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Optimal control of tuberculosis and HIV/AIDS

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Abstract: The human immunodeficiency virus (HIV) and mycobacterium tuberculosis are the first and second cause of death from a single infectious agent, respectively, according with the World Health Organization. Acquired immunodeficiency syndrome (AIDS) is a disease of the human immune system caused by infection with HIV. There is no cure or vaccine to AIDS. However, antiretroviral (ART) treatment improves health, prolongs life, and substantially reduces the risk of HIV transmission. Nevertheless, ART treatment still presents substantial limitations: does not fully restore health; treatment is associated with side effects; the medications are expensive; and is not curative. Individuals infected with HIV are more likely to develop tuberculosis (TB) disease because of their immunodeficiency, and HIV infection is the most powerful risk factor for progression from TB infection to disease. Collaborative TB/HIV activities (including HIV testing, ART therapy and TB preventive measures) are crucial for the reduction of TB-HIV coinfected individuals. The study of the joint dynamics of TB and HIV present formidable mathematical challenges. We propose a new population model for TB-HIV/AIDS coinfection transmission dynamics, where TB, HIV and TB-HIV infected individuals have access to respective disease treatment, and single HIV-infected and TB-HIV co-infected individuals under HIV and TB/HIV treatment, respectively, stay in a chronic stage of the HIV infection. We apply optimal control theory to our TB-HIV/AIDS model and study optimal strategies for the minimization of the number of individuals with TB and AIDS active diseases, taking into account the costs associated to the proposed control measures.
Keywords: Tuberculosis, human immunodeficiency virus, coinfection, treatment, equilibrium, stability, optimal control.
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