Mathematical analysis on the bias of dengue infection process caused by hospitalization

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Dengue has become a major disease in many tropical and sub-tropical countries since it is first time found in China, 256–420 AD. This disease spread by Aedes mosquitoes and caused by 4 different serotype of DEN viruses. Since no special medical treatment to cure infected human, the only thing that can be done to treat them is to providing hospital care which will isolate them from a possibility to infect susceptible mosquito. Many mathematical models have been developed by many authors to understand how dengue might spread among the human population. Most of the model introduced the infection process as a mass interaction between susceptible human with infected mosquito and between susceptible mosquito with an infected human. Whereas, the infection might appear mostly only between un-hospitalized infected human with susceptible mosquito, which brings us into a bias interpretation of incidence data when this data is available from hospital record.

Here in this talk, we construct an SIR-UV model of dengue spreads with an intervention of hospitalization. Quasi-Steady-State-Approximation (QSSA) method then applied to the model which reduced the model into a simple IR model. A comprehensive analysis of the existence of the equilibrium points and their stability will be analyzed together with the basic reproduction number ($\mathcal{R}_0$). The parameters on the model then parameterized using data from the 2017-2018 dengue outbreak in Jakarta and used to estimate the $\mathcal{R}_0$ when no intervention for dengue control implemented. The parameter estimation problem is constructed an optimal control problem in a purpose to minimize the Euclidian distance between simulation and the incidence data using an optimal parameter(s). Once the parameters found, a second optimal control problem then applied to investigate the optimal strategy of hospitalization intervention which treated as a time-dependent variable to minimize the number of infected humans as small as possible. Some numerical results of the optimal control problem will be discussed in this talk.

Keywords : dengue, hospitalization, bias of infection process, incidence data, optimal control