Winners of the first precision health competition, "Implementing Precision Health Projects in Clinical Care at the CHUM"

Projects with a maximum amount of $600,000:

1. **Dr. Simon Grandjean Lapierre (Immunopathology Research Theme) - *Whole genome sequencing of bacteria for identification, rapid genotypic DST and public health interventions.***

Tuberculosis (TB) remains the world's deadliest infectious disease and has seen a resurgence in recent years, including in Canada and Montreal. At the same time, nontuberculous mycobacteria (NTM) are affecting an increasing number of immunocompromised individuals, organ transplant recipients and cancer patients. At the CHUM, a particularly high number of patients are treated for these infections. However, current diagnostic methods are slow and incomplete, often requiring weeks to identify the species, antibiotic resistance and chains of transmission. Traditional approaches (prolonged culture, phenotypic drug susceptibility testing (DST), molecular typing) are not always sufficient to quickly guide treatment decisions or outbreak investigations.

This project seeks to integrate precision genomics into the CHUM through next-generation sequencing. This will make it possible to identify the species more quickly, accurately predict susceptibility or resistance to antibiotics, better trace transmission, and reduce unnecessary treatments, toxicities and hospital stays. The goal is to improve care for vulnerable patients and to position the CHUM as a leader in precision microbiology.

2. **Dr. An Tang and Dr. Benoît Desjardins (Imaging and Engineering Research Theme) - *Clinical implementation of artificial intelligence (AI) software to improve care for patients with stroke, pulmonary embolism or cancer.***

This project aims to implement three artificial intelligence (AI) software solutions at the CHUM to quickly analyze medical images, thereby helping teams prioritize urgent cases and speed up clinical decision-making.

Three critical situations are targeted:

1. Stroke, to quickly identify the type and intervene before the brain suffers irreversible damage.

2. Pulmonary embolism, to quickly detect a life-threatening condition and immediately begin anticoagulant therapy.

3. Cancer, to assess how tumours respond to treatment earlier.

By implementing this software, thousands of scans could be automatically analyzed and significant abnormalities flagged before they are interpreted by a radiologist. An analysis will be conducted to assess the impact on patient care pathways and flow, and the associated costs. By improving the speed and accuracy of image interpretation, these tools provide tangible support for precision health approaches, positioning the CHUM as a leader in Quebec in the practical application of AI in medical imaging, and paving the way for its adoption across the entire health care network.

3. **Dr. Michaël Chassé and Dr. Han Ting Wang (Health Innovation and Evaluation Hub Research Theme) - *From the laboratory to the bedside of neurocritical care patients: clinical implementation of gene expression profiling and biomarkers for personalized care.***

Patients admitted to the intensive care unit with a severe neurological injury are in critical, unstable and highly complex condition. This project aims to personalize—that is, to adapt the care provided to these vulnerable patients based on their individual characteristics—using cutting-edge technology: RNA sequencing, which analyzes gene messenger RNA. A simple blood test could thus provide a snapshot of gene activity. This would have a direct impact on patient care, such as faster and more targeted interventions for each individual, a reduction in and more judicious use of antimicrobial treatments, optimized use of analgesics and sedatives, and potentially a reduction in costs associated with complications.

This project would bring precision health to the patient's bedside and would be the first step toward a more precise and more human intensive care of the future, where every patient receives the right treatment at the right time.

4. **Dr. Antoine Desilets (Cancer Research Theme) - *CHUM Molecular Diagnostics and Cancer Treatment Committee.***

Since 2023, more than 7,000 patients at the CHUM have undergone a test that decodes the genetic characteristics of their tumour. These tests help provide a better understanding of each type of cancer and aid in selecting the most appropriate treatments. In this context, this project aims to create a secure database that represents the Quebec population living with cancer, which will compile genetic test results and patients' health information. This will help to make informed decisions more quickly and in a more targeted manner.

Central to the project is also the creation of a committee of experts—the Molecular Diagnostics and Cancer Treatment Committee (MDCTC)—which will play a key role in integrating sequencing results into patient care. The committee will meet regularly to discuss complex cases and recommend the best treatments based on the genetic profile of each tumour. The committee can also refer patients to promising clinical trials or programs that provide access to new medications that would otherwise not be available. For doctors, this committee will provide better decision support. It will also help the health care system use resources more effectively and develop policies based on data that accurately reflect the Quebec population.

Projects with a maximum amount of $100,000:

1. **Dr. Sami Obaid (Neuroscience Research Theme) - *Personalized white matter tractography: a tailored approach to make neurosurgical procedures safer.***

To improve surgical safety, this project aims to implement an approach at the CHUM that will enable the precise mapping of white matter connections (the brain's "wiring") linking the different regions of the brain that support language, movement, memory and other essential neurological functions, and are unique to each patient. To do so, the project proposes using an advanced MRI-based technique called tractography, as well as developing a fully automated tool called SurgeryFlow, capable of generating customized white matter maps within minutes that can be integrated into the neuronavigation system and used during surgery. These maps could help the surgical team to significantly reduce the incidence of neurological complications.

