle, including sexuality or drug use. Also the conspiracy theories alleged that HIV was created in a bio-weapons laboratory, as an agent of genocide or an accident. These hypotheses have been rejected by scientific consensus, hence it is baseless.

It is very evident that rural dwellers have very little or no access to medical facilities. In some areas where there is one, the basic amenities are usually lacking. This negative trend impacts heavily on patient with HIV who have to trek long distances to access treatment. In most cases, they pay dearly to different Cities to receive treatments. However, this increases heavily the cost which the patients have to bear even though the treatment is said to be free. This means that, HIV/AIDS treatment may be more effective only to patients that are living within the urban areas due to easy accessibility of treatment centers.

3.1 ECONOMIC IMPLICATIONS OF HIV/AIDS INFECTION IN NIGERIA

In Nigeria, an estimated 3.6 percent of the populations are living with HIV and AIDS. Nigeria's population is estimated to be about 149 million, meaning that by the end of 2009, there will be about 3.3 million people living with HIV/AIDS.

Over 220,000 people died from AIDS related diseases in Nigeria in 2009. The consequent is a decline in Nigeria's life expectancy from 54 years for women and 53 years for men in 1991 to 48 years for women and 46 for men in 2009. This has created severe economic impacts in the country different from most other diseases because it strikes people in the most productive age, UNAIDS (2010).

These effects can be identified in several ways:

- A) a reduction in the labour supply and
- B) increase in the cost of labour
- C) increase in social cost
- D) increase in the cost of production
- E) a reduction in the supply of health service
- F) high numbers of school dropout.

In terms of a decrease in labour Supply, when young people infected with HIV lose their lives in their most productive age, the productive capacity of the Nigerian economy is reduced thus impeding on the level of outputs and further reducing the level of GDP. In situation where the victim is still alive, he/she could stop work and may decide to be indoors due to stigmatization. This negatively affects the rate of productivity given the numbers of patients suffering from this disease in Nigeria.

Furthermore, is the cost estimate of HIV/AIDS. This is found to be very alarming due to the extents of effect. For instance if costs are financed out of savings, it will cause a reduction in investment which will ultimately lead to a significant reduction in economic growth. Also, household expenditures for medical expenses may increase substantially and this may likely have a negative multiplier effect on other members of the household especially if the breadwinner of the family is affected by the disease. It may ultimately reduce human capital formation as a result of the inability of the breadwinner to sponsor children of school age to school. This is a threat to the country's (Nigerian) future manpower/human capital formation. Furthermore, if the prevalent of HIV/AIDS is more among elite, then impact will be much as they are the key players in nation building.

In most cases a firm may suffer from some indirect cost. This is usually recorded after recruitment and training of staff. Replacing such workers usually take time causing such company to lose substantially.

AIDS affects the education sector in at least three ways: the supply of experienced teachers will be reduced by AIDS-related illness and death; children may be kept out of school if they are needed at home to care for sick family members or to work in the fields; and children may drop out of school if their families cannot afford school fees due to reduced household income as a result of an AIDS death. Another

problem is that teenage children are especially susceptible to HIV infection. Therefore, the education system also faces a special challenge to educate students about AIDS and equip them to protect themselves (Nwaorgu 1999).

Furthermore, AIDS will affect the health sector for two reasons: (1) it will increase the number of people seeking services and (2) health care for AIDS patients is more expensive than for most other conditions. Governments will face trade-offs along at least three dimensions: treating AIDS versus preventing HIV infection; treating AIDS versus treating other illnesses; and spending for health versus spending for other economic goals/objectives. Maintaining a healthy population is an important goal in its own and is crucial to the development of a productive workforce essential for economic development (Nwaorgu, 1999). It can be seen from the above analysis that the economic implications of AIDS ridden country is enormous, therefore serious government attention is needed to speedily reduce the rate of infection so as to achieve a sustained economic growth in Nigeria.

4.1 RESEARCH QUESTIONS

Consequently, the following research questions are raised to enhance effective research.

