Issue 8 | 2023

GRAND RIVER HOSPITAL

Innovation & Research

action

Where innovation becomes application

CARE NEVER STOPS

contents

The Office of Innovation & Research coordinates all research- and innovation-related activities at Grand River Hospital—one of the largest and busiest community hospitals in Ontario, with over 600 beds and an outstanding team of 5,000 dedicated health care workers and volunteers. The Office of Innovation & Research supports and participates in multidisciplinary, clinician-based applied research in each of Grand River Hospital's eight Areas of Care.

Through partnerships with institutions across the Waterloo-Wellington Region, including the University of Waterloo and McMaster University Michael G. DeGroote School of Medicine Waterloo Regional Campus, the Office of Innovation & Research provides researchers and clinicians the opportunity to work together on groundbreaking studies that helps the Hospital contribute to a world class health system supporting healthier lives.

Carla Girolametto
Director of Innovation, Research, and Clinical Trials

Letter from the director

Courage to Start, Heart to Finish is a core value at Grand River Hospital. Our team upholds this value every day with their courage to innovate and continuously raise the bar.

In this issue of ACTION, we are pleased to highlight a number of current initiatives in research and innovation that exemplify our commitment to Courage to Start, Heart to Finish at Grand River Hospital.

You'll read about how our laboratory is moving towards state-of-the-art technology, how our intensive care unit (ICU) is exploring a new way to make diagnostic decisions at the bedside, how our cancer program is testing a new method of patient-centred health information management, and more.

Being innovative doesn't always mean achieving success, especially the first time around. But having the courage to start and try new things is the first step to changing the future.

Join me in learning about all the first steps being taken at Grand River Hospital: **where innovation becomes application.**

CREATE-ing opportunities to learn

In an ongoing partnership with the University of Waterloo's Center for Bioengineering and Biotechnology NSERC CREATE Training in Global Biomedical Technology Research and Innovation (CBB CREATE), fourth-year Ph.D. candidate Nargess Heydari Beni recently completed the second internship of this program at Grand River Hospital.

CBB CREATE is a "needs-first" graduate program in which trainees learn to interact directly with end-users and stakeholders in the patient, medical, and biotechnology industry communities to co-discover technology problems and solutions. During this internship, University of Waterloo graduate students get the opportunity to investigate research topics at Grand River Hospital and learn from this collaboration.

A principal focus of the CREATE program is strengthening interns' abilities to explore a problem and needs from all angles before suggesting potential solutions. This helps to prepare interns for real-world experiences in health care where focusing on the solution may only resolve a part of the problem and can cause teams to overlook other possible solutions that would produce similar or better results than the initial idea. This approach is particularly vital in interdisciplinary research projects in which many unknown factors are presentpresent. Nargess Heydari Beni's CREATE internship focused on exploring possible interventions to reduce fall-related injuries in some adult inpatient units at Grand River Hospital. They were mentored by Chantelle Archer and Sandra Paleczny, co-leads of the Grand River Hospital Corporate Falls Prevention and Harm Reduction committee, throughout. While some physical injuries following a fall are temporary or relatively minor, such as abrasions and bruises, others, including hip fractures and head injuries, may lead to longer hospitalizations or even death, devastating for families and increases health care costs.

Average stay for fall-related hospital admissions among older adults:

22 days

Estimated annual cost for the Canadian health care system:

$8.7 billion

Nargess Heydari Beni
Ph.D. Candidate

While numerous products and interventions have previously been introduced to prevent or reduce the incidence of patient falls, many of these technologies are ineffective because they do not adequately address the needs of patients and health care providers. This is where the critical role of the engineering-health care relationship becomes evident: to design products that address the real needs of patients, health care providers and health care settings.

After background research to understand the core problem and issues relevant to patient falls in health care settings, Nargess observed Grand River Hospital's current falls prevention and assessment processes. This opportunity allowed Nargess to observe current solutions and remaining gaps first-hand. Nargess developed questionnaires and conducted focus groups with an interdisciplinary team of hospital clinicians to better understand the hospital's needs related to adult inpatient falls and to explore solutions collaboratively. Utilizing the findings from background research, observations and focus groups, possible solutions were generated.

"This exciting partnership provided a unique opportunity to leverage knowledge from distinct key stakeholders and explore new possibilities around innovative solutions to address the universal issue of preventing falls and, more importantly, reducing the injuries associated with them," said Sandra Paleczny.

