Mathematical Modeling of Pancreatic Cancer with Clinical Data

Tuğba Akman Yıldız[1,*], Emek Köse[2], Samantha L. Elliott[3]

[1]*Department of Industrial Engineering, Faculty of Engineering, University of Turkish Aeronautical Association, 06790 Ankara, Turkey*
[2]*Department of Mathematics and Computer Science, St. Mary's College of Maryland, St. Mary's City, MD 20619, U.S.A.*
[3]*Department of Biology, St. Mary's College of Maryland, St. Mary's City, MD 20619, U.S.A.*

takman@thk.edu.tr

Pancreatic cancer is a highly fatal disease and difficulties in diagnosis result in poor survival outcomes. Indeed, five-year survival rate is approximately 8%. In this study, the model proposed by He and Xu [2] has been considered where different cell types, such as pancreatic cancer cells, pancreatic stellate cells and some immune cells, and some cytokines, such as IL-2 concentration, IFN-γ concentration and TGF-β concentration have been included. We extend this model with the cancer stem cells to follow cancer progression. Moreover, the experimental data presented by Cioffi et al. [1] have been used to find the patient specific parameters such as tumor growth rate, inverse carrying capacity and activation rate of pancreatic stellate cells. As treatment choices, chemotherapy (with Abraxane and Gemcitabine) and immunotherapy (with Anti-CD47 treatment) have been incorporated into the model and simulation results have been compared with the clinical data. Then, optimal drug protocols have been investigated with different immune strengths and initial conditions. Based on our numerical findings, it is revealed that the most successful treatment strategy is the combination treatment and drug dose is more critical than drug scheduling [3]. However, high drug dose may not be preferable due to side effects. Therefore, we believe that this study will encourage new drug studies not only to reduce side effects of therapy, but also to stop cancer progression.

References

[1] M. Cioffi, S. Trabulo, M. Hidalgo, E. Costello, W. Greenhalf, M. Erkan, J. Kleeff, B. Sainz, C. Heeschen, Inhibition of CD47 effectively targets pancreatic cancer stem cells via dual mechanisms, Clinical cancer research, 21 (10) (2015) 2325–2337.

[2] D.H. He, J.X. Xu, A mathematical model of pancreatic cancer with two kinds of treatments, Journal of Biological Systems, 25 (01) (2017) 83–104.

[3] T. Akman Yıldız, E. Köse, S.L. Elliott, Mathematical Modeling of Pancreatic Cancer Treatment with Cancer Stem Cells, Manuscript submitted for publication (2020).