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Montreal Neurological Institute and Hospital
The Montreal Neurological Institute and Hospital – The Neuro – is acknowledged globally as a leader in fundamental neuroscience and its translation to therapies, in clinical treatment and research, and in the education of the leading young minds in this field. As the Director of The Neuro, I am privileged to witness daily the commitment of our research, clinical, and pedagogical teams. I am also privileged to meet and talk with many of you, our donors, who are so critical to sustaining our efforts in these areas of expertise.

I am pleased to share with you this report, reflecting the powerful impact that your philanthropy has had across the many projects underway inside The Neuro’s walls – and across the globe. You will read about how technology drives what questions we can ask, and nowhere is this more true than in fields such as neuroengineering, where atomic force microscopy and other technologies enable our researchers to work on the micro and nano-scale. Our researchers are also driving clinical care, creating technologies to enhance the treatment patients receive – from neurosurgery simulation programs to the Raman spectroscopy probe.

Because of you, our teams are also developing new ways of working together. For instance, the Reed Lab, created with a gift from the Reed Family/Tenaquip Foundation, brings together researchers and clinicians who work on the problem of neurodegenerative diseases like ALS and ARSACS from different perspectives. This makes for a particularly rich blend of expertise and people, fostering collaborations and leading to an explosion of ideas for new processes and therapies. The Reed Lab is the wave of the future; it promotes efficiency and innovation in research, and is also directly connected to patient care, another important part of our mandate. Another important donor-supported initiative in this area is the Transforming Care at the Bedside (TCAB) program, which has improved patient care while also increasing staff efficiency and satisfaction.

Successful labs rely on brilliant students, and donors like you have been generous in providing us with studentships, fellowships, and awards that allow us to attract the best and brightest young minds in neuroscience to The Neuro. Eventually, these students will take the torch from the current generation of principal investigators, directing labs of their own and continuing the search for knowledge of the brain, its diseases, and the therapies that can address them.

In addition to their research and studies, our students are also active in outreach initiatives that bring neuroscience into French and English elementary and high schools, educating youth about the brain and its care, and perhaps even playing an important role in recruiting enthusiastic youngsters to the world of science and medicine. All this too, thanks to your generosity.

At The Neuro, we are proud of our research record, proud of our excellent students, and proud of our exceptional patient care. We are also proud, and grateful, to have committed, visionary donors who support us, such as you. You are crucial to the success of our research, clinical and pedagogical missions, and I thank you on behalf of all of us at The Neuro – and on behalf of all of the patients who continue to benefit from your dedicated philanthropy.

Sincerely,

Guy Rouleau MD PhD FRCP(C) OQ
Director, Montreal Neurological Institute and Hospital
On the edges of a brain tumour, its remnants can be hard to distinguish from normal tissue after surgical intervention. But if not removed by the surgeon, these remaining cancer cells can lead to a recurrence of the tumour. Consequently, removing as much tumour as possible is critical for a positive patient outcome.

Michael Jermyn, holder of the National Bank Post-Doctoral Fellowship in Experimental Therapeutics, is helping to refine cancer detection technology that could dramatically improve brain tumour removal during surgery. The revolutionary Raman spectroscopy probe is a hand-held tool resembling a pen that performs a laser scan of brain tissue. "Based on shifts in energy that occur in the laser light due to the molecules in the tissues, we can characterize the tissues," says Jermyn, who has developed machine-learning algorithms that utilize this information to distinguish cancerous from normal brain tissue. "Michael’s contribution to the Raman project is profound," says Dr. Kevin Petrecca, Chief of the Department of Neurosurgery and one of Jermyn’s supervisors. "This type of development may have a substantial impact on patient survival and quality of life," states Jermyn. "National Bank’s generosity is very much appreciated, and I’m grateful for all the opportunities [the fellowship] will provide for me."

An initial clinical study with 17 patients assessed how accurate it was at identifying cancer. The results were stunning, with the Raman scoring above 90 per cent accuracy for all the types of tumours. Currently, surgeons identify cancerous cells by colour and feel, as well as by using MRI scans intra-operatively, but these approaches record accuracy of only 73 per cent. "So Raman spectroscopy offers a substantial improvement," Jermyn notes.
How do neurodegenerative diseases such as Alzheimer’s develop? There are competing explanations – notably, the amyloid, vascular and metabolic hypotheses. “But we have a lack of data-driven models to bring these together,” says Yasser Iturria-Medina, the recipient of a 2015 Molson Post-Doctoral Fellowship in Neuroengineering. Iturria-Medina is addressing this lack by creating mathematical models bringing together different hypotheses and deriving results to determine how we might best understand neurodegeneration.

