Modelling the impact of immunosenescence on the dynamics of HIV-1 infection

J. Ssebuliba
University of Stellenbosch
joseph@sun.ac.za

SAMS Subject Classification: ODE's and Dynamical Systems

The severity of the numerous factors that influence the rate of HIV-1 disease progression leads to alterations in the observed clinical picture of HIV-1 infected individuals. Age of the human immune system at infection is one of such factors, whose impact on HIV-1's pathogenesis has not been substantially evaluated. The time of emergence of HIV-1 associated opportunistic diseases also varies according to the patients immune regenerative capacity, which is partly dependent on age. Our principle objective is to determine the patient's lifespan and account for the puzzling qualitative features of age-related immune deficiency associated with HIV-1 infection. A compartmental ordinary differential equation model describing the immunological changes in the concentration of $CD4^+$ and $CD8^+$ T lymphocytes, macrophages, stem-cell reservoir and virions in the blood is used to assess the dynamics of HIV-1 infection with respect to immunosenescence and to address the rapid exhaustion of the T-cell reservoir and the accelerated aging of the immune system. Variation of age at HIV-1 infection showed that older age (≥ 50 years) is linked to both a shortened interval between the onset of AIDS and death, and a very low virologic suppression compared to younger individuals (≤ 30 years). Incorporating anti-retroviral therapy indicated that its administration fails to increase the concentration of the haematopoietic stem-cell reservoir, but it strengthens the immune responsiveness towards opportunistic diseases (Tuberculosis). We conclude that: age at HIV-1 infection is a significant predictor of a patient's lifespan; the quality of immune resources, the degree and speed of immune restoration is reduced in older patients; and lastly, elderly individuals rapidly progress to AIDS and die faster compared to younger individuals.