CHAPTER II

BIOLOGICAL ASPECTS OF HIV TRANSMISSION

Introduction

Human Immunodeficiency Viruses (HIV) is a different type of virus which leads to the so called AIDS. Any virus or bacteria will have the capacity to produce some infection which will lead to a disease that affects the human systems. The HIV is a special type of virus which is RNA based. The HIV can be classified as HIV-1 and HIV-2. The HIV in its RNA stores the genetic information in terms of RNA. HIV infection otherwise called transmission takes place in a very silent and strategic manner.

There are four different methods of transmission such as

i) Sexual contact
ii) Transfusion of infected blood and blood product
iii) Sharing of contaminated needles for drugs abuse
iv) From the mother to baby with fetus

Once a person is exposed to HIV transmission the progression of the growth and expansion of the virus will affect the human immune system and wipe out the CD4 lymphocytes of the human system.

Antigenic diversity is a very important aspect of HIV infection and its expansion. The invading HIV antigens get to then CD4 cells and create mucous
membrane cover in such a way that the macrophages are unable to identify the HIV which has entered into the CD4 lymphocytes. The HIV uses its RNA and the DNA from the host cell so that the process of the reproduction is completed. In doing so the newly produced HIV has various new species which are antigenically different. This is called antigenic diversity. The antigenic diversity results in the development of new type of HIV which has different antigenic property. The macrophages as well as antibodies produced by the human immune system are not able to fight against the antigens so that the human immune system becomes weaker and weaker.

At a certain stage the expansion of the antigenic diversity of the invading antigens namely HIV is so vast that the human immune system is unable to fight against the same and so the human immune system fails so that the person becomes the seropositive and all types of infection becomes more competent to fight against the human immune system. It is in this connection Nowak and May (1991) have suggested the antigenic diversity threshold hypothesis. This hypothesis suggests that HIV’s rapid mutation rate allows the virus to churn out a constant stream of escape mutants. As more and more escape mutants strains appear, the immune system has to keep increasing the number of strain specific antibody classes and at the same time that its being systemically attacked by the virus. Eventually the virus builds up enough diversity so that the immune system may find it harder and harder to mount responses against these newly emerging viruses variant. Once the antigenic diversity of the virus population has increased above a threshold value the immune system can no longer control of virus, which results in the development of AIDS.

Another concept relating to the HIV is that it not only increases the antigenic diversity but also the virulence of the invading antigens. The concept of the virus
virulence have been introduced the May and Anderson (1993). The term antigenic diversity threshold and the virulence discussed by many authors reveals fact that the critical variability levels are such that if either the antigenic diversity or the virulence of the invading antigens cross the threshold levels the human immune system is not capable of controlling the impact of viral infection.

**Mechanism of HIV**

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1. The T4-cells responsible for the immune system of the human body is invaded by HIV
2. HIV invading in to T4-cells create mucous membrane cover
3. Using the DNA of T4-cells it combines its RNA to create new forms of HIV
4. The process of replication is repeated
5. The newly produced HIV comes out of the infected cells
6. The process of spread to other T4-cells
7. The destruction T4-cells leads to lack of immune power
8. The fall in the T4 lymphocyte leads to seroconversion
Structure of Virus

HIV is a 90-120 nm icosahedral, enveloped, RNA virus. HIV comprises of an outer envelope consisting of a lipid bilayer with uniformly arranged 72 spikes or Knobs of glycoprotein (gp) 120 and gp 41 in HIV-1 and gp 140 and gp 36 in HIV-2, respectively. Glycoprotein 120/140 protrudes out on the surface of the virus and gp 41/36 is embedded in the lipid matrix. Inside is the p24 protein core surrounding two copies of RNA. This core also contains viral enzymes; reverse transcriptase, integrase and protease, all essential for viral replication and maturation. Proteins p7 and p9 are bound to the RNA and are believed to be involved in regulation of gene expression.
Pathogenesis of HIV

In most of the persons infected by HIV the deficiency of T4 lymphocytes are very much pronounced. The lymphocytes are white cells in the blood, which are responsible for the immune ability of an individual. The T4 cells help the process of resistance in the growth of invading antigens. A particular sub group of T cells are called CD4 cells. They are also known as the helper cells.

The CD4 cells play a vital role in creating an effective immune response. The immune system depends upon the CD4 cell count. The HIV aims at reducing the CD4 cell count, so that the human immune system fails. The virus starts the process of reproduction. So that the CD4 cells will fall or decreasing and so the human immune system fails. This period is called the latency period.

The antibodies generated by the human immune system to fight against the antigens. In the initial pace of the HIV infection the antibodies are not manifested but the presence of virus can be found and this period is called the window period. Once the antibodies get appraised in number compared to the value of antigens the seroconversion occurs. After the seroconversion it takes a random period of time for the incidence of AIDS and the related complexities.

Prevalence of HIV, AIDS – Identification by Signs and Symptoms

Generally the presence of HIV virus and symptoms of AIDS is by several methods. The presence of AIDS can very easily identified by cryptococcal meningitis or generalized Kaposi Sarcoma. Generalized pruritic dermatitis is also an indicated.
The major signs of HIV infection and the occurrence of AIDS is by severe weight loss, fever for a prolonged period consistently or intermittently, chronic diarrhea, etc. The progression of HIV and AIDS differ from to person to person and the stages of the progression can be called as early HIV stage, late HIV stage and early AIDS stage.

**Stages of HIV infection**

There are several stages related to the HIV infection and its progression. They are as follows

a) **Primary HIV infection**

In this stage of HIV infection the indications like flu like illness prevails for a few weeks. The symptoms are severe but the diagnosis of HIV infection is not properly made in many cases. In many cases the opportunistic infections like gastrointestinal disorders, nausea, vomiting or diarrhea may occur.