Iturria-Medina, supervised by neuroimaging and neuroinformatics specialist Dr. Alan Evans, has compiled a neuroimaging data-bank to compare different modalities, and the models he is building could offer a clearer understanding of how neurodegenerative diseases evolve, especially in their earliest stages. “Each modality affects the others,” he explains. “But the most consistent result suggests that vascular dysregulation is the first to appear. Knowing what happens first will help guide therapeutic directions.” His models can also track how biomarkers of disease appear or vanish over time in one subject – data that can then be used to identify tendencies and perhaps forecast a prognosis for that patient. “And if someone is using a specific drug or therapy, we can see how much that person is moving away from characteristic data, which gives us a way to measure how effective a drug or therapy might be,” he says.

“This kind of work is very demanding, so you need support,” he says. “The Molson Fellowship has enabled me to focus fully on my research.”


Refining Therapies

T cells are a type of lymphocyte (a subtype of white blood cell) that play a central role in cell-mediated immunity. T cell responses are thought to be involved in the bodily mechanisms leading to multiple sclerosis. However, the actual T cell subsets and their antigenic targets involved in the initiation and progression of disease are not known. This is important because more specifically defining cellular disease mediators and their targets could guide more selective treatments with better safety profiles. “In contrast, current therapies for multiple sclerosis are non-selective, that is they deplete or functionally inhibit ‘normal immune cells’ as well as pathogenic cells,” says post-doctoral fellow Mukanthu Nyirenda. “This is a problem because it leads to harmful effects, limiting their use.”

Nyirenda, who works in the lab of neuroimmunologist and physician Dr. Amit Bar-Or, is exploring disease-specific T cell subsets in early-onset multiple sclerosis. Identification of disease-specific T cell subsets is key to developing highly specific therapies in MS. “It is important that my research offer a better understanding of the disease and lead to better treatments,” he says. Thanks to the Arthur Victor Movement Disorder Travel Award, Nyirenda was able to present his work at the 12th International Congress of Neuroimmunology in Mainz, Germany. “Presenting our work at this meeting gave me the chance to get valuable feedback. In addition, this conference was an excellent venue for developing a network of international contacts in neuroimmunology,” says Nyirenda. “I met many people interested in developing collaborations.”
The protein RAB13 is very important in the development of all types of cancers. "Our lab performed studies on cells grown in a cultured dish to show that RAB13 drives epithelial cells to detach and migrate away from one another – a common trait of cancer cells," explains Maria Ioannou, a doctoral student in Dr. Peter McPherson’s lab, part of The Neuro’s Neurodegenerative Disease Research Group. Working with the lab of Dr. Morag Park at McGill’s Goodman Cancer Research Centre, she used animal models to show that RAB13 did in fact drive the spread of cancer. So the challenge, then, became discovering how the RAB13 protein was activated. “These proteins cycle from an active to inactive form, so we wanted to know where and how this activation was occurring in the cell,” she says, “but no tools existed to answer this question.”

“We built a biosensor that would fluoresce one colour when RAB13 was active and another when it was inactive, so we could image living cells and see where RAB13 was being activated in the cell in real time.” This strategy led to the identification of the protein responsible for activating RAB13, and thus opens a promising research path. “We found that if we silenced RAB13 in cancer cells, we could pretty much prevent metastasis and the growth of tumours in mice,” she says.

“Support during the late stages of graduate studies allows you to complete another study and that is a huge benefit for my lab, for my career, and hopefully for science,” says Ioannou, who holds the 2015 Ann and Richard Sievers Award in Neuroscience, created by Marc Sievers, BSc (Hon)’69 and named for his parents. “I am incredibly grateful for this award.”
Student Volunteers: Bringing the Brain to Classrooms
Each year, lucky elementary and high school students across Montreal participate in BrainReach workshops, thanks to the student volunteers in McGill’s Integrated Program in Neuroscience (IPN). “BrainReach has three main objectives,” says BrainReach Elementary president Falisha Karpati, an IPN doctoral student. “We provide interactive science experiences to students in remote or under-resourced communities, we provide teachers with a network for their science inquiries by connecting them to the BrainReach committee, and we help graduate students develop teaching skills.”

