“If we can catch arthritis earlier in patients, then ultimately, we should be able to cure it.”

Drs. Igor Jurisica and Christian Veillette hope to improve treatments and eventually stop arthritis from developing in patients. How? With data and analysis

By Bryan Borzykowski

Drs. Igor Jurisica (left) and Christian Veillette, two leading AI researchers, share their thoughts on how the technology is being used to better treat arthritis.

For Drs. Igor Jurisica and Christian Veillette,

AI isn't just a buzzword.

The two have been using AI and machine learning algorithms to analyze arthritis-related information and create rich data sets, which will help doctors diagnose arthritis earlier and treat the disease more effectively.

Q: DR. JURISICA, YOU BEGAN YOUR CAREER USING PREDICTIVE ANALYTICS FOR CANCER RESEARCH. WHAT DREW YOU TO FOCUS ON ARTHRITIS?

Dr. Igor Jurisica: With cancer, we usually have one sample per patient, and we're trying to predict where it's coming from and where it's going. With arthritis we have at least a few samples, so we can, on a molecular level, analyze where the disease was before surgery, what changes were made during the surgery and how it's changing as a response to treatment over time. We started to develop computational tools to analyze these individual data sets, which gives us so much more opportunity to study what happens to these patients in their recovery, and long term, it can help us personalize treatments for individuals.

Dr. Christian Veillette: It was our samples that caught Igor's attention. We have a large and well-documented repository for clinical samples – called a biobank – that we've built up over the years, using pre- and post-op samples from arthritis patients. We have tissues from the hand, wrist, knee and spine, including synovial fluid, blood samples and more. We've amassed thousands of samples, and the collection continues to expand in numbers and richness. It's really incredible to have access to such a wealth of high-quality data. You don't have as much data with cancer, and especially not longitudinal samples from the same patient.

Q: WHAT'S THE BENEFIT OF INCORPORATING AI INTO MEDICINE?

CV: One of the main reasons for incorporating AI into medicine is to create efficiencies in order to help people get better faster. In 2007, when I joined University Health Network, I was involved in getting rid of all paper-based outcomes, such as the questionnaires people filled out in the clinic, and creating an electronic platform. This is one example of how using AI can help create an infrastructure, which allows you to capture data that you can then use to help drive decisions.

IJ: AI isn't new in medicine, but it's evolved. We now have faster computers so we can perform large-scale image analysis, using visualization and simulation to make more accurate outcome predictions. When I did my PhD, I had access to 700 patient samples from an in vitro fertilization clinic. At that time, this was considered a huge data set for machine learning algorithms. Now, we have tens of thousands of highly characterized patient samples with tens of thousands more data points, and hundreds of clinical parameters and lab measurements. In our Arthritis Data Integration Portal (ADIP, developed with funding from the Krembil Foundation), when we combine clinical information and molecular profiles, we have more than 11,000 patient samples.

Q: HOW ARE YOU USING ALL OF THAT DATA?

IJ: We participate in multiple collaborations where the data and our algorithms help us understand a complex spectrum of diseases. And we use it in our own studies to look for new treatments for arthritis, such as repurposing existing drugs for other diseases and modifying lifestyle factors specific to each patient, to increase their response to the treatment. For example, we used these data to predict a novel treatment for osteoarthritis, and we expect we'll be able to validate it using pre-clinical models and eventually translate that into the clinic.

CV: On the clinical side, the data is helping us with the prediction of patient outcomes. So, basically, we're saying, "This person has this per cent chance of having a good outcome," or "These are the modifiable factors, such as exercise, surgery or therapeutics, that we should change in order to improve their chance of having a successful outcome." That's where we've started taking the data we've been capturing from the biobank and from the clinic, and we're now able to bring that full circle into actually making and assisting with decisions.

DID YOU KNOW?

UHN's Arthritis Program, funded by the Campaign to Cure Arthritis, was the first in North America to safely inject a patient's own stem cells into knee joints for OA treatment.

Q: ONE OF THE TOOLS YOU'VE DEVELOPED IS CALLED MIRDIP. HOW DOES IT HELP YOU ANALYZE INFORMATION?

CV: MirDIP is a data integration portal developed by Igor that helps researchers pull up information on microRNAs (small molecules that play an important role in arthritis and other diseases, and identify which genes they regulate). When we started taking in data, we had a lot of questions. How do we annotate it? How do we understand what all this is? How do we help impact actual decisions? I started looking into data integration platforms, which is when I came across some of the work Igor had done on cancer. Data integration portals are enabling us to integrate different data sets on arthritis and identify novel, previously missed connections.

IJ: We can benefit from experiments done in multiple laboratories around the world, which expands the variety of patient samples we can use. Integrating data from different experiments also provides richer information about the context or conditions of the experiment. Combined, we can identify more accurate prognostic and predictive biomarkers, and better determine who will respond to what therapy and find new drug targets for developing new therapies.

CV: Essentially, it's about understanding all the different interactions that happen within a person's body and within the cells, at different levels. These portals help us organize all that information so we can see those interactions, which will help us better predict a patient's final outcome. Igor and his group have been able to study different types of microRNAs to see how they're working, and which ones are going to provide a benefit and which ones are harmful. They can now see that drugs that had previously been used for other diseases might work well for arthritis. There are different ways to use these different integration portals in order to find answers.

Q: ARE THERE ANY RISKS TO ALL THIS DATA COLLECTION AND ANALYSIS? HOW DO YOU MAKE SURE YOU'RE DOING IT RIGHT?

CV: If you don't do it properly, you can come up with incorrect decisions or predictions. One thing we've learned is that integration across the team – having that clinical information and clinical knowledge paired with technical, analytic knowledge – is key to mitigating those risks and not generating erroneous results.

IJ: We go through multiple steps to ensure that what we are following is not just smoke and mirrors, but hopefully something actionable. Integrating data into networks enables us to separate signal from noise and build explainable models.

Q: IS EARLY DIAGNOSIS THE GOAL?

CV: That's what it really boils down to. If we can catch the disease earlier in patients, then ultimately, we should be able to cure it. Or at least minimize its impact.

IJ: I'm fascinated by how medicine is changing from being reactive to proactive or predictive. If somebody has specific joint damage from a sports-related injury, maybe that's the time when stem cells should be injected instead of waiting until the cartilage degrades. With an earlier diagnosis, you have more options for treatment, and you can generate better outcomes at a reduced cost to the patient and to society.

World-class researchers

DR. IGOR JURISICA, a senior scientist at Krembil Research Institute, combines integrative computational biology with advanced AI and data mining algorithms to tackle chronic diseases. In 2019, analytics agency Deep Knowledge Analytics named him one of the Top 100 AI leaders in drug discovery and advanced health care, and he has won numerous awards and distinctions, including an IBM Faculty Partnership, an IBM Shared University Research Award and a Tier 1 Canada Research Chair in Integrative Cancer Informatics.

DR. CHRISTIAN VEILLETTE is division head of Orthopedic Surgery at UHN and a clinician investigator at Krembil. He has also been recognized internationally for his work with AI technology and informatics, including winning the Edit This award for the most innovative and best use of the Confluence enterprise wiki platform, and an award from the Canadian Orthopedic Association recognizing his leadership and innovation in orthopedic informatics.