Nargess described her experience, "As an engineer, my area of expertise is designing

and implementing biomedical systems. This is highly important for me to understand what factors I should consider in the design process and how I should approach the problem. I was extremely excited when I learned about the CREATE internship program in partnership with Grand River Hospital on this very critical topic! It was a priceless chance for me to learn about a health care provider's perspective. I cannot describe the support that I received from the team that I worked with. They were very knowledgeable and patient and did their best to help me understand the core problem, current solutions, and gaps. The internship gave me valuable insights regarding the design process, needs assessment, and concept generation, and I feel very fortunate for that," said Nargess, describing her experience with the CREATE internship program.

"By hosting students like Nargess, we are challenged to think broadly about the ways in which potential solutions from the biomedical technology world can integrate with and address the unique needs of patients and clinical staff within health care organizations," said Chantelle Archer. "It was a wonderful opportunity to help inform the future design of innovative technologies and establish mutually beneficial relationships with teams at the University of Waterloo."

"In a rapidly changing landscape, it is imperative that we extend ourselves beyond familiar professional relationships and sector partnerships to broaden networks that reach beyond industry norms and encourage collaboration through the exchange of knowledge and resources," explained Dr. Victoria Crowder-Bansen, Director Professional Practice, Grand River Hospital. "Boundary spanning allows us to examine matters from multiple perspectives to transform health care and work toward optimal solutions."

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>
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> Director Professional Practice, Grand River Hospital

I can see clearly now

X-ray is the most common imaging modality and is often used to get an early look for disease and injury.

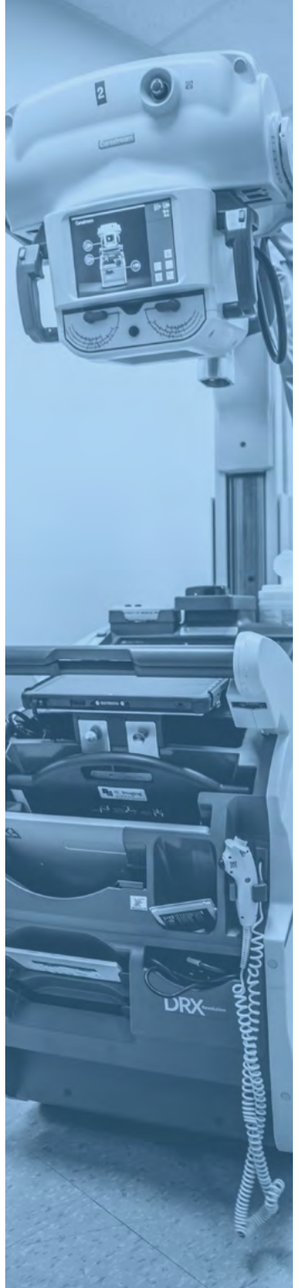
Since x-rays produce lower quality images, these images are often the entry door to other procedures such as CT scans and MRIs. Is it possible to improve the imaging gathered from a simple x-ray machine? KA Imaging has developed a solution that does just that – the Reveal 35C Detector. In the simple process of just one x-ray exposure – which usually produces 1 image – the Reveal Detector can produce 3 images. To do this, KA Imaging uses a technique known as dual-energy.

Dual-energy subtraction was invented in the 1920's and uses physics to remove bone or soft-tissue from an image, enabling a more accurate diagnosis than a standard x-ray. By focusing on different types of energy inside the x-ray beam, it can differentiate between these structures providing a clearer view. However, this old technology came with issues – it required a higher dose of radiation, it was expensive for hospitals to implement, the system was clunky and non-mobile, and any motion by the patient distorted the final images.

KA Imaging has found solutions for these problems. With advancements in the technology, KA Imaging's Reveal Detector is now able to produce three images from a single x-ray exposure.

So what does this mean for patient care? Grand River Hospital is proud to have participated in one of KA Imaging's first clinical trials in 2018 where 22 patients underwent x-ray imaging with the KA Imaging detector. During this trial one of the study participants presented with a lung lesion that was not visible on a conventional x-ray image because it was hidden behind a bone in the chest. Using the KA Imaging Reveal Detector allowed the radiologist to view the x-rays with the bones digitally removed, making a once unnoticed lesion now clearly visible.

Seeing the value in the diagnostic capabilities of the Reveal Detector technology, Grand River Hospital is now testing the application of this system for all bedside chest x-rays that are conducted on ICU patients. By doing so, Grand River Hospital anticipates we will see an increase in physician confidence to make bedside diagnosis and treatment decisions, faster diagnosis and treatment for patients, and a reduction in the number of patients that require additional imaging via CT scan.



