

# Modelling the dynamics of HIV-related malignancies in the presence of HIV treatment and chemotherapy

Farai Nyabadza<sup>1</sup>, Rosemary Aogo<sup>2</sup>

<sup>1</sup> Stellenbosch University, nyabadzaf@sun.ac.za

<sup>2</sup> University of New South Wales, rosemary@aims.ac.za

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HIV/AIDS and cancer co-existence both *in vivo* and *in vitro* in a cancer-immune environment leads to specific cytokines being produced by various immune cells and the cancer cells. Most of the studies have suggested that specific cytokines produced by the immune system cells and the tumor play an important role in the dynamics of Non-Hodgkin lymphomas (NHLs). In this paper, a mathematical model describing the NHL-immune system interaction in the presence of the Human Immunodeficiency Virus (HIV), HIV treatment and chemotherapy is developed. The formulated model, described by non-linear ODEs shows existence of multiple equilibria whose stability and bifurcation analysis are presented. From the bifurcation analysis, bistability regions are evident. We observe that with and without HIV treatment, the system results in a non-aggressive tumor size or aggressive tumor (full-blown tumor) depending on the initial conditions. The results further suggest that at a low endemic state, patients can live for longer period of time with the tumor which might explain why some patients can live with cancer for many years. However, initiation of HIV treatment in patients with NHL is observed to lower these endemic states of the tumor. Our results explain why late initiation of HIV treatment might not be helpful to NHL patients. We further investigated the effect of chemotherapy on the dynamics of the tumor. Our simulation results might explain why a few of these chemotherapeutic drugs are more effective when given at a slow continuous rate. The model provides a unique opportunity to influence policy on HIV related cancer treatment and management.

## References

- [1] B. J. Alimonti, T.B. Blake, and R.K. Fowke, *Mechanisms of CD4+ T lymphocyte cell death in human immunodeficiency virus infection and AIDS*, Journal of General Virology, **84**(7):1649–1661, 2003.
- [2] J.C. Arciero, T.L. Jackson, and D.E. Kirschner, *A mathematical model of tumor-immune evasion and siRNA treatment*, Discrete and Continuous Dynamical Systems-series B, **4**(1):39–58, 2004.