In some people, particularly those with epilepsy who have electrodes temporarily implanted in the brain, it is possible not only to map the anatomy of white matter connections using tractography, but also to determine their actual functions by stimulating these pathways and observing the effect of the stimulation. Therefore, the second phase of the project is to build on this approach to identify the connections essential to neurological function in patients, in order to preserve them during surgery and reduce the risk of neurological sequelae.

This initiative would position the CHUM at the forefront of precision neurosurgery, offering each patient personalized care that helps preserve their quality of life.

2. **Dr. Alice Doreille and Dr. Marie-Chantal Fortin (Immunopathology Research Theme) - *Integrating nephrogenomics into the kidney pre-transplant care pathway at the CHUM: an assessment of clinical impacts and patient experience.***

Since 2024, the CHUM has established a nephrogenomics clinic, which focuses on the use of genetics in kidney diseases. This clinic provides rapid access to genetic testing for patients undergoing a pre-transplant evaluation. The results help doctors better understand the cause of the disease, anticipate the risk of recurrence after transplantation and confirm whether a related living donor can safely donate a kidney.

This project aims to assess the impact of this new approach in two phases: by analyzing the records of patients who have undergone genetic testing (diagnosis, changes in treatment, donor selection and evaluation timelines), and by engaging with patients, potential donors and family members to document their experiences (understanding of the tests, perceived benefits, as well as concerns, doubts or family impacts).

In addition to assessing the effectiveness of this clinic, the objective is also to work with patients to develop educational resources (fact sheets, consent forms, decision-making aids) to better guide them and support informed decision-making. In short, this project places patients and their loved ones at the heart of precision medicine. It will help improve the safety and quality of pre-transplant care, while consolidating the role of the CHUM as a pioneer centre in precision health applied to kidney transplantation.

3. **Frédéric Leblond and Dr. Moujahed Labidi—*Clinical Integration of Raman Spectroscopy and AI for Real-Time Guidance in Endonasal Skull Base Surgery.***

This project aims to integrate an innovative surgical guidance technology at the CHUM that combines Raman spectroscopy—an optical technique used to identify tissues based on their molecular composition—with artificial intelligence (AI) that has been trained to recognize different types of lesions in real time. The system provides a result in less than three seconds, without dyes or tissue sampling.

For the past two years, the teams led by Prof. Frédéric Leblond and Dr. Moujahed Labidi have adapted this technology for use in endoscopic endonasal surgery, which provides access to the skull base through the nose. More than 40 patients have already been studied at the CHUM, and the AI model can now accurately distinguish pituitary adenomas from normal glandular tissue and other structures such as bone, the dura mater and mucous membranes.

With this funding, the project will be expanded to include 100 patients and will focus on the clinical integration of the tool into the operating room. The ultimate objective is to deliver a validated, ready-to-use surgical guidance system that improves the safety, precision and outcomes of surgical procedures, while establishing the CHUM as a leader in precision surgery.

4. **Dr. Patrick Benoit (Immunopathology Research Theme) - *Non-invasive precision diagnosis of infectious diseases using next-generation metagenomic sequencing.***

This project aims to develop a new diagnostic method called next-generation metagenomic sequencing (mNGS) at the CHUM. This technique analyzes DNA circulating in the blood to rapidly detect a wide range of microorganisms, including bacteria, viruses, fungi and parasites, using a simple blood sample. This non-invasive approach takes less than 24 hours, making it much faster than traditional diagnostic tests, and can identify rare or unexpected infectious agents.

The main goal of the project is to develop and locally optimize this method so that it can be used to care for patients at the CHUM. In the long term, researchers will validate its performance by comparing the method to existing tests and will assess its impact on clinical care.

Ultimately, this new tool could significantly increase the speed and accuracy of diagnosis, enabling more targeted treatments and improving patient survival. The CHUM would thus become a pioneer in Canada in applying precision medicine to infectious diseases.

5. **Dominique Trudel (Cancer Research Theme) - *CAPTURE Lung Cancer: Clinical and Pathological Tool Use for the Rapid Evaluation of Lung Cancer.***

Lung cancer remains the leading cause of cancer-related deaths in Canada. A rapid and accurate diagnosis is essential for providing the right treatment at the right time. However, in many cases, the small samples of lung tissue taken to confirm the presence of a tumour do not contain enough tumour cells to allow a definitive diagnosis or advanced molecular analyses. These limitations often result in delays, repeated procedures and stress for patients.

This project aims to change this situation with an innovative technology: Raman spectroscopy. This method uses a beam of light to analyze the biochemical composition of

tissues in real time. The system makes it possible to immediately determine whether a tissue sample contains tumour cells, which helps clinicians decide whether to take another sample during the procedure. The objective is to obtain a sufficient, high-quality sample on the first attempt, in order to reduce the number of non-diagnostic samples and to avoid repeating the procedure.

