INTERNATIONAL SYMPOSIUM ON INFECTIOUS DISEASES AND VACCINES

Chrysovalantis Voutouria,b,#, C. Corey Hardinc,#, Vivek Naranbhaid,e,f, Mohammad R. Nikmaneshia, Melin J. Khandekarh, Justin F Gainord, Lance L. Munna,*, Rakesh K. Jaina,* and Triantafyllos Stylianopoulosb,

a Edwin L Steele Laboratories, Department of Radiation Oncology, Massachusetts General Hospital and Harvard Medical School, Boston, MA
b Cancer Biophysics Laboratory, Department of Mechanical and Manufacturing Engineering, University of Cyprus, Nicosia, Cyprus
c Department of Pulmonary and Critical Care Medicine, Massachusetts General Hospital and Harvard Medical School, Boston, MA
d Massachusetts General Hospital Cancer Center, Division of Hematology/Oncology, Department of Medicine, Massachusetts General Hospital, Boston, MA
e Dana-Farber Cancer Institute, Boston, MA
f Center for the AIDS Programme of Research in South Africa, Durban, South Africa
h Department of Radiation Oncology, Massachusetts General Hospital and Harvard Medical School, Boston, MA

Mathematical modeling of booster vaccine efficacy for SARS-CoV-2 in healthy, cancer, and immunosuppressed patients

Abstract: This study develops a mechanistic mathematical model to evaluate the effectiveness of booster doses of SARS-CoV-2 vaccines in varying patient populations: healthy individuals, cancer patients, and immunosuppressed individuals. While current vaccines significantly reduce COVID-19 severity, immunocompromised individuals often experience reduced immunity, especially as antibody levels decline over time. Our model integrates viral dynamics, immune response, and booster dose impact, simulating scenarios for mRNA and vector vaccines under multiple conditions, including exposure to COVID-19 variants. By validating predictions with clinical data, we examined how booster timing influences immunity, comparing antibody and immune cell responses among different patient groups. Results indicate that booster doses effectively sustain antibody levels in healthy patients for extended periods but reveal a faster decline in cancer and immunosuppressed patients. For these high-risk groups, the model suggests tailored, more frequent booster intervals to maintain protective immunity levels. Furthermore, simulations reveal that variants with increased immune escape capabilities may pose significant infection risks, highlighting the importance of personalized booster strategies for vulnerable populations. The findings support targeted booster schedules and adaptation of booster formulations, aiming to enhance protection against emerging variants for at-risk groups. This model provides a foundation for optimizing vaccination protocols and developing adaptive immunization strategies for diverse patient needs.

Keywords: Booster vaccines, SARS-CoV-2, immune response, immunosuppressed, cancer, mathematical modeling

ISBN: 978-1-0685851-5-9

Biography: Dr. Chrysovalantis Voutouri is a researcher specializing in mathematical modeling of biological systems, with a focus on immunology and oncology. He holds a PhD from the University of Cyprus, where he developed expertise in systems biology, and completed postdoctoral training at Harvard Medical School and Massachusetts General Hospital. Dr. Voutouri is the founder and CEO of AnaBioSi-Data, a startup aimed at developing data-driven solutions for personalized cancer therapy. His recent work includes modeling SARS-CoV-2 vaccine efficacy across patient populations, contributing to adaptive immunization strategies for high-risk groups. He collaborates internationally to advance healthcare innovation through data and computational modeling.

ISBN: 978-1-0685851-5-9