The volunteers – often working in pairs – will visit the same classroom each month to discuss a different aspect of the brain. The elementary school program introduces grade four students to basic neural anatomy and the five senses, and features such activities as handling a cow brain and checking out brain tissues under a microscope. High school students in grade nine are given more advanced modules, including details about the impact of drugs on the brain. With 70 to 80 volunteers, BrainReach reaches about 1,500 students each month. “The kids absolutely love it! They are so excited whenever volunteers walk in,” says Karpati, who was herself a presenter for two years before volunteering as president of the elementary school program. “Students are always asking their teachers ‘When are we getting brain class again?’ They particularly like the interactive activities.”

BrainReach is not the only volunteer initiative to benefit from the support of IPN students. Brain Awareness Montreal (BAM) hosts an annual Brain Awareness Week during which many IPN students visit schools to introduce children to basic neuroscience and the brain. In addition, IPN students serve as presenters and guides at the BAM-sponsored Neuro Open House. “The IPN student presenters are amazing,” says BAM president Clara Bolster-Foucault. “They are dynamic and open to all kinds of questions.” The Neuro also hosts BAM’s annual Brain Bee, during which students team up with mentors who prepare them for a battle of neuroscience knowledge; the competition champion then goes on to the Canadian National Brain Bee.

Students are always asking their teachers ‘When are we getting brain class again?’ They particularly like the interactive activities.

– BrainReach Elementary president, Falisha Karpati
SUPPORT FOR RESEARCH
Developing New Therapies to Fight Brain Cancer
Compelling evidence suggests that stem cells lie at the origin of brain cancer, so in Next Generation we’re focusing on understanding how a normal brain stem cell transforms to a cancer cell.

– Dr. Kevin Petrecca
TARGiT offers a discovery validation platform for approaches developed in Next Generation. “TARGiT is that step just before the clinic, where we confirm that whatever drug we are testing, or whatever pathway we are disrupting, actually works in a model that represents the human disease,” explains Dr. Petrecca. Researchers take a mouse with no immune system, and implant a specific patient’s brain cancer cells in it. “This is the best model for brain cancer,” he says. “In this model, the cancer’s response to a medicine very closely mimics the human disease. If our discoveries work in this preclinical model of disease, then they can go on to clinical testing.”

TARGiT was launched in 2011 with support from the family and friends of Dr. Francis Boulva, and has led to the development of two medicines; the earliest phase of Next Generation started informally about two years ago, and is now growing thanks to the funds raised by the volunteer-led fundraising gala A Brilliant Night and a generous donation from the Trottier Family Foundation. “We’re just now making Next Generation a strategic priority,” explains Petrecca. “Stem cell work is expensive, and the role of philanthropy is critical. Classical funding agencies want proof of principle prior to providing support and this can stifle innovation. Philanthropy allows us to test new approaches and achieve proof of principle.”

Brain cancers are best treated by surgically removing the cancer first, but if cancer cells remain, the cancer is likely to return. Raman, a pen-sized scanner developed in the labs of Petrecca and Polytechnique Montreal collaborator Frédéric Leblond, has produced an outstanding accuracy rate in identifying cancer cells that have invaded into the brain. “It’s very precise, which is great for neurosurgical oncologists, because in surgery we don’t resect invasive cells in large sections, we do so millimetre by millimetre,” states Dr. Petrecca. The scanner offers a response in less than a second, so surgeons can use it as they operate. [See also: Michael Jermyn profile on page 4]
**A World Leader in Scientific Discovery**

- More than 50 research teams
- 56 principal investigators
- More than 100 faculty
- More than $30 million total funding: grants and contracts per year
- **Highest** publication impact for neurosciences in Canada
- McConnell Brain Imaging Centre: one of the top three brain imaging research groups in the world

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**Clinical Care Profile**

- 13 neurosurgeons
- 30 neurologists
- 300 specialized nurses and allied health care professionals
- 2,150 admissions per year
- 1,800 surgeries per year
- 28,000 neuroradiology interventions per year
- 42,000 ambulatory visits per year
- 5,300 Neuro Day Treatment Centre treatments/year
- 6,300 EEG and EMG exams per year
More than 300 trainees (postdoctoral fellows, residents and graduate students) from more than 60 different countries

More than 2,000 nurses from more than 20 countries have graduated from the Neuroscience Nursing Program, the first program of its kind in North America

The Integrated Program in Neuroscience at McGill University is North America’s largest neuroscience graduate program

15 biotechnology companies have originated from the Neuro in the last 20 years

1,443 skilled jobs have been created

More than 50 patents

114 research contracts include clinical trials helping bring new therapies to market
Taking Aim at Neuro-Motor Diseases

“We needed a space that had some magic to it, and the Reed’s gift created that magic.”