1. Is there any cost in receiving anti-retroviral treatment, and to what level can the majority of the infected persons, especially rural dwellers access treatment services in Akwa Ibom, Cross River and River states of Nigeria.
2. What is the level of regularity in receiving ART by patient due to distance between their residence and treatment receiving centers in these states?
3. Will there be a higher response if the treatment centers are located close to them?

5.1 RESEARCH HYPOTHESIS

Sequel to the research problems enunciated above, the following hypotheses are formulated to aid in realizing the objectives of this research. To this end the hypotheses are stated in null forms as follows:

1. H2: There is low level of regularity by patient with HIV/AIDS in accessing anti-retroviral drugs
2. H1: HIV/AIDS Patients bear low or no cost for accessing anti-retroviral therapy.

6.1 RESEARCH METHDOLOGY

For a detail and comprehensive result, a chi-square approach was adopted to evaluate the

level of regularity or frequency rate by patients in accessing ART, after gathering the response from the respondents. Three hundred questionnaires were distributed, one hundred in each state to elaborately establish a vivid fact

about the aim of this research. All questionnaires were received because it was personally administered, hence a direct interaction with the patients.

Based on the method of analysis, the chi square formular is:

$$\chi^2 = \sum_{i=1}^R \sum_{j=1}^e \frac{(O_{ij} - E_{ij})^2}{E_{ij}}$$

(C - 1) (R - 1) is the degree of freedom.
Where C = column, R = Row

The following tables were prepared based on our findings.

TABLE 1: Frequency table on regularity by Patients in accessing ART;

SEX	REGULAR	IRREGULAR	UND	TOTAL
MALE	37	82	18	137
FEMALE	46	95	22	163
TOTAL	83	177	40	300

Source: Computed by the Author from Field Survey 2011

TABLE 2: Frequency table for why irregularity in receiving ART;

SEX	HIGH COST	STIGMATIZATION	NO AWARENESS	UND	TOTAL
MALE	77	52	40	11	180
FEMALE	96	10	12	2	120
TOTAL	173	62	52	13	300

Source: Computed by the Author from Field Survey 2011

7.1 DISCUSSION OF FINDINGS

From Table 1, 28% admitted regular attendance to clinical attention. 57% were on the opposite. That is, they are very irregular in receiving treatment. While 15% are undecided because they gave no comment.

In Table 2, 56% said high cost of clinical attention is the cause of their irregularities in receiving treatment. However, 23% said it was due to stigmatization, 15% said it was because of lack of proper awareness, while 6% made no comment as such classified as undecided.

When these results were subjected to empirical analysis, it was discovered that in Table 1, the T-value at 5% level of significance was

5.99 while the calculated value was 9.14. Hence, the null hypothesis was rejected the alternative hypothesis was accepted which states that, there is high level of irregularities in attending to General hospitals in order to receive ART treatment, by Patients living with HIV.

Table 2, shows a tabulated value of 7.81 and a calculated value of 43.74 at 5% level of significance. This further prove that we reject the null hypothesis and accept the alternative hypothesis, which state that, there is high cost in receiving treatment for HIV.

Furthermore, of the three hundred respondents, over one hundred and ninety, that is about 63% agreed that if treatments centers are extended to local Clinics, there will be high level of accesement of ART.

8.1 RECOMENDATIONS

Based on the findings above, the researcher proposed the following recommendations for policy framework to enhance a more efficient distribution of ART:

- i) That government should extend treatment center to local area health centers, (i.e bay centers) with at least one instructor.
- ii) There should be visiting days set for local centers.
- iii) Mobile facilities should be provided with prescribe days of traveling for treatment. This in one way could reduce the rate of stigmatization as others will see a paramount interest of government in her citizens.

9.1 CONCLUSION

This study does not conform to government policy as it affects HIV/AIDS where Anti Retroviral Therapy receiving centers are only in General hospitals. The claim is that, professionals who are capable of handling these cases can only be seen in urban hospitals. However, from our study it is quite clear that most of the critical issues of HIV/AIDS are predominant in the rural areas, yet most of them finds it very difficult to locate treatment center due to high cost encountered in trying to access treatment areas. In real sense government said this treatment is free and the poor could easily access it, but this is absolutely not true as the cost of accessing the treatment is high. In actual sense, it is not free. It has become one of the most expensive medications one could afford. The poor patient can't afford it, hence, a medication for only the rich patients.

