UNIVERSITI TEKNOLOGI MARA

TECHNICAL REPORT

MATHEMATICAL MODELING FOR HIV AND AIDS SPREAD IN MALAYSIA

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ABSTRACT

The spread of human immunodeficiency virus (HIV) has become one of the major concerns in some parts of the world. This virus also has the possibility to develop into acquired immune deficiency syndrome (AIDS) which is the advance stage of HIV. To understand the spread and behavior of this disease, mathematical models are commonly developed and applied for better understanding. In this current case study, by using the list of parameters used, basic equations are developed and derived to estimate number of individuals infected with HIV who develop into AIDS and number of individuals who do not advance into the AIDS stage. The results of the estimated number of individuals for both groups are compared with the annual data set in Malaysia to ensure the estimated values compliments the real data. Also by using the derived formula, the value of critical threshold parameter R_0 is calculated and analyzed to assess the stability of the disease in Malaysia. If $R_0 < 1$, the disease dies out; and if $R_0 > 1$, the disease free-equilibrium is unstable. As the value of R_0 calculated is unconditionally greater than unity 1, it shows a major concern on Malaysian's public health because the aim was to stabilize the epidemic spreading at disease-free equilibrium point. It can be concluded that HIV disease in Malaysia shows epidemic behavior, especially in understanding and forecasting emerging cases of HIV and AIDS.

1 INTRODUCTION

According to Hyman & Stanley (1998), human immunodeficiency virus (HIV) is believed to be originated around 1920in Kinshasa, the Democratic Republic of Congo. The HIV transmission was not traceable back then causing the number of people developed HIV and AIDS was undiscovered until year 1980. By that year, HIV has spread to 5 continents. The figure for the infected individuals are between 100,000 and 300,000 during that period.

According to The U.S. Department of Health and Human Services (HHS) (2016), HIV infection could advance into acquired immune deficiency syndrome (AIDS) which is the final stage of HIV infection. In this stage, the immune system is severely damaged and becomes vulnerable to opportunistic infections. This arises major concern in many part of the world as the disease is deadly. HIV is a virus that constantly attacks the immune system causing the body incapable to fight off infections.

The HIV is transmitted by three main routes which are sexual contact, being exposed to infected body fluids or tissues from HIV positive mother to their babies during pregnancy or breastfeeding. In addition, based on the World Health Organisation-HIV department (2016), the total number of people living with HIV and AIDS in 2013 was 35 million globally.

Study by Apenteng & Ismail (2015), Markov Chain Monte Carlo (MCMC) approach is used to estimate the value of the parameters assigned considering each parameter's uncertainties. This is because, Haario et al. (2006) mentioned in his research that MCMC approach is one of the numerical techniques that is significant in mathematical modeling, quantifying the parameter's uncertainty to create a sample from a posterior distribution, and it has been widely used. By using the estimated parameter, the number of HIV and AIDS cases is then estimated and is compared to Malaysian's HIV and AIDS statistic to ensure that the result of estimated ones with actual data complement each other. The result shows that the MCMC approach could be used as a supplement to estimate the HIV and AIDS cases in Malaysia. In this case study, the