The Constituents of HIV Reproductive Rate Equation and Ways That Each Constituent Is Decreased to Control HIV

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Introduction to Reproductive Rate Equation

The basic reproduction number of an infection is the average number of secondary cases which a single infected person causes during his infectious period in a susceptible population with no immunity to the disease. According to Giesecke (2002, 15) the potentiality of a disease to spread from an infected individual to others in a populations is called reproductive rate. The reproductive rate is highly related to the degree of the risk of transmission in each contact and the frequency of the contact. The principles of reproductive rate are:

1. Probability of transmission of infection during the contact between the susceptible individuals and infected person.
2. How common the contact in a population is.

3. The amount of time the person remains infectious.
4. The proportion of immune people in the population.
5. The basic reproductive rate is usually denoted by $R_{o.}$ This is useful because it helps to determine if an infectious disease spreads in a population or not. The general idea about Ro, as Giesecke (2002, 122) states, is that if R_o is more than 1, an epidemic of the infection will emerge; on the other hand, if R_o is less than 1, the epidemic will not happen and the infection will gradually decrease or die. Also if R_o equals to 1, then the infection will be endemic. the main equation that gives a good understanding and value of R_o is:

   $(R_o = \beta \times K \times D)$

As mentioned by Giesecke (2002, 124), β indicates the risk of transmission in each contact, K is the frequency of the contact that an individual has in the population per the time unit while the disease is absent, and D is the length of infectivity of the infected person. Understanding the above definition and formula for R_o, now we start thinking about the HIV prevention and control in the light of this reproductive rate equation.

β or the risk of transmission in each contact

First of all we have to discuss the constituents of this equation in the case of HIV in more details and show what each of them implies in HIV. To begin with, β which, as was mentioned before, indicates the risk of transmission in each contact, is different in various situations for HIV. For example, for kissing, shaking hands and using the same glasses for drinking water is zero because the infection is not transmitted in that way. Koenig (2004, 156) states that the main transmission routes of HIV from one person to another are sexual contact, exposure to body fluid (blood, milk) and from mother to foetus or child during perinatal period. For sexual intercourse, as Giesecke (2002, 124) states, β is between 0.001 and 0.1, and for blood transfusion β is roughly 1 because of close contact between the donor and the blood receiver.

K or the frequency of the contact between an individual and the population per the time unit

As far as κ is concerned, this was mentioned above that it is the number of contacts per time unit that an individual has in the population. In the case of HIV, in countries, where having many sexual partners is usual the risk of the spread of HIV is high and control measures of HIV comes

under a challenging condition. Giesecke (2002, 250) reveals that several case-control studies proved that there is a strong correlation between HIV acquisition and the number of sexual partners that the person had. Therefore the more sexual partners a person has the more exposed he or she will be to the risk of HIV infection.

D or length of infectivity of the infected person

Regarding D, as mentioned earlier it is the period of infectivity of an infected person in the population. The two main challenging facts about HIV, the lack of a cure and long duration of infectiousness are the main characteristics of this disease. The long duration of HIV infectiousness increases the probability of passing the infection to others by the infected people. The other shocking fact about HIV is that because a person with HIV typically remains asymptomatic for a long time, he or she and his partners are unaware of the risk of transmission, therefore, the longer the duration of asymptomatic HIV infection the more potentiality to put many more partners at risk. (Note: partner in this context refers to any persons in contact to the infected people via the route of transmission).