It is quite clear that Anti Retroviral Therapy, a prescription for patients with HIV/AIDS was approved by UNIADS, WHO and other related organization to suppress the deadly virus, HIV/AIDS. The idea is to help both developed and developing nations to reduce the menace caused by this disease without any cost. However, the method of dispensing has generated a challenge to most patient, observers, and researchers alike. It was this interest that motivated the researcher to carry out this study. Government should apply these recommendations above to alleviate the poor patients from these problems enumerated in the research above.

REFERENCES

- Centers for Disease Control (CDC)., July 1982. "Pneumocystis Carinii pneumonia among persons with hemophilia A". MMWR Morb. Mortal. Wkly. Rep. 31, (27): 365-7. PMID 6815443. <http://www.cdc.gov/mmwr/preview/mmwrhtml/00001126.htm>.
- Centers for Disease Control (CDC)., June 1981. "Pneumocystis pneumonia-Los Angeles". MMWR Morb. Mortal. Wkly. Rep. 30, (21): 250-2. PMID 6265753. http://www.cdc.gov/mmwr/preview/mmwrhtml/june_5.htm.
- Centers for Disease Control (CDC)., June 1982. "A cluster of Kaposi's sarcoma and Pneumocystis carinii pneumonia among homosexual male residents of Los Angeles and Orange counties, California". MMWR Morb. Mortal. Wkly. Rep. 31, (23): 205-7. PMID 681184. <http://www.cdc.gov/mmwr/preview/mmwrhtml/00001114.htm>.
- Centers for Disease Control (CDC)., May 1982. "Update on Kaposi's sarcoma and opportunistic infections in previously healthy persons – United States". MMWR Morb. Mortal Wkly. Rep. 31, (22): 294, 300-1. PMID 810086. <http://www.cdc.gov/mmwr/preview/mmwrhtml/00001096.htm>.
- Chitins, Amit, Rawls, Diana; Moore, Jim., 2004. "Origin of HIV Type 1 in Colonial French Equatorial Africa?". AIDS Research and Human Retroviruses 1, (1): 5-8. doi: 10.1089/088922200309548. PMID 10628 811.
- Crib, M., Drucker, E., Alcabes, P. G and Marx, P. A., 2001. The injection century: Massive unsterile injections and the emergence of human pathogens". Lancet 358, (9297): 1989-92. doi:10.1016/S0140-736(01)06967-7. PMID 11747942".
- Gallo, R. C., Popovic, M., Samgadharan, M. G and Read, E., 1984. "Detection, isolation, and continuous production of cytopathic retroviruses (HTLV-III) from patients with AIDs and pre-AIDs". Science 224,

