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Optimal Control Solution of A Tuberculosis Transmission Model with Reccurent Infection and Vaccination Using C# Programming

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This paper presents a model of tuberculosis (TB) transmission with vaccination by explicitely considering the total number of recovered individuals, either from natural recovery or due to vaccination. Based on this continuous model, the tuberculosis control is formulated and solved as an optimal control theory problem, indicating how a control term in the population to reduce the number of individuals with active TB. Control model on treatment to reduce actively infected individual populations. The end of this study determined numerically solution of optimal control model of tuberculosis treatment approach Principle Pontryagin Maximum by using programming C#.

Keywords: Programming C#, optimal control, tuberculosis, treatment, vaccination.

1. INTRODUCTION

Tuberculosis is a disease that affects human and animal population. The disease is able to spread quickly through the air medium and becoming the second most killer among all transmission disease. This report on global tuberculosis in 2011, there were an estimated 8.7 million incident cases of TB (range, 8.3 million–9.0 million) globally, equivalent to 125 cases per 100 000 population. The five countries with the largest number of incident cases in 2011 were an estimated India (2. 25 million), China (1 million), South Africa (0.5 million), Indonesia (0.45 million) and Pakistan (0.4 million). India and China alone accounted for 26% and 12% of global cases, respectively[11].

Some researchers have been studying the tuberculosis transmission[3-6,11]. Some of them have include intervention to over come the spread of TB in their models[3-5]. Control programs have continued to function as if the TB epidemiological situation is stable and indeed all approaches including Directly Observed Treatment Short Course strategy have so far failed to control TB in areas of high HIV/AIDS prevalence[5,11]. Prevention of tuberculosis WHO (World Health Organization) recommended intervention is by giving BCG (*Baccilus Calmete Guerin*) vaccination to newborn baby at ages 2 to 3 months an in general population, while in some of these studies the vaccine is only given to people newly recruited into the population[6,11]. An example of the person that is vaccinated with BCG could be protected 70% - 80% from tuberculosis infection[13].

Some past models of tuberculosis, particularly the predictive models attempting to calculate a threshold for the basic reproductive number R_0, have incorporated drug treatment and/or vaccination, and have discussed control of the disease by looking at the role of disease transmission parameters in the reduction of R_0 and the prevalence of the disease[7].

Both approaches of studying control strategies produce valuable theoretical results which can be used to suggest or design epidemic control programs, several researchers have studied the optimal control of tuberculosis by using MATLAB[1-2]. In this paper, we consider (time dependent) optimal control strategies associated with treatment actively infected individuals a tuberculosis transmission model developed in[3]. Introduced into the model are control mechanisms on treatment for individuals actively infected with TB and solution of optimal control model with approach Pontryagin Maximum Principle by using programming C#[9-10].

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