Acute HIV infection is defined as the period between the exposure to virus and indication of initial immune responses. In about 2 to 3 months the antibodies test may be negative for HIV but the amount of HIV virus in blood can the quite high. The chronic HIV disease can be divided in to the following stages based on a degree of immune deficiency.

1. Early stage – CD $4^+$ T-cell count $> 500/\mu L$
2. Intermediate stage – CD $4^+$ T-cell count $250 - 500/\mu L$
3. Advanced stage – CD $4^+$ T-cell count $< 200/\mu L$
b) Clinically Asymptomatic Stage

This stage of infection occurs after 10 years on the average but the symptoms are not major. The HIV antibodies are detectable in blood. Research has shown that HIV is not dormant during this stage, but is very active in the lymph nodes.

c) Symptomatic HIV infection

Since the immune system is severely destroyed by HIV the symptoms of HIV infection are easily identifiable. The symptomatic HIV infection is mainly caused by the emergence of many opportunistic infections. In this stage of infection the lymph modes are getting damaged. Many pathogens which are stranger and more variant are generated show that the T-helper cells are destroyed at a higher rate. The human system is unable to replace the destroyed T-helper cells at a high rate.

d) HIV Infection and AIDS

This stage occurs after a person has become seropositive. The progression of HIV to AIDS occurs at this stage. The human body becomes the playground of all diseases at this stage so that the incidence of cancer, skin disease and other diseases occur in those cases who are with full blown AIDS.

The lymphocytes may be with swelling and its is an early sign of HIV infection. There are many identifications of HIV prevalence which can be identified by suitable medical care.
Human Immunodeficiency Virus (HIV) Test

The identification of HIV infection is done by using several clinical tests. These tests are mainly based on the parameters like the levels of antibodies the level of CD4 cells and the level of antibody which are specific to HIV. This procedure is call serology which is branch of immunology that deals with the identification and measurement of antibodies in the serum. This test is not very much confirmative.

Enzyme- linked Immune-Sorbent Assay (Elisa) Test

This test involves two different components namely is enzyme and an antibody or antigens called immunologic molecules. The Elisa test is used to identify the substances which have antigenic properties and the antibodies which prevail in the system. It the antibodies present are all against HIV then the test is repeated to conform the incidence of HIV infection. If Elisa is negative other test are not usually carried out to confirm the presence of HIV infection. One disadvantage of Elisa test is that is not confirmatory in character.

Western Blot Test

It may be absented that the Elisa test is not very much confirmatory and repetition of some may be needed but the western blot test is an antibodies deflection test and more difficult in practice. It is also possible that the results may be in determinate the test is also very expensive.

Polymerase Chain Reaction (PCR) Test

The polymerase chain reaction test is more confirmatory but it requires more of technical skills. The interpretation of the results also involves the use of
equipments which are costly and expensive. This test is very much used to examine
the presence of HIV infection in persons who are willing to denote organs or blood.

In addition to the above test, IFA Test ARC Test is carried out.

**Indirect Florescent Antibody (IFA) Test**

The IFA test is of serological nature to identity specific antibodies which are
developed for fighting against certain disease. These tests are rapid, inexpensive and
highly sensitive but it requires very much skilled technicians who could properly
interpret the results.

**AIDS Related Complex (ARC) Test**

The AIDS related complex test is to process the identification of a group of
signs and symptoms which would expose or characterize of a particular disease
namely AIDS.

There are some symptoms which are related to the incidence of AIDS and
ARC test aims at identification of signs and symptoms which would indicate the
likelihood of HIV infection.

**Treatment for HIV infection**

It is a known fact that the HIV infection is a very dangerous one from the
medical point of view due to the reason that the infection cannot be wiped out by
medical treatment. Once a person is getting infected the progression of the infection to
higher levels or intensity is unavoidable. Once a person is declared as seropositive by
clinical tests then the progression to AIDS is a sure event. Hence till this day no
medicine or treatment is available to wipe out the infection. The only possible alternative measure is to arrest the velocity or progression to AIDS. This would result only in the prolongation of life time. But the intensity of infection and its progression can be arrested by using the so called Anti Retroviral Therapy (ART).

The ART involves certain drugs which are injected into the human body and system. If arrests the antigenic diversity of the invading antigens and also the suppression of the human immune system. But the ART is a costly one and hence the government supplies such drugs and low cost to the patients who are infected. But the fast increase in the number of infected causes results in more expenditure to the government.

**Prevention of HIV infection**

As already indicated the treatment of HIV infected is not very much easy and hence it is not advocated. Even though the ART is given it can only prolong the Life span of the infected. Hence the most desirable and useful measure is to adopt the suitable strategies to avoid HIV infection and its spread. So much of concentration is paid to avoid the HIV infection using several prevention strategies which are advocated in this respect.

Various methods and strategies are suggested and adopted in practice as a measure of prevention of HIV infection. The most important aspect is the knowledge or information regarding the various modes of transmission of HIV and the consequences of the same. So information education about the modes of transmission, the indication of infection, the consequences of infection, and the effective strategies
to the adopted by any individual and all vital. The governments in various countries have taken this as a serious issue and steps have been suitably taken and implemented.

**Strategies suggested to avoid the various transmission of HIV are indicated as, follows.**

i. Sexual activities should be restricted only with life partner.

ii. Use of Condom at the time of sexual activities is very much helpful.

iii. Sharing of needles should be avoided especially in the case of drug abuse.

iv. Advising mothers, medical personnel to avoid the incidence of injuries to the baby in fetus and at the time of delivery so that contaminated blood from the infected mother to the baby is avoided.