- (4648): 497-500.doi:10.1126/science.6200935. PMID 6200935.
- Gisselquist, D., 2003. "Emergence of the HIV type 1 epidemic in the twentieth century: comparing hypotheses to evidence". *AIDS Res Hum Retroviruses* 19, (12): 1071-78.doi:10.1089/088922203771881158.PMID14709242. <http://www.liebertonline.com/doi/abs/10.1089%2F088922203771881158>.
- Horowitz, Leonard., 2001. *Emerging Virus: AIDS and Ebola-Native, Accident on Intentional Tetrahedron Press, 1998, 1-888-5084787*; <http://www.tetrahedron.org>.
- Marx, P. A., Alcabes, P. G and Drucker, E., 2001. "Seral human passage of simian immunodeficiency virus by unsterile injections and the emergence of epidemic human immunodeficiency virus in Africa". *Philos Trans R. Soc Lond B Biol Sci* (356): 911-20. doi:10.1098/rstb.2001.0867. PMC 1088484. PMID 11405938. <http://rstb.royalsocietypublishing.org/content/356/1410/911.abstract>.
- Montagnier, L., Barre-Sinoussi, F., Chermann, J. C., Rey, F., Nugeyre, M. T., Chamaret, S., Gruest, J., Dauguet, C., Axler-Blin, C., Vezinet-Brun, F., Rouzioux, C and Rozenbaum, W., 1983. "Isolation of a T-lymphotropic retrovirus from a patient at risk for acquired immune deficiency syndrome (AIDS)". *Science* 220, (4599): 868-71. doi:1.1126/science.6189183. PMID 189183.
- Nwaogo, O., 1999 Consultant's reports written communication.
- Pepin, J and Labbe, A. C., 2008. "Noble goals, unforeseen consequences: control of tropical diseases in colonial Central Africa and the iatrogenic transmission of blood-borne viruses". *Trop Med. Int Health* 13, (6): 744-53. doi:10.1111/j.1365-3156.2008.02060.x.PMID 18397182. <http://onlinelibrary.wiley.com/doi/10.1111/j.1365-3156.2008.02060.x/abstract>.
- Sharp, P. M., Bailes, E., Chaudhuri, R. R., Rodenburg, C. M., Santiago, M. O and Hahn, B. H., 2001. "The origins of acquired immune deficiency syndrome viruses: where and when?". *Philosophical Transactions of the Royal Society B: Biological Sciences* 356:867-76. doi:10.1098/restb.2001.0863. PMC 1088480. PMID 11405934. <http://www.pubmedcentral.nih.gov/articlerender.fcgi?tool=pmcentrez&artid=1088480>.
- Shits, R., 1987. "And the band played on".
- Sousa, Joao Dinis de., Muller, Viktor., Lemey, Philippe and Vandamme, Anne-Mieke., 2010. "High GUD Incidence in the Early 20th Century Created a Particularly Permissive Time Window for the Origin and Initial Spread of Epidemic HIV Strains". *PLoS ONE* 5(4): e9936. doi:10.1371/journal.pone.0009936. PMC 2848574. PMID 20376191. <http://www.pubmedcentral.nih.gov/articlerender.fcgi?tool=pmcentrez&artid=2848574>.
- UNAIDS., 2010. 'Report on the global AIDS epidemic'
- USA Today., 2006-05-25. http://www.usatoday.com/news/health/2006-05-25-hiv-cameroon_x.htm. Retrieved 2010-05-20.
- Worobey, M., Telfer, P., Souquiere, S., Hunter, M., Coleman, C. A., Metzger, M. J., Reed, P and Makuwa, M. et al., 2010. "Island Biogeography Reveals the Deep History of SIV". *Science* 329, (5998): 1487. doi:10.1126/science.1193550. PMID 20847261.

APPENDIX 1
WORKINGS FOR THE RESULT IN TABLE 1

TABLE 3: CHI-SQUARE STATISTICAL ANALYSIS

O	Working	E	O-E	(O-E)²	$\frac{(O-E)^2}{E}$
37	83/300 x 137	37.9	0.9	0.81	0.02
46	83/300 x 163	45.1	0.9	0.81	0.018
82	177/300 x 137	80.8	1.2	1.44	0.017
95	177/300 x 163	96.2	-1.2	1.44	0.015
18	40/300 x 137	18.3	-0.3	0.09	4.92
22	40/300 x 163	21.7	0.3	0.09	4.15
				X² =	9.14

5% Degrees of freedom

(C - 1) (R - 1)

(3 - 1) (2 - 1)

(2) (1) = 2

APPENDIX 2
WORKINGS FOR THE RESULT IN TABLE 2

TABLE 4: CHI-SQUARE STATISTICAL ANALYSIS

0	Working	E	0-E	(0-E)²	$\frac{(0-E)^2}{E}$
77	173/300 x 180	103.8	-26.8	718.24	6.92
96	173/300 x 120	69.2	26.8	718.24	10.38
52	62/300 x 180	37.2	14.8	219.04	5.89
10	62/300 x 120	24.8	-14.8	219.04	8.83
40	52/300 x 180	31.2	8.8	77.44	2.48
12	52/300 x 120	20.8	-8.8	77.44	3.72
11	13/300 x 180	7.8	3.2	10.24	1.31
2	13/300 x 120	5.2	-3.2	10.24	1.97
					43.74

5% Degrees of freedom

$$(C - 1) (R - 1)$$

$$(4 - 1) (2 - 1)$$

$$(3) (1) = 3$$

O = OBSERVED C = COLUMN

E = EXPECTED R = ROW UND = UNDECIDED