– Dr. Bernard Brais, co-director of The Neuro’s Rare Neurological Disease research group

Currently about 3,000 Canadians are living with Amyotrophic Lateral Sclerosis (ALS), also known as Lou Gehrig’s Disease. Most will die within five years of diagnosis, and only a small number will live past 10 years. After Ken Reed, founder and CEO of Tenaquip, was diagnosed with ALS, he wanted to help researchers combat this devastating neurodegenerative disease. Impressed with the care Mr. Reed received from Dr. Angela Genge and her team at the Montreal Neurological Institute and Hospital, in 2011 the Reed Family/Tenaquip Foundation made a transformative $2 million gift to create the Reed Family Motor Neuron Disease Research Unit – familiarly known as the Reed Lab.

“The Reed Lab is a wonderful, dynamic place to work,” says Dr. Bernard Brais, co-director with Dr. Eric Shoubridge of The Neuro’s Rare Neurological Disease research group. “It’s a modern, open-space lab that has allowed us to recruit new graduate and post-doctoral students, and expand our research efforts significantly.” The lab brings together the research teams of Brais, Dr. Heidi McBride and Dr. Hiroshi Tsuda. “Having an open lab where all of the groups are sharing the same space creates an intellectual ferment,” says Brais. “Other research groups also come here to do experiments and use our infrastructure. We needed a space that had some magic to it, and the Reed’s gift created that magic.”

While lab members, especially Tsuda, carry out significant ALS research and work closely with other ALS researchers at The Neuro, including Dr. Heather Durham and Dr. Shoubridge, the Reed Lab also explores other motor neuron diseases. “We are all looking at the same motor neuron, and at manifestations of diseases of their dysfunction in ALS and other hereditary diseases,” says Brais. “So looking at the range of diseases connected to this system has helped everyone to think in more global terms of how these neurons are vulnerable in different ways.”
Figuring Out the Founder Effect: The Example of ARSACS

In 2006, Sonia Gobeil and Jean Groleau discovered that their first child had a rare condition known as autosomal recessive spastic ataxia of Charlevoix-Saguenay (ARSACS), a hereditary degenerative neurological disorder that appears in childhood — usually between the ages of two and five — and progresses through adulthood, with individuals eventually requiring a wheelchair. It is also a "founder effect" disease in Quebec, meaning that its higher prevalence in the province is due to a higher carrier rate of the mutation because of the shared historical genetic pool of French-Canadians.

While the gene was cloned in 2000, it had attracted very little attention from researchers. So Groleau and Gobeil created the Ataxia Charlevoix-Saguenay Foundation in 2006 and launched fundraising activities, initially garnering about $30,000 that they directed toward Dr. Bernard Brais’ lab at The Neuro.

Nine years later, the Foundation collects more than $700,000 each year for ARSACS research. Through their initial gift, Gobeil and Groleau asked Dr. Brais to launch a collaborative team on ARSACS to better understand the disease and its associated upper motor neuron disease. From its modest start, Brais developed with Dr. Peter McPherson, also of The Neuro, and Dr. Kalle Gehring of McGill, a substantial Quebec and international research team, while always leveraging the Foundation’s continued gifts to win grants from government funding agencies.

“The goal is to build enough scientific knowledge about the disease to be able to increase public funding," he says.

Brais, who is also a historian, occupies a particular niche as a researcher-clinician interested in rare French-Canadian diseases. He has developed, over the years, a series of collaborations that have grown from the support of small disease foundations — usually created by an affected family interested in spurring research on a founder effect disease. "The diagnostic journey can be very stressful, so being able to tell people what they have always changes how they see themselves, their future, and how they can work with us to accelerate the development of better treatments," he says.

