José A. García
Department of Preventive and Social Medicine, University of Otago, PO Box 913, Dunedin 9054, New Zealand
e-mail: jose.garcia@otago.ac.nz
Aidin Jalilzadeh
Department of Mathematics and Statistics, University of Otago, Dunedin 9054, New Zealand
e-mail: aidin_jalilzadeh@yahoo.com
Boris Baeumer
Department of Mathematics and Statistics, University of Otago, PO Box 913, Dunedin 9054, New Zealand
e-mail: bbaeumer@maths.otago.ac.nz

A reinforced random walk model for studying the acute inflammatory response

The theory of reinforced random walks (RRWs) provides a natural framework for modelling the movement of individuals. RRWs are in particular suitable for modelling cell motility in response to one or more control substances [1]. In the past RRWs have been used to model angiogenesis and solid tumour growth and metastasis [2, 3].

In this work we have developed a spatio-temporal mathematical model consisting of a system of diffusion-advection-reaction equations, to capture some aspects of tissue inflammatory response. Two sorts of cell movement mechanisms are considered: 1. Chemotactic as the major physiological effect that leads the movement of leukocytes towards the site of infection/inflammation, 2. Leukocytes' random motility described via diffusion process. The proposed model accounts for (1) antigen recognition, (2) the effector function (activation/inhibition), (3) innate immune response, (4) elimination of antigen and resolution of the infection and (5) returning the immune cells back to a steady state. In case of a persistent source of antigen, i.e. chronic infection, it is observed that the immune response reaches an equilibrium level. 2-D Matlab simulations have enabled us to visualise the dynamics of the immune cells and chemicals.

Our simulations could provide insights for better understanding complex diseases associated with chronic inflammation like cancer and autoimmunity.

References

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