ABSTRACT

ANALYSIS OF TUBERCULOSIS DISEASE SPREAD MODEL AND OPTIMAL CONTROL STRATEGY THROUGH HEALTH EDUCATION, PREVENTIVE THERAPY, AND TREATMENT

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Tuberculosis (TB) remains a global health challenge. This infectious disease caused by Mycobacterium tuberculosis is spread through the air, and although treatment is available, the emergence of drug resistance poses a serious challenge in disease control. This thesis discusses the stability analysis of the TB disease spread model and the implementation of optimal control strategies. The model consists of six subpopulations: a susceptible subpopulation, a vaccinated subpopulation, a latent subpopulation, an infected subpopulation, a drug-resistant infected subpopulation, and a cured subpopulation, referred to as the SVLIMR model. The results of the positivity and limitedness analysis of the solution indicate that the model system has a non-negative and limited solution for each simulation time. Based on the analysis, two equilibrium points were obtained: a disease-free equilibrium point and an endemic equilibrium point. Furthermore, local stability analysis was conducted using the Routh-Hurwitz criterion, while global stability analysis employed the Lyapunov method. The results of the sensitivity analysis indicate that the vaccination parameter plays a role in reducing the basic reproduction number, while the recruitment rate of the susceptible population increases the basic reproduction number. The basic reproduction number obtained is 1.499, indicating that the value is greater than one, so the system is in an asymptotically stable condition around the endemic equilibrium point. This suggests that tuberculosis remains a persistent issue in the population. The optimal control problem is solved using the Pontryagin minimum principle, with three types of controls: health education, TB preventive therapy, and medication. The results of the optimal control analysis indicate that the implementation of controls can significantly reduce the number of infected individuals. Numerical simulations using TB case data in Demak Regency show that the combination of the three controls simultaneously is more effective in reducing the number of sufferers than the implementation of one control alone. Thus, an integrated control strategy can suppress the spread of TB.

Keywords: TB, Mathematical Model, Basic Reproduction Number, Stability Analysis, Optimal Control