While the founder effect diseases studied in his lab are connected to Quebec, they are not diseases exclusive to the province. "ARSACS is a classic French-Canadian disease, but we now know that it is the second most common recessive ataxia in the world, a realization that has increased the visibility of our work globally. This has fostered the interest of other researchers. We now have thirty-one principal investigators around the globe working on ARSACS research." The Ataxia Charlevoix-Saguenay Foundation has also grown, and continues its essential support of ARSACS research, at The Neuro and in other institutions across Canada and the world.
Guiding the development of neurons, and recovering the functions lost in damaged nervous systems, involves learning how to build (or rebuild) complex networks of neurons linked through synaptic connections. And reconnecting or rebuilding neurons in patients is coming closer to being a medical reality, thanks to inspired efforts like those of The Neuro’s interdisciplinary Neuroengineering program.

“Building a neural network means finding a way to grow or extend a neuron to its target, which is another neuron, and then prompt them to form a synaptic connection,” says The Neuro’s Dr. Tim Kennedy, co-director (with McGill Dean of Science, Bruce Lennox) of the program. These challenges – growing the neurons and sparking the formation of synapses – provide the research focus for the program, which has benefitted from tremendous infrastructure support from Rio Tinto Alcan and Hydro Quebec, and the creation of a Neuroengineering Training Fund by the Molson Foundation.

“If we can understand the mechanisms governing neuron growth during development, perhaps we can manipulate similar mechanisms in adults with spinal cord injuries,” says Kennedy. “And for neurodegenerative diseases, if a patient has lost the function of a neural circuit, we want to restore it or enhance what remains. We basically have to grow new connections.” And that demands some technological innovation, such as building engineering tools small enough for nerve cells to respond to them.

One of Kennedy’s former doctoral students, Sébastien Ricoult, MSc’11, PhD’15, developed a technique to guide the direction of neuron growth by manipulating the density of growth promoting cues patterned on the substrate. “We can take a silicon wafer patterned with 3D features at the microlevel, and then ‘ink’ it with protein, so it becomes a kind of glorified rubber stamp. And then we stamp it onto the surface where we want to grow cells,” explains Kennedy. These microdots are small enough to be on a scale meaningful to neural cells,
which will grow along the protein map that has been inked out for them. “With this approach we can guide nerve cells that are only 10 microns across to extend in any direction we want, meaning that we can build neural circuits by mapping them onto these structures.”

Neuroengineering researchers also aim to enhance the biocompatibility of neural implants. “There has been enormous work on biocompatibility with hip joints and vascular stents, but very little on neural biocompatibility,” says Kennedy. Another of his doctoral students, Maran Ma, holder of a Molson Foundation Studentship, is applying her background in electrical engineering to the problem of bridging the gap between electrical and neurobiological systems.

“Neurons conduct signals electrically, and that seems perfect, as our technology is also electrical. Why not just plug the two together?” asks Ma, who then notes that the task is not so simple. “There are mysterious problems with the signal changing or getting weaker in amplitude.” She has recently developed two designs for neural implants: one could be inserted into the spinal cord to try to connect the stalk of an injured nerve to an electronic interface, while another involves a cortical implant made of graphene, a honeycomb lattice of carbon atoms that is also a flexible, transparent biocompatible semi-conductor. “The nervous system is completely self-contained and protected, so it’s almost impossible to try to clumsily stick electronic tools in there and expect them to work,” says Ma, who notes that eventually better materials will lead to improved results. “But until we have those materials, I want to help build systems that will improve the lives of people with nervous system injuries.”

The Science of Growing Neurons

“When you try to grow spinal cord neurons on a petri dish, they do not grow like a spinal cord. The neurons get all entangled like a bowl of spaghetti,” says Margaret Magdesian, a former neuroengineering post-doctoral fellow. “So an important part of research into neural development involves making cells grow in vitro as they do in the body.”

Magdesian, working with Physics professor Peter Grüter and other collaborators, created silicone scaffolds to grow 120 mini-spinal cords in less than one square centimeter. Her miniaturized approach can lead to an impressive reduction in costs with reagents and samples. More recently, Dr. Magdesian and collaborators used those silicone scaffolds and micromanipulation techniques to extend and connect neurons at a rate 60 times faster than current processes. “This technique opens many doors for people studying axonal growth and looking for ways to reconnect spinal cords after injury, and even in understanding how neurons communicate,” she says. Not surprisingly, the article documenting this research was selected as the Editors’ Choice when published in the January 2016 Journal of Neuroscience.

