Mathematical and numerical modeling of inflammation

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Abstract

When the body is attacked by a bacterial infection, it initiates a series of events designed to eradicate the infection while causing minimal damage to the body. Our goal is to investigate the defenses of the organ walls to the spread of infection. To do this we have chosen to model a volume of the body that includes the organ wall, the lumen outside of it and the blood and tissue within it. We have also taken into account the varied responses of the body, and our model includes many interacting agents that are part of the infection and defense processes, including the agents that attempt to prevent the infection from breaching the organ wall. The mathematical model is based on a system of nonlinear transient partial differential equations. The numerical model is based on cell-centered finite differences in space and implicit Euler in time. The model is implemented in MATLAB, and has many visualization options to better see the progression of the infection. It is hoped that this model will help in better understanding the failure of the body's defenses in such situations as Necrotizing Enterocolitis (NEC), and eventually lead to the development of a method of prevention.