Ways that each constituent can influence and decrease the HIV infection

Understanding the role of reproductive equation constituents in HIV, helps us develop some control measures against this disease. Generally, we must attempt to decrease the R_o to be smaller than 1 in order to prevent establishment of an epidemic and be able to bring the disease under the control. The complexity of the reproductive equation constituents in the case of HIV put the organization of control measures of HIV into a tough condition. Each of the three elements of the reproductive equation has its own importance in controlling HIV. They are briefly discussed below:

The effect of β

β which is the risk of transmission in each contact is an important factor to consider while setting up the control measures for HIV. The risk of transmission as was previously mentioned varies according to the route of transmission. Pinkerton and Abramson (1996) reveal that the average chance that an infected male sexually transmits HIV to an uninfected female partner in

unprotected vaginal sex is estimated to be between 1 and 2 per 1,000 exposures, while the risk of transmission from an infected female to an uninfected male partner via unprotected vaginal sex is confirmed to be one-third to one-half as great. Therefore, it is believed that women have a somewhat higher probability of becoming infected from an infected male partner than the reverse. On the other hand the mentioned authors state that anal sex holds the highest risk, especially for the receptive partner. In fact, the risk of transmission of HIV in an anal unprotected intercourse is estimated to be between 5 and 30 per 1,000 exposures which show a 5 to 30-fold higher degree of risk of transmission. The other issue regarding the risk of transmission is the risk of transmission of infection via blood transfusion. It has been proven that the blood transfusion and using the same needles for the intravenous drug use carries the highest probability of transmitting the infection from an infected individual to susceptible people. According to Fan et al. (2005, 136) needle sharing is the cause of 35% of all new cases of HIV-infections in North America, China, and Eastern Europe.

In this regard, WHO (2006) reveals that about 5% to 10% of worldwide HIV transmission occurs via unsafe infected blood transfusion.

In the case of the third route of transmission of HIV, the transmission of the infection or virus from mother to her child can occur in uterus during the last weeks of pregnancy and at the time of child birth. If no treatment is supplied, the transmission rate between mother to the child during pregnancy, labor and delivery is 25%. (Coovadia 2004, 290)

Now let's see what we can do to decrease the risk of transmission per contact:

1. considering the sexual relationship as the route of transmission the following steps may be effective in decreasing the risk of transmission per contact;
    A. The use of condom can reduce the chances of infection in HIV. Cayley (2004, 1268) indicates that the use of condom reduces the risk of heterosexual HIV transmission by almost 80% over long term in case that condom is used correctly and in every sexual occasion. Condoms are available in two forms; male and female; now a days male condoms are frequently used as a control measure of HIV and other STIs because it is cheep and easy to use, on the other hand, female condoms are expensive and rarely used, but as Path (2006, np) reveals if female condoms are used, the overall protected sexual intercourse increases compared to unprotected sexual acts, which makes them important HIV prevention measure.

   B. Homosexual intercourse should be avoided or condoms should be used while having homosexual intercourse because the risk of transmitting the virus and infection via homosexual intercourse is up to 30 times more than heterosexual relationship.
2. Considering exposure to body fluid as the route of transmission the following steps has optimal effect in reducing the risk of transmission per contact.
   A. Donor blood should be screened for HIV.
   B. Avoid or deny using blood which comes from a suspicious person until laboratory examinations confirm the safety of the blood.
   C. Intravenous drug users should avoid using the same needle because it increases the chance of being infected with HIV.
3. Considering mother to child as the route of transmission, taking the following steps into consideration will help reduce the risk of transmission of virus from mother to the child.
   A. Single dose of nevirapine, costing less than $1, given to a mother and infant at the time of delivery can reduce infection by 50%. (Newell 2006, 4)
   B. Mother should where feasible use antiretroviral drugs for example AZT, and give birth by caesarean section. According to Coovadia (2004, 291) if mother uses antiretroviral drugs and give birth by caesarean section the rate of transmission will be reduced to 1% which is otherwise 25%.
   C. Mother should not breastfeed her child because breastfeeding increases the risk of transmission to 10-15% (Coovadia 2004, 291), but if breastfeeding cannot be avoided due to serious needs, UNAIDS (2006) suggests that mother can feed her child for the first months of life and try to find a good replacement to feed her child as soon as possible.

All above information about β shows the importance of this element of the HIV reproductive equation, if the information outlined above come into consideration, they will significantly decrease the risk of transmission in each contact time.