Magdesian’s innovation first attracted attention from her peers – other McGill researchers started asking her if she could make silicone moulds for them to use in their research. “Then a company asked me for 10,000 devices. But I build them by hand, and don’t have the skill or material to make more than 300 per day.” After consulting with the University, she launched a start-up, Ananda; its name is short for “advanced nanodesign applications” and is also a Sanskrit word for “bliss”. Magdesian entered her start-up idea in the 2014 Dobson Cup challenge hosted by the Desautels Faculty of Management, and was a winner in the innovation-driven enterprise category, earning seed money and extensive mentoring. In September 2015, she left McGill to run her company full time. “I could have stayed in academia, keeping these devices in my desk drawer and using them for my own research,” she says. “But after selling them for a year, I realized how many people could benefit from this technology, and how through the company I could help many more people advance their research.”

For neurodegenerative diseases, if a patient has lost the function of a neural circuit, we want to restore it or enhance what remains. We basically have to grow new connections.

– Dr. Tim Kennedy, co director of The Neuro’s interdisciplinary Neuroengineering program.
In 2015, 3,000 Canadians were diagnosed with brain cancer or cancer of the nervous system. Before entering the operating room, a neurosurgeon will typically plan the surgical approach by examining 3D models drawn from MRI scans of a patient’s skull, brain, and tumour. But there is a problem: once surgeons open the skull and cut through the dura – the brain’s tough, thick covering – the brain starts to swell. If the internal swelling becomes too great, the anaesthesiologist will make adjustments to reduce swelling and the brain will shrink. “So with the brain swelling and shrinking as much as three or four centimeters, biology throws a wrench into the works of our surgical guidance systems,” says Dr. Louis Collins, who directs the Image Processing Laboratory at The Neuro’s McConnell Brain Imaging Centre. “But we have discovered how we can address that problem.”

Collins’ team has developed a system for using an ultrasound scanner to create images of the brain cortex while the surgeons are actually operating on it. “The images are difficult to interpret on their own, so we use them only to measure how the anatomy moves,” he explains. Team members include researchers like doctoral student Ian Gerard who is supported by Brain Canada, a charitable entity that funds excellence in neuroscience research, and PhD student Simon Drouin, who developed the surgical system and is supported by NSERC (the Natural Sciences and Engineering Research Council of Canada).

“We can take the pre-operative MRI scan data and then, using fresh information from the intra-operative ultrasound and applying algorithms developed by students in my lab, we can determine how much deformation has occurred.” Collins’ system can now correct images with an accuracy of 2 mm for guidance, but the task has not been easy. “When we began working with surgeons, it would take 15 minutes to process an image, and by then surgery has advanced and the brain would have moved again,” Collins says. “Now, however, the system produces a reliable 3D image in 15 to 20 seconds. Surgeons are asking to have it in surgery, which is very flattering for us.” These successes have built a solid foundation for further research: Collins’ team is now applying the same tools and techniques to spinal surgery, with the hope of benefiting an even wider population of patients.
How can we prevent surgical errors to give patients the best possible outcome? Well, no pilot gets into an aircraft cockpit without having learned to fly the plane in a flight simulator, where their responses to emergency situations can be measured and evaluated,” says Dr. Rolando Del Maestro. So to answer the question: neurosurgery simulation.

Del Maestro directs The Neuro’s Neurosurgical Simulation Research and Training Centre, and in 2007 began working with the National Research Council Canada and a consortium of university centres to create NeuroVR. This state-of-the-art neurosurgery simulation technology helps medical students, residents, and neurosurgeons develop and hone crucial surgical skills by practicing on virtual brain tumours representing different levels of difficulty. The first NeuroVR prototype was developed in 2010, and launched, with support from a number of donors, the world’s first neurosurgical simulation centre at The Neuro.

Neurosurgery simulation promises to be especially useful for the assessment and training of residents; the simulation technology can identify neurosurgical residency applicants with differing levels of technical ability. Recent research carried out by Del Maestro’s team found that when applicants for the Neurosurgery Program were tested on the simulator, their hand dexterity clustered in definable top, middle, and bottom groups. “So we can now customize the training of applicants utilizing a system we developed called Technical Abilities Customized Training (TACT),” he says. This program maximizes individual resident bimanual training and utilizes continuously updated virtual reality simulation assessment.