"This is an exciting project and we are pleased to partner with Grand River Hospital to support innovation that may improve patient care and outcomes," says Amol Karnick, President and Chief Executive Officer for KA Imaging. "Our technology produces images that separates soft tissue and bones and are much higher resolution creating images that are easier to read. We also offer the only portable dual energy x-ray solution in the world and it's being tested right here, in Waterloo Region."

"My team and I in the ICU are excited to put to use a novel method of analyzing information in a relatively routine tool, the chest x-ray," says Dr. Paul Hosek, staff intensivist at Grand River Hospital. "We hope this provides additional necessary bedside information that we can put to use saving lives."

This project was made possible by the CAN Health network, a nationwide network of hospitals and other healthcare institutions known as "Edges". This initiative provides Canadian companies with access to real healthcare environments such as Grand River Hospital in which they can implement their market-ready solutions, gain valuable feedback from end-users, and scale rapidly across the network and beyond.

"These partnerships are helping to promote and accelerate the adoption of home-grown solutions in health care," says Dr. Dante Morra, Chair of the CAN Health Network. "We are pleased to work with leading organizations like Grand River Hospital and KA Imaging who are validating Canadian technologies and creating new, streamlined paths for scaling that benefit all Canadians."

About KA Imaging

Founded in 2015 and located in Waterloo, KA Imaging is a spin-off from the University of Waterloo that specializes in innovative x-ray imaging technologies and systems.

Today, KA Imaging develops unique detectors and imaging products that leverage cutting edge multi-energy and phase contrast x-ray technologies for medical, industrial, veterinary, non-destructive, and scientific imaging customers. Grand River Hospital partnered with KA Imaging in 2018 to conduct the very first clinical trial of the Reveal Detector.

Glass slides to digitized

Do you remember grade 10 biology class? It was likely the first time you were introduced to a microscope. Your science teacher would have taught you how to combine the power of lenses and light to enlarge the object being viewed.

That same science still exists in hospital laboratories to this day. You may never meet a pathologist during your visit to a hospital, but this team of specialists plays a vital role in the diagnosis and prognosis of illnesses by examining tissues and other materials taken from the body and studying those samples under a microscope. Pathology can be described as the bridge between basic science and clinical practice and is central to the understanding of disease so that accurate treatment plans can be made.

At Grand River Hospital, we're excited to take a giant leap forward in diagnostic technology with the introduction of digital pathology. Digital pathology is the process of taking the glass slides that would be traditionally viewed under a microscope and creating a digital image of the slide that can instead be viewed on an image viewer, which is similar to a computer monitor. Now, instead of looking at a sample through a tiny microscope lens, the image of the sample can be magnified and viewed with ease on a large screen. But digital pathology enables more than just ease of view—it also means easy sharing!

> **Digital pathology has the potential to change the delivery and speed of diagnosis and prognosis for patients across the health care system.**
>
> – Renee Giroux
> Integrated Administrative Director of Laboratory Services for Grand River Hospital and St. Mary's General Hospital

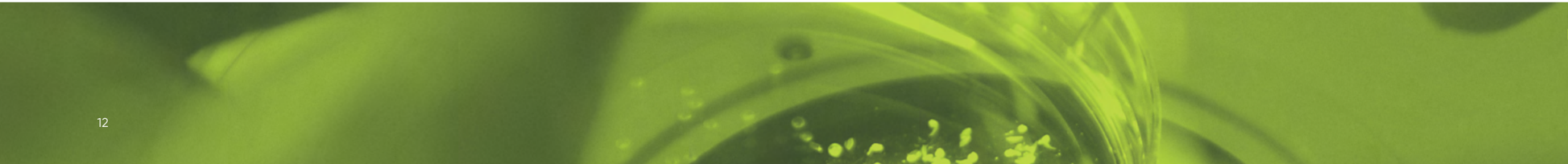
Currently, if a pathologist needs a second opinion to diagnose a case, the slide is packaged and sent via courier to another facility. Once there, a second pathologist views the slide and helps consult on the diagnosis. With digital pathology, a pathologist can now send those same images to a colleague for consultation in mere moments.

At Grand River Hospital, a multi-stage program is underway to bring our pathology program into the digital era. Currently, digital scanners are being implemented to facilitate scanning all of the glass slides into digital images. These digital images will be integrated into our health information system, Cerner, to allow them to be connected with patients' demographic information. Pathologists will then be able to view all samples as digitized images on large screens, instead of under microscopes, for their analysis and diagnosis.