The Effect of Ƙ

The second constituent of HIV reproductive equation is Ƙ, which is the frequency of contact that an infected person has in a susceptible population per time unit when disease is absent. It is obviously clear that as an infected person contacts the susceptible individuals in a fully

susceptible population he or she can transmit the disease to that individual. In case of HIV which there is not immunity against it, (no vaccine has yet been introduced to completely immune the people against HIV) all non-infected people are the susceptible persons that can get the infection from infected individual via one of the three routes of transmission. Therefore, it is needed to consider some factors that enable us to reduce or avoid this phenomenon. The following steps might be effective in reducing the value of Ķ in HIV reproductive equation:

1. In case of sexual intercourse as the route of transmission number of sexual partners should be reduced. Unprotected sexual intercourse with multiple partners more likely put the uninfected people at risk of being infected by the infected partners. People with multiple sex partners are very likely to become infected and also unknowingly pass HIV to others. A good strategy in this regard is the arranged marriage and screening tests for HIV before choosing the partner. Monogamy or having one wife can also contribute to controlling the HIV.
2. In case of exposure to body fluid as the route of transmission, use of the same needle should be prevented. All AIDS-prevention organizations advise drug-users not to share the needles and other materials required to prepare drugs for example syringe, cotton balls, etc. and instead use new properly sterilized needles for each injection. To do this, in most of countries, clean disposable needles are available free for the use.
3. Considering the Mother-to-Child Transmission (MTCT) as the route of transmission, women can avoid any unwanted pregnancies. According to Duerr (2005, np), the number of wanted pregnancy should also be minimized to the lowest. Otherwise steps which were mentioned in β part should not be neglected.

These steps will reduce the frequency of contact between the infected person and susceptible individuals in the community and in turn reduces the risk of being infected by HIV.

The Effect of D

The last constituent of HIV reproductive equation is D, which is the period of infectivity of the infected person. Although still there is not any vaccine or cure for HIV, but antiretroviral drugs are now used to reduce infectivity period, reduce the risk of infection per contact, extend the lives of people with HIV, and reduce the acquisition of new cases. But because these drugs are very

expensive very few developing countries afford to buy them, therefore to prevent and control the prevalence and incidence of HIV worldwide, it is strongly needed that developed countries and United Nations Organization provide these drugs and make them available for developing countries for free or lower costs.

HIV Prevention Issues Specific in Women

Besides all the information and control measures given above, there are some specific prevention issues and control measures for the women. According to the article *preventive issues specific to women* (2004) published by John Hopkins University, women are prone to higher risk for HIV transmission due to biological and behavioral factors. In unprotected intercourse, women are at higher risk for HIV and STD transmission for both biological and behavioral factors. During unprotected intercourse, women are more likely exposed to higher viral infection than their male partners. As stated by the mentioned article, the essential HIV prevention measure specific in women is the use of female condoms. It is a double ring latex pouch which is used prior to intercourse. As was mentioned before, the expensive cost of female condoms is the biggest barrier against its widespread use.

The other preventive measure specific for the women is the application of vaginal microbiocides. The article adds that this method establishes physical and chemical stability in vagina. It should be used before intercourse, it does not cause any harms to the epithelium, it is inexpensive, and fights against bacterial and viral pathogens. They are available in the form of cream, gel and foams which are easy to use but optimally effective. And as McCosmey (2003) indicates educating female about HIV is an important issue in preventing the spread of HIV among women. The wrong belief among women that HIV is a disease specific for gay men sometimes causes women not to think about prevention issues of HIV. The fact that women are more prone to getting the infection and complications of HIV than men during the sexual intercourse necessitates the implementation of training and educating campaigns among women to make them aware of their status and the control measures and prevention issues that are effective for them.

Conclusion

Scientifically speaking, understanding the elements of reproductive rate of HIV infection enables us to establish control measures and preventive issues against the spread of this threatening disease in the world. All people and specifically women should be aware of the dangers and risks of HIV because of their biological and behavioral characteristics. Implementing the preventive measures of HIV can enable us reduce and perhaps eliminate the prevalence and incidence of this disease in the future.

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