The project will be conducted at the CHUM with a multidisciplinary team and patient partners, and will include a phase to adapt the technology to lung tissue before evaluating the technology's impact on diagnostic accuracy, diagnostic timelines and clinical outcomes. In the long term, this approach could become a new standard and apply to other types of cancer.

6. Alexandre Pellan Cheng **(Cancer Research Theme) -** ***Multi-Omics Classifier for Identifying Primary Sites of Cancers of Unknown Primary (COMPASS-CPI).***

To provide targeted treatment, it is essential to identify the "primary site" of a cancer, as therapies vary depending on the organ where the disease began. In cases of cancer of unknown primary (CUP), this information often remains unknown despite comprehensive testing. Current tests, which focus on identifying mutations, often yield inconclusive results and rarely allow for a clear determination of the tissue of origin.

This project proposes a different approach, based on the "chemical fingerprints" of DNA. Each organ imprints specific methylation marks on DNA, and these signatures remain present even in cancer cells. By learning to recognize these patterns, a computer program can estimate the most likely organ of origin.

At the CHUM, the team will establish a clinical pipeline that measures genome-wide DNA methylation in order to develop a tumour-of-origin classifier, which will be integrated into the pathology workflow without multiplying the number of tests. Phase 1 aims to develop and validate the tool using samples and documented cases. Phase 2 will adapt the tool for use in a less-invasive blood test. The ultimate goal is a unique, robust test that is adaptable and developed with input from patient partners.

7. **Dr. Guillaume Plourde (Health Innovation and Evaluation Hub Research Theme) -** ***Proactive monitoring and early detection of vasospasm following severe subarachnoid hemorrhage in intensive care.***

The CHUM's mandate includes treating severe brain hemorrhages, including a subarachnoid hemorrhage (SAH). One of the priorities in the intensive care unit is to prevent and treat complications, particularly vasospasm—a narrowing of the brain's arteries that can lead to oxygen deprivation, severe disabilities or even death. Currently, medical teams do not have a tool for detecting vasospasm at the patient's bedside, which often leads to a delayed diagnosis after potentially preventable brain injury has occurred.

This project aims to implement a new IT tool at the CHUM for the personalized, real-time monitoring of the diameter and responsiveness of cerebral arteries. With this data, the medical team will be able to detect vasospasm earlier, adjust treatment goals and identify patients at risk of sequelae.

The tool will be rolled out over a three-year period in the intensive care unit. It will first be validated for the detection of vasospasm, and then evaluated for its ability to reduce the need for diagnostic tests and anticipate disability. The team believes that this proactive and personalized approach will significantly improve the care and quality of life for patients with SAH.

8. **Dr. Laura C. Gioia and Dr. Christian Stapf (Neuroscience Research Theme) - *PRECISION-STROKE: A multimodal approach to improving prehospital diagnosis of stroke.***

A stroke is a time-sensitive condition that occurs when blood flow to the brain is interrupted, either by a clot blocking a blood vessel (ischemic stroke) or by a ruptured blood vessel causing bleeding in the brain (hemorrhagic stroke). Each type of stroke requires a rapid diagnosis to administer specific treatment, particularly in cases of severe stroke that require transfer to a specialized centre to receive advanced treatments aimed at saving lives and minimizing long-term effects. As the saying goes, "time is brain": the earlier treatment is administered, the better the chances of recovery.

Currently, patients who have suffered a severe stroke are often initially evaluated at a nearby hospital before being transferred to a specialized centre, resulting in major treatment delays that often exceed 90 minutes.

The PRECISION-STROKE study aims to improve prehospital diagnosis by incorporating innovative portable technologies, such as teletriage, rapid analysis of blood biomarkers and sensors that measure brain activity in the ambulance. By combining these tools, paramedics and clinicians will be able to identify the type and severity of a stroke more quickly and accurately, optimize patient triage, and initiate targeted interventions even

before arriving at the hospital to accelerate treatment and improve the chances of recovery.

9. **Houda Bahig and Samuel Kadoury (Imaging and Engineering Research Theme) - *Personalized Treatment Optimization Using AI and Advanced Biomarkers in ENT (OPTIMA-ORL).***

The OPTIMA-ORL project aims to offer shorter and less intensive treatments for people with HPV-related throat cancer, which is the most common head and neck cancer in Canada. Currently, treatments are highly effective, but they often cause significant side effects that impair patients' quality of life.

OPTIMA-ORL uses modern technologies, such as artificial intelligence, medical image analysis and a blood test, to determine which patients are at a low or high risk of cancer recurrence. Based on the results, low-risk individuals will receive a shorter 3.5-week course of treatment, while high-risk individuals will continue with the standard 7-week course of treatment.

This project involves 50 patients and aims to reduce serious side effects by half (compared to standard treatments), while maintaining a high cure rate (92% or more of patients recurrence-free after 6 months). Regular blood monitoring will also allow doctors to adjust treatment in real time.

In addition to improving patients' quality of life, OPTIMA-ORL seeks to reduce hospitalizations and the costs associated with side effects, while training clinical teams in the use of these new technologies. This project helps provide more human, effective cancer care that is tailored to each individual.