"We're excited to be moving digital pathology outside of the research space and into clinical practices," says Dr. Dimitrios Divaris, Medical Director Integrated Pathology and Laboratory Medicine for Grand River

Diagnosis: the process of determining what disease is affecting a patient

Prognosis: a prediction of how the disease is likely to affect a patient



Hospital and St. Mary's General Hospital. "This move to incorporate the digitization of clinical images will allow pathologists to connect with ease throughout Waterloo-Wellington and beyond, opening up new opportunities to collaborate provincially, nationally and globally. Connecting patient specimens with world experts ensures a world class experience and care for our patients."

Grand River Hospital was first introduced to digital pathology during a research study conducted in partnership with the University of Waterloo that began in 2019, and in the future, we expect that digital pathology will also open the door to using artificial intelligence (AI) to support diagnostic practices. As AI technology advances in the area of digital pathology, it is highly anticipated that it will be able to easily sort these digital images and compare them to previously defined cases, allowing for diagnoses to be made even more quickly.

"Digital pathology has the potential to change the delivery and speed of diagnosis and prognosis for patients across the health care system," says Renee Giroux, Integrated Administrative Director of Laboratory Services for both Grand River Hospital and St. Mary's General Hospital. "This technology will allow for more accurate and timely diagnosis, ensuring an efficient and patient-focused health care experience."

By April 2023, Grand River Hospital will be connected to a large provincial repository network for digital pathology, which will allow digital images to be transferred to pathologists who work outside of the hospital for immediate consultation. Building upon these initial steps, our goal is to be able to use artificial intelligence to effectively screen for negative cancer cases and assist in diagnosing cancer and other diseases by 2024.

Empowering patients through their cancer journey

At Grand River Hospital, we're focused on ensuring health care is person-centred. As such, we strive to empower patients with innovative tools to facilitate their health care journey.

TAMVOES is a health management platform that allows patients to take charge of their health and treatment journey. The platform facilitates sharing health information between individuals, families, and their professional teams. Founded in 2019 and based in Waterloo, TAMVOES aims to empower people with their health information—their platform allows individuals to easily manage their health information and access it to make more informed health decisions.

Grand River is excited to partner with TAMVOES to explore how this technology can support and empower patients in the cancer program. The hospital will work with cancer patients, their care partners and oncology providers to examine the benefits of the TAMVOES platform and determine whether it helps patients feel less stressed and more supported while they undergo intense treatments.

"We're delighted to team up with TAMVOES to offer this project and explore the ways their platform may be able to help our patients manage their health information," says Paul McIntyre Royston, President & CEO, Grand River Hospital Foundation. "To support this project, our volunteers will work with patients at the hospital to help them register with TAMVOES and provide ongoing support and education."

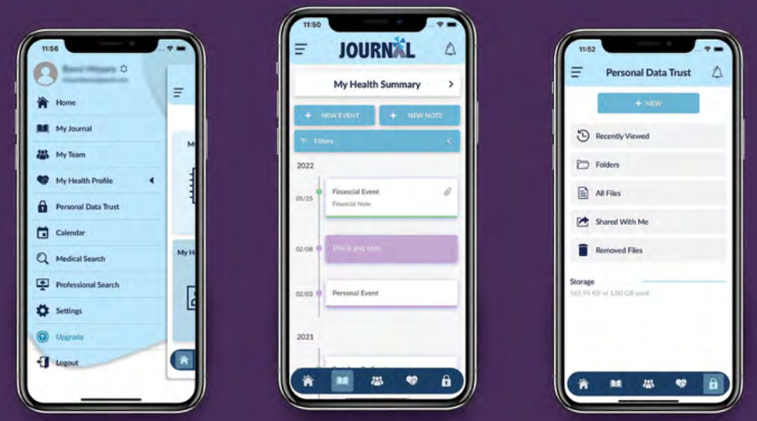
The project has also received support from Ontario Bioscience Innovation Organization (OBIO) through their Early Adopter Health Network (EAHN™), which provides funding to help health care organizations access innovations that can impact the patient journey.

"This EAHN™ project with Grand River Hospital will test the TAMVOES platform through a study in one of the cancer clinics to measure the benefits of this tool for cancer patients and their caregivers," says Dr. Maura Campbell, CEO, OBIO. "We are excited to support this innovative work that has the potential to lead to an improved patient journey, and we are pleased to support both TAMVOES and Grand River Hospital."

