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Optimal controls for enhancing natural response of the immune system in obesity-related chronic inflammation

Recent researches shows that the prevalence of obesity has increased by 70 percent over the past decade [2]. According to World Health Organization estimates, over 300 million adults are obese [4]. As the severity of the problem continues to grow worldwide, many scientific experts consider the obesity crisis a pandemic [3]. Chronic inflammation within fat tissue is now recognized as a contributor to the many ill health consequences that come with obesity, from diabetes to cardiovascular disease. The new discovery may therefore point to a targeted therapy designed to limit the health impact of the obesity epidemic, the researchers say. Unlike acute inflammation, which is the natural response to injury or infection, chronic inflammation results from a defective immune response. The excessive activity of pro-inflammatory cells and proteins can result in additional defects for surrounding tissues. These effects of chronic inflammation can lead to diseases such as cancer, kidney failure, atherosclerosis, and type 2 diabetes mellitus.

In this work, the optimal control theory is applied to an extended version of the model introduced by P. Díaz et al. in [1]. The model is defined by a system of ordinary differential equations and reflects the molecular and cellular interactions of the macrophages, T cells, chemokines, and cytokines that cause chronic inflammation, after the onset of adipocyte hypertrophy. The model does not account for the time period in which the subject becomes obese. In comparison with the model in [1], here a linear model for pharmacokinetics has been added. Seeking to maximize the effect of drug treatments to the model, we use a control representing the treatment. The optimal control is characterized in terms of the optimality system, which is solved numerically for several scenarios.

References

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