Math model developed to personalize cancer treatments

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Researchers at UW designed an advanced mathematical model that allowed them to gain more insight into the nature of interaction between immune system and Cancer Stem Cells (CSCs), which trigger tumor growth.

In addition, the model demonstrates the inefficacy of the independent application of traditional cancer treatments like chemotherapy and radiotherapy in targeting specific CSCs. Therefore, this led to the shift toward immunotherapy approach, which uses the body's immune system to combat cancer.

Dr. Michelle Przedborski, a postdoctoral fellow in Waterloo's Department of Applied Mathematics, said that the preliminary step to the research work involved perusing several literature papers to better comprehend the underlying interactions among different cell types.

Dr. Przedborski further added that garnering relevant experimental data is important for effective model calibration. Experimental data have been very helpful in determining the nominal or patient-specific measurement variables that shed valuable information as to how a particular patient is likely to respond to different methods of treatments.

"Using different experimental measures to capture the patient-specific tumor micro-environment parameters is crucial to achieving the personalized cancer treatment mechanisms", Dr. Przedborski said.

In other words, it is recommended for the model to have ample patients' attributes that are biologically meaningful and have clinical applicability. That said, if the model captures a multitude of patients' biological parameters (for instance, protein level interactions), there will be uncertainties introduced in the system leading to undesirable outcomes.

Therefore, it is imperative to settle for the trade-off between having enough parameters that captures all the essential information, but at the same time not to feed the model with several superfluous parameters that have little role in personalizing cancer treatments.

Dr. Przedborski mentioned about the importance of profound collaboration with the doctors, clinicians, biologists and immunologists and how the subject matter experts from various disciplines, more often than not, work in tandem for the development of predictive mathematical models.

One of the key challenges is to thoroughly comprehend the patients' response to treatments and tailor the dosage levels or schedules until optimality has been achieved. The developed prototype is expected to play a vital role in bridging the gap between patients' responsiveness and optimal treatments.

When asked about the future enhancements to the current model, Dr. Przedborski emphasized that the model's performance could be elevated by incorporating all types of immune cell population as well as the cytokines, a broad category of proteins that help the immune cells differentiate into more specialized cells and taking into account the spatial localization of the tumor or immune cell population.

In conclusion, the developed model allowed UW researchers to gain a much deeper understanding of the different treatment methods for patients under the given circumstances and the interaction among different cell types. This could very well lead to a robust personalized cancer treatment strategy in the near future.