Features of the TAMVOES app include chronological journals to keep track of appointments, reminders and notes; vitals sign tracking to track essential metrics such as heart rate, blood pressure and mood; historical care information, including details about previous surgeries, allergies, immunizations, exercise and lifestyle; and secure file storage for PDFs, documents, images and more all within an encrypted cloud environment.

"TAMVOES was built within the walls of Grand River Hospital while I was caring for my mom and my grandma, who were in and out of the hospital because of cancer," says founder Jessica Lunshof. "With limited communication between health providers and hospitals, we had to constantly repeat their health information. Being a caregiver and raising children, all while working full time, was a huge strain on me. The coordination of care was complex and inefficient, and it left me concerned that there would be gaps. I created TAMVOES as a patient-centred platform that would alleviate the strain. It allows patients to have access to all of their health information in one place and helps ensure health providers are all on the same page."

Innovative tools, such as TAMVOES, are one of many opportunities being explored at Grand River Hospital to elevate patient care and bring us closer to achieving our vision to build a world class health system supporting healthier lives.



Above is a sampling of the user interfaces from the TAMVOES application.

Prof. John McPhee Ali Asghar Mohammadi Nasrabadi

Using AI to triage spine disorders

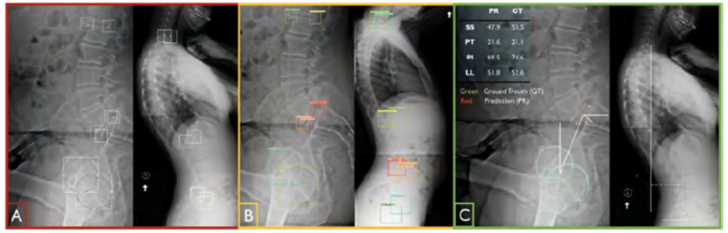
Back pain is one of the most common reasons to visit the doctor. In cases of acute pain, disorders or injury, a health care provider will request x-ray images of the spine and pelvis to help make a diagnosis.

With traditional x-ray images, the position and angle of key bony landmarks are measured to indicate if there is a misalignment that requires further treatment or surgery.

A University of Waterloo research team led by Prof. John McPhee of Systems Design Engineering (SYDE) is proposing to replace this time-consuming process with artificial intelligence (AI) to create a virtual triage process for assessing spine disorders. The team developed a deep learning method of object detection that can locate the required anatomical landmarks, such as the head of the femur bone and points on several vertebrae, to produce the measurements (known as spinopelvic parameters) that signal the diagnosis.

To compare the accuracy of automatic AI detection with the current standard, in which measurements are performed manually by a radiologist, the University of Waterloo team partnered with Dr. Gemah Moammer, an orthopedic surgeon and head of the spine program at Grand River Hospital.

This process involved training, validating and testing the deep learning method on 750 lateral spine x-ray images of patients referred to Grand River Hospital and 250 x-ray images of the lumbar spine and pelvis from Intellijoint Surgical.



To train the AI model, boundary boxes were placed around the relevant landmarks on the image as shown in image A. This training process was repeated on 80% of the collected images, and the remaining 20% of the images were then used to test the accuracy of the AI model. You can see the AI model at work in image B as it automatically detects the desired landmarks, and image C shows the resulting measurement of spinopelvic parameters being generated automatically.

The AI model's strong performance is encouraging: The automatically detected spinopelvic parameters had an average accuracy of 85% compared to the manual measurements, which is on par with the accuracy of two different radiologists annotating these measurements on the same x-ray.

The team developed a deep learning method of object detection that can locate the required anatomical landmarks to produce the measurements that signal the diagnosis.

In addition to its encouraging level of accuracy, the deep learning method also showed promise in overcoming common image quality issues that can impede the ability to measure the spinopelvic parameters in pelvic x-rays.

When pelvic x-rays are taken, a shield is often used around the pelvis to protect internal organs from radiation, but if improperly placed, the shield may cover landmarks that are involved in the measurement process (e.g. the head of femur), making it more difficult to interpret the resulting image. However, the AI model was able to accurately detect all required landmarks throughout the testing process, even if obstacles were present in the images.

The results of the study were presented by AliAsghar MohammadiNasrabadi, Ph.D. student and research assistant in SYDE, at the Medical Imaging with Deep Learning conference in Zurich, Switzerland in July 2022.

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