Simulation training may eventually allow top residents to be fast-tracked and sent into practice quickly, cutting down on educational costs and, ideally, extending how long a neurosurgeon functions at peak performance.

Neurosurgery simulation also opens new avenues of research, such as exploring how expert surgeons actually use their technical ability to perform operations and deal with stress in the operating room. “Ultimately, we want to globalize neurosurgical operative care using simulation technology so that all the world’s neurosurgeons will be trained and verified on a simulation program such as NeuroVR,” says Del Maestro. The intended results? Improved patient outcomes. And this vision is achievable: the NeuroVR technology that The Neuro’s simulation team helped develop is now in use at over 25 training centres across the globe.
A NEW DIRECTION
in Patient Care

Transforming Care at the Bedside is embedded in what we do on a daily basis. The nurses feel at ease in encouraging change in response to patients and families, empowering everyone involved in the patient care process.

–Christine Bouchard, Neurosurgical Unit Nurse Manager

Excellence in patient care should be the goal of any health institute. So when the Transforming Care at the Bedside (TCAB) project was launched in the Montreal Neurological Institute and Hospital’s neurosurgical unit in 2010, Christine Bouchard, the unit’s nurse manager, knew the project represented a great opportunity. “We were very enthusiastic about it; we are a very dynamic team and were up for the challenge.” TCAB, an international initiative created in 2003 by the Robert Wood Johnson Foundation and the Institute for Healthcare Improvement in the United States, draws on input from patients and front-line care providers to enhance patient care, build stronger teams, and improve both patient and staff satisfaction. In the process, the nursing unit becomes a laboratory exploring avenues for improving care.

The Neuro’s neurosurgical unit was one of five selected to pilot TCAB across the McGill University Health Centre; this represented the first TCAB deployment in Canada. Six years later, Bouchard remains as enthused about the program given the results she has witnessed.

The process required firm commitment and openness from all involved. “The first year and a half saw a complete change in culture, as we had to learn from the patient representatives and they had to learn from us in order to bring ideas together to benefit patients,” says Bouchard. “Working with them was new for us, but ended up being a great experience. They would bring feedback from the patients, and we would go back to the drawing board to make sure we were meeting their needs as best we could.”

The collaborations between nursing staff and patient representatives transformed how the unit delivers care. Some changes were basic: all patient rooms have whiteboards to ensure that important information can be shared and updated easily. Other equipment was made more readily available by designating a ‘parking spot’ for commonly used devices like wheelchairs and vital signs monitors. “We have the tools we need, and don’t have to spend
time that could be directed to patient care looking for things like blood pressure machines,” says Bouchard. TCAB also led to refined processes, including daily meetings to share information between teams at shift changes and clear structures for organizing all-important family meetings. Coordinating volunteers also became an important aspect of the new approach.

“Now TCAB is embedded in what we do on a daily basis,” Bouchard says. “The nurses feel at ease in encouraging change in response to patients and families, empowering everyone involved in the patient care process.”

None of these accomplishments would have been possible without the help of philanthropic support. A generous multi-year pledge from the Roasters Foundation, alongside annual gifts from members of The Neuro’s volunteer Advisory Board, ensure that TCAB has the funding it needs to dedicate time, talent, and technology to advance this project.

The program continues to have an impact. Last year, The Neuro received provincial government accreditation for a new tertiary stroke care program, specifically for patients who have experienced a stroke in the 10 to 12 hours before arriving at the hospital. “We had very little time to establish it, but the government said it was just what they envisioned such a stroke program should be,” says Bouchard. “I believe it was so successful because we have learned so much from TCAB, and TCAB strategies have become natural for us.”

Implementing TCAB necessitated that the unit release staff from work in order to focus on finding ways to change the environment. “Without funding from the Roasters Foundation and other donors, we could not have done it,” says Bouchard. Since the initial launch in neurosurgery, TCAB’s influence has spread throughout The Neuro’s units. Bouchard concludes, “Our patient care has been transformed by this program.”

