Computational medicine—moving from uncertainty to precision

February 10 2021, by Faith Singer-Villalobos

Radek Bukowski, MD, PhD, professor and associate chair of Investigation and Discovery in the Department of Women's Health at Dell Medical School at UT Austin. Credit: University of Texas at Austin

Individual choices in medicine carry a certain amount of uncertainty.

An innovative partnership at The University of Texas at Austin takes

aim at medicine down to the individual level by applying state-of-the-art computation to medical care.

"Medicine in its essence is decision-making under uncertainty, decisions about tests and treatments," said Radek Bukowski, MD, Ph.D., professor and associate chair of Investigation and Discovery in the Department of Women's Health at Dell Medical School at UT Austin.

"The human body and the healthcare system are complex systems made of a vast number of intensely interacting elements," he said. "In such complex systems, there are many different pathways along which an outcome can occur. Our bodies are robust, but this also makes us very individualized, and the practice of medicine challenging. Everyone is made of different combinations of risk factors and protective characteristics. This is why precision medicine is paramount going forward."

To that effect, in the January 2021 edition of the *American Journal of Obstetrics Gynecology*, experts at Dell Med, Oden Institute for Computational and Engineering Sciences (Oden Institute), and Texas Advanced Computing Center (TACC), along with stakeholders across healthcare, industry, and government, stated that the emergence of computational medicine will revolutionize the future of medicine and health care. Craig Cordola of Ascension and Christopher Zarins of HeartFlow co-authored this editorial review with Bukowski and others.

According to Bukowski, this interdisciplinary group provides a unique combination of resources that are poised to make Texas a leader in providing computational solutions to today's and tomorrow's health care issues.

"At UT Austin we're fortunate to have found ourselves at a very opportune point in time for computational medical research," Bukowski

said. "The Oden Institute has world-class expertise in mathematical modeling, applied math, and computational medicine; TACC is home to the world's largest supercomputer for open science, and also committed to improving medical care, including outcomes for women and babies."

Powered by such collaborations, the emerging discipline of computational medicine focuses on developing quantitative approaches to understanding the mechanisms, diagnosis, and treatment of human disease through applications, more commonly found in mathematics, engineering, and computational science. These computational approaches are well-suited to modeling complex systems such as the human body.

An on-point area of study for obstetrics

While computation is pivotal to all domains in medicine, it is especially promising in obstetrics because it concerns at least two patients—mother and baby, who frequently have conflicting interests, making medical decision-making particularly difficult and the stakes exceptionally high.

According to state Rep. Donna Howard, D-Austin, a co-author of the editorial review, Texas legislators should be concerned about the unacceptably high rate of maternal morbidity and mortality in the state.

"When I became aware of the efforts to bring computational medical approaches to addressing maternal morbidity and mortality, I was immediately intrigued," Howard said. "And when I learned of the interdisciplinary expertise that has found itself conveniently positioned to create this new frontier of medicine, I was sold."

Individualized medicine is happening now because of advancements in computing power and mathematical modeling that can solve the problems which were unsolvable until now.

Case in point: in 2018 the National Science Foundation awarded UT Austin a $1.2 million grant to support research using computational medicine and smartphones to monitor the activity and behavior of 1,000 pregnant women in the Austin area.

In particular, the growing array of data sources including health records, administrative databases, randomized controlled trials, and internet-connected sensors provides a wealth of information at multiple timescales for which to develop sophisticated data-driven models and inform theoretical formulations.

"When combined with analysis platforms via high performance computing, we now have the capability to provide patients and medical providers analysis of outcomes and risk assessment on a per-individual basis to improve the shared decision making process," Bukowski concluded.

The study, "Computational medicine, present and the future: obstetrics and gynecology perspective," was published in the *American Journal of Obstetrics and Gynecology.*

More information: Radek Bukowski et al. Computational medicine, present and the future: obstetrics and gynecology perspective, *American Journal of Obstetrics and Gynecology* (2020). DOI: 10.1016/j.ajog.2020.08.057

Provided by University of Texas at Austin