Mathematical Model of a Personalized Neoantigen Cancer Vaccine and the Human Immune System: Evaluation of Efficacy

Science and Mathematics

Colloquium Series

Wed., March 3, 3:30 p.m.

Zoom link: http://links.asu.edu/science-math

Cancer vaccines are a novel immunotherapy, enhancing the immune response to malignant cells by activating CD4+ and CD8+ T-cells. In this work, Dr. Rodriguez's team has developed a mathematical model of nonlinear ordinary differential equations to describe key interactions of a personalized neoantigen cancer vaccine with the immune system of an individual patient. They quantify the effect of a personalized, peptide-based neoantigen cancer vaccine on the CD4+ and CD8+ T-cell species and tumor size. This model was calibrated using patient-specific data from a neoantigen peptide vaccine for anti-melanoma clinical trial.

Model parameters estimated through model fitting describe the activation of naïve T-cells, and the killing and proliferation interactions between activated T-cells and tumor cells. The model predicts the clinical outcome of patients from a clinical trial and simulate their observed CD4+ and CD8+ T-cells response over time. Based on sampled initial tumor burden of a patient, the model predicts the 'best' clinical outcome of a personalized neoantigen peptide vaccine. Some model parameters were identified to be important through global sensitivity analysis such as proliferation rate of activated T-cells, which has been shown to be a favorable prognostic sign and may help determine efficacy of the immunotherapy. Their model has the potential to lay the foundation for generating in silico clinical trial data and aid in the development and efficacy assessment of personalized cancer vaccines.

Questions? Contact Steven.Saul@asu.edu

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Marisabel Rodriguez earned a PhD in applied mathematics at ASU in 2018. She then held a visiting lecturer position at Dartmouth College before joining the Data Science Initiative at Brown University for a postdoc position. In December 2019, Rodriguez joined the Analytics and Benefit-Risk Assessment Team under the Office of Biostatistics and Epidemiology in the Center of Biologics Evaluation and Research at the FDA as an ORISE Research Fellow, where she has been working on developing a computational tool that can aid the development and efficacy assessment of personalized cancer vaccines.

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