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Uniting Forces: The Neuro’s New Cambridge Collaboration

In 2014, The Neuro and the Department of Clinical Neurosciences at the University of Cambridge, including the John van Geest Centre for Brain Repair, established a new research and training partnership focusing on brain repair with the support of a generous gift from Groupe Yellow. “International collaborations are increasingly important in neuroscience,” says Dr. Stefano Stifani, The Neuro’s Associate Director of Academic Affairs. The benefits of this collaboration, for instance, include close contact between The Neuro and Cambridge that will stimulate new research collaborations while allowing young scientists to develop and learn important skills. Such partnerships also facilitate the establishment of international research teams with the potential to compete successfully for research funding in North America, Europe, and elsewhere.

The collaboration with Cambridge saw the first set of three projects launched in spring 2015, with Neuro co-Principal Investigators Drs. Tim Kennedy, Alyson Fournier, and Ed Ruthazer. Each is working with a Cambridge co-PI on projects related to brain repair. An important focus is on multiple sclerosis (MS) and the process of myelination – as MS involves a loss of myelin – and what steps might be taken to promote re-myelination.

A second cohort of projects was announced in December 2015, including one involving Stifani that focuses on the nerve cells, termed motor neurons, that degenerate in diseases like amyotrophic lateral sclerosis (ALS). One research goal: finding a way to regenerate specific types of motor neurons, starting from stem-like cells derived from individual patients.

When the research flourishes, students also benefit. “Scientists today are increasingly working as part of large networks, and it is important that trainees learn how to do this,” Stifani says. “Our collaboration gives some of our students the opportunity to go to Cambridge for extended exchanges, while Cambridge students also can come here. So they not only acquire new techniques not available at their home base, but also learn how to act as liaisons between groups.” Each project will support the exchange of at least one student per university.

“This kind of collaboration is very important for our work, so we hope it will grow,” says Stifani. “Building international relations is a high priority for The Neuro, but traditional funding bodies don’t have sufficient funding mechanisms to make them happen. For that, we really need philanthropic support.”
Not only has my research been revolutionized by the generous support from the Irving Ludmer Family Foundation – an awful lot of neuroscience research at McGill has been affected.

– Dr. Alan Evans
Not only has my research been revolutionized by the generous support from the Irving Ludmer Family Foundation— an awful lot of neuroscience research at McGill has been affected,” says Dr. Alan Evans, a James McGill Professor of Neurology and Neurosurgery, Psychiatry, and Biomedical Engineering. “We are creating an interface between neuroscience and mathematics, computer science and information technologies. This allows us to analyse the brain in ways that are common to mathematicians and physical scientists. In the process, we’re moving neuroscience out of the realm of less precise clinical language and into quantitative descriptions of brain circuitry and their genetic determinants. We aim to revolutionize how people think about the brain.”

The source of this revolution is a $4.5 million gift from the Irving Ludmer Family Foundation to create the Ludmer Centre, a virtual focal point bringing Evans’ brain imaging lab at The Neuro together with the labs of Dr. Michael Meaney, an epigenetics researcher at the Douglas Mental Health University Institute, and Dr. Celia Greenwood, a statistical geneticist at the Lady Davis Institute, the research arm of the Jewish General Hospital.

“Binding these three very different labs within a common vision means that we can capture an incredible amount of information about the relationship between genotype and phenotypes for neurological diseases and other conditions,” says Evans. While the genotype refers to all of an individual’s genes, the phenotype refers to the observable characteristics which arise from that genotype, such as an individual’s brain structure or function, or their performance on tests of behaviour, such as memory or attention. The Ludmer Centre’s goal is to be able to model the complexity of the human brain in all its dimensions— with data from as many sources as possible— with the objective of understanding precisely how the brain works, and how diseases can disrupt its workings.

“Traditional neurology and psychiatry research often goes from the gene to the clinical symptoms without necessarily understanding anything about the circuits or mechanisms in between. The Ludmer Centre allows us to develop a vision which is not psychiatry, nor neurology, nor mathematics nor computer science, but all of these,” says Evans. “It is a new engine enabling us to combine a tsunami of different kinds of data and to place it all into a common analytic framework. It’s innovative and ground-breaking.”

With close to 55 people, split between scientific researchers and IT, Evans’ lab alone is similar to a small company. And while the Ludmer Centre formally embraces only the labs of Evans, Meaney and Greenwood, dozens of other researchers across McGill are informally connected to its work, seizing the opportunity to make use of the Centre’s ideas, physical resources and lab members.