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Examples of Mathematical Modeling in Drug Development

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ABSTRACT

I will share two examples of mathematics used in the biopharma industry.

1) How much better could patient responses be if we used the same drugs but changed the dosing regimen? With a mathematical model for the disease-therapy dynamics, and a quantitative therapeutic goal, we can apply optimal control to predict the regimen that will perform the best according to the goal. We can also quantify how much better the outcomes are predicted to be in comparison with standard of care regimens. I will explain the method using some examples, and will discuss some of the challenges of applying optimal control in the biopharma industry.

2) Immunotherapies don't work for many cancer patients; but when they do work, they can work extremely well. So it is important to figure out as early as possible if a patient will be a "responder" or a "non-responder": we don't want to switch their therapy if they will end up responding, and we don't want to waste their time on a therapy they won't respond to. I will present a simple mathematical model of tumor dynamics I used to fit the patient tumor size data. I combined the fitted model parameters with a machine learning technique to create an early predictor of response/non-response. I will also show how I validated the predictor on data sets for different cancer types and immunotherapies.

BIO:

Dr. Helen Moore graduated from the North Carolina School of Science and Mathematics and the University of North Carolina at Chapel Hill. She received her PhD in mathematics in 1995 from Stony Brook University. Her original work in differential geometry focused on shapes that minimize volume under certain constraints. Over a period of 11 years in academia, she won two teaching awards and received a National Science Foundation grant for her research. While at Stanford University, she began collaborating with faculty in the medical school, and shifted her use of optimization techniques to apply them to therapies for cancer, HIV, and hepatitis C. In 2006, Dr. Moore entered the biopharma industry. She first worked at Genentech, and then Pharsight/Certara in California. Dr. Moore moved to the east coast in 2014 to work for Bristol-Myers Squibb in Princeton, NJ, and moved near Boston, MA in 2018 to work for AstraZeneca. Dr. Moore was recently selected as a Fellow of the Society for Industrial and Applied Mathematics (SIAM, with over 14,000 members), with the following citation: "For impactful industrial application of mathematical modeling in oncology, immunology, and virology. For mentoring, teaching, and leadership."

