Transmission Dinamics Model Of Dengue Fever

Debora¹, Rendy² and Rahmi³

Department of Mathematics, Universitas Sumatera Utara, Medan, Indonesia

E-mail: ¹dexasi84@gmail.com, ²rendyis@ymail.com, ³rahmisiregar51@yahoo.com

Abstract. Dengue fever is an endemic disease that is transmitted through the Aedes aegypti mosquito vector. The disease is present in more than 100 countries in America, Africa, and Asia, especially tropical countries. Differential equations can be used to represent the spread of dengue virus occurring in time intervals and model in the form of mathematical models. The mathematical model in this study tries to represent the spread of dengue fever based on the data obtained and the assumptions used. The mathematical model used is a mathematical model consisting of Susceptible (S), Infected (I), Viruses (V) subpopulations. The SIV mathematical model is then analyzed to see the solution behaviour of the system.

Keywords: dengue fever, endemic, SIV model, model simulation.

1. Introduction

Dengue Haemorrhagic Fever (DHF) or dengue haemorrhagic fever is a viral disease transmitted by mosquitoes that is currently the main concern of the international community. DHF is found in parts of the tropical and sub-tropical earth, mostly in urban and semi-urban areas. DHF was first noticed in Southeast Asia in the 1950s but starting in 1975 is now the leading cause of death in children in Asian countries. Even since 1997 DBD has been declared the most important viral disease of dangerous origin and fatal to humans. DHF is transmitted to humans through the bite of Aedes female mosquitoes infected with dengue virus.

According to WHO DHF problems have grown dramatically in the last decade, about 40% of the world’s people are at risk of dengue. Based on information from the Health Center Protection website in Indonesia, the disease was first reported in 1968, in the cities of Jakarta and Surabaya. The epidemic of DHF outbreaks outside Java was first reported in West Sumatra and Lampung in 1972. Since then, the disease has become widespread in many parts of Indonesia. DHF transmission can only occur through mosquito bites in the body containing Dengue virus. Until now there has not been found a special drug that can kill dengue virus, therefore the main preventive effort is to avoid mosquito bites (Zeth, 2012).

2. Literature Review

2.1 The Ordinary Differential Equations

A common differential equation is an equation that expresses the relationship between a function with a single independent variable and the total derivative of this function against that independent variable. The dependent variable (y) depends on the physical problem being model. The independent variable is usually one of the variables of time (t) or space (x). The Order of GDP is the highest-order derivative in a differential equation.
The general form of first order GDP is: \( \frac{dy}{dt} = f(t, y) \)

where \( f(t, y) \) is called the derivative function. For simplification of notation, the derivative is usually expressed by a single quotation mark: \( y' = \frac{dy}{dt} \), So we get: \( y' = f(t, y) \)

GDP has a common form:

\[ a_n y^{(n)} + a_{n-1} y^{(n-1)} + \ldots + a_2 y'' + a_1 y' + a_0 y = F(t) \]

Where superscript \((n), (n-1)\), etc., denotes the order derivatives to \( n, n-1 \), and so on.

### 2.2 Ordinary Differential Equations Linear and Nonlinear

Linear GDP is the GDP of which all derivatives appear in linear form and no coefficients depend on the dependent variable. Coefficients can be a function of independent variables, in which GDP is called linear GDP with coefficients changed.

\[ y' + ay = F(t) \quad \text{(Linear, constant coefficient, one-order GDP)} \]
\[ y' + aty = F(t) \quad \text{(Linear, changeable coefficient, one-order GDP)} \]
\[ y' = f(t, y) \quad \text{(Common form of linear GDP)} \]

If the coefficient depends on the dependent variable, or derivatives appear in the form of nonlinear, its GDP is nonlinear.

Example:

\[ yy' + ay = 0 \quad \text{(GDP common form of non-linear)} \]
\[ (y')^2 + ay = 0 \]
\[ y'' + P(x, y)y' + Q(x, y)y = F(x) \]

### 2.3 Model Mathematics for Transmission Virus Dengue

Model that will discussed on chapter this is model SIV (Susceptible, Infectious, viruses) on transmission virus dengue in body man, with Pay attention Facts And assumptions.

### Table 1. List of Variables

| Variable | Information | Terms |
|----------|-------------|-------|
| \( S(t) \) | amount cell that susceptible infected virus on time \( T \) | \( S(t) \geq 0 \) |
\[ I(t) \] amount cell that Infected virus on time \( T \) \[ I(t) \geq 0 \]

\[ V(t) \] Number of Dengue Virus in in body on time \( T \) \[ V(t) \geq 0 \]

| Parameter | Information | Terms |
|-----------|-------------|-------|
| \( \alpha \) | Pure birth rate of susceptible cells | \( \alpha > 0 \) |
| \( \beta \) | The proportion of dengue viruses that move | \( \beta > 0 \) |
| \( \delta \) | Pure cell death rate is vulnerable | \( \delta > 0 \) |
| \( \sigma \) | The pure mortality rate of infected cells | \( \sigma > 0 \) |
| \( n \) | Number of new dengue virus duplications | \( n > 0 \) |
| \( \mu \) | The proportion of the number of infected cells that produce the virus | \( \mu > 0 \) |
| \( \gamma_1 \) | The pure death rate of dengue virus | \( \gamma_1 > 0 \) |
| \( \gamma_2 \) | Dengue virus death rate caused by T cells | \( \gamma_2 > 0 \) |
| \( \gamma_3 \) | The rate of death of dengue virus caused by herbal medicine | \( \gamma_3 > 0 \) |

Diagram in under this Illustrates process transmission virus dengue in in the body human.

![Diagram](image_url)

**Figure 1. Diagram Process Transmission Virus dengue in Human body**

Based on diagram above Obtained Differential equations of dynamic transmission virus dengue that presented in the model Mathematics, namely:
\[
\begin{align*}
\frac{dS}{dt} &= \alpha - \beta SV - \delta S \\
\frac{dI}{dt} &= \beta SV - \sigma I - \mu n I \\
\frac{dV}{dt} &= \mu n I - \gamma_1 V - \gamma_2 V - \gamma_3 V - \beta SV
\end{align*}
\]

3. Conclusion

Based on the graph, the number of cells that are vulnerable to the relative \(S\) a lot with the passage of time will decrease and toward the value of zero. As for the number of cells that are important \(I\) at a time will reach the highest point, which indicates the maximum number of infected cells and gradually decreases with the passage of time. Because since \(S\) and \(I\) are getting less infected, the amount of virus in the body as well \(V\) decreases. This can be seen based on graphs for \(S\), \(I\), and \(V\).

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