ORTHOPAEDICS

Orthopaedics researchers at Capital Health are charting a visionary course to improve patients' mobility and joint function for healthier, longer, more active lives. Their work is making a global impact.

Researchers tackle on-the-ground issues with the big picture in mind

Whether a person's physical activity is hampered by osteoarthritis or the lingering pain of a poorly healed fracture, the end result is the same. Their overall health declines and their risk of diabetes, heart disease, cancer and other chronic diseases rises.

Orthopaedics researchers at Capital Health and Dalhousie University in Halifax, NS, are global leaders in the development of new approaches to joint replacement, fracture repair and spinal surgeries. They're also on the cutting edge of a movement to prevent or delay the need for certain surgeries. Their goal: to help people stay active and healthy into old age.

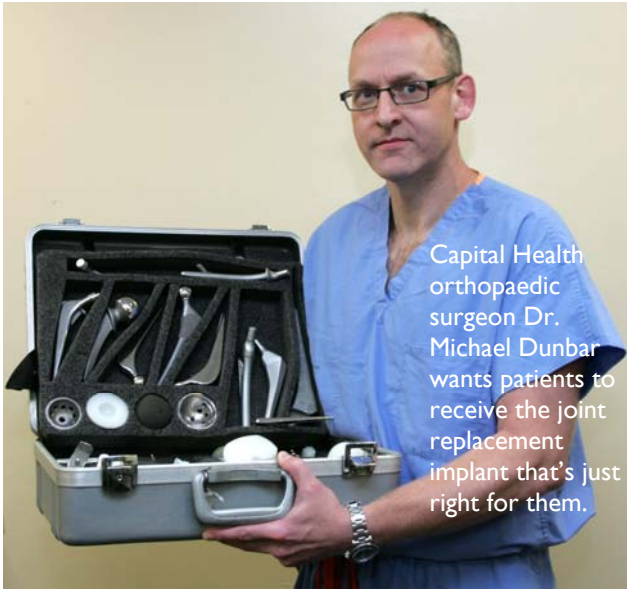
The Capital Health orthopaedics research team holds nearly eight million dollars in funding from the Canadian Institutes of Health Research, the Atlantic Innovation Fund, Capital Health Research Fund, Dalhousie Medical Research Foundation, the Nova Scotia Health Research Foundation and the Canadian Orthopaedic Trauma Association, along with substantial industry funding.

One size does not fit all in this operating room

Orthopaedic surgeons face a dizzying array of options when choosing prosthetic implants for knee replacement patients. How do they know which implant will work best in a particular patient? Or, how to place it 'just so,' to allow proper joint function and avoid a painful implant failure?

These are questions Dr. Michael Dunbar wants to answer. As director of research in the Division of Orthopaedics, Dr. Dunbar is leading a multi-faceted research program that's giving surgeons the means to make optimal prosthesis selections and placements for every patient's unique knees.

"Gender, body mass index, the quality and quantity of bone in the joint, the way a person walks… all interact with the implant and its particular design," says Dr. Dunbar. "We're developing more objective, precise and reliable measures of factors that influence implant performance—in any given patient and overall."



Capital Health orthopaedic surgeon Dr. Michael Dunbar wants patients to receive the joint replacement implant that's just right for them.

Joint replacement surgery is a saving grace for most patients, but as many as 20 per cent are not satisfied with their results. And, many implants fail within 10 years, generally due to faulty design. It can take years for the problem to be detected and meanwhile thousands of patients receive that implant.

ACOA's Atlantic Innovation Fund has awarded Dr. Dunbar $5 million to develop a multi-national RSA research program that will improve the results of joint replacement surgery worldwide. RSA—radiostereometric analysis—is an imaging technique that uses double x-rays to trace the three-dimensional motion of tiny metal beads embedded in the implant and in the bone on either side. In his study, Dr. Dunbar brings patients in for regular follow-up testing for two years after surgery to see if the implant is holding steady or wiggling ever so slightly in its place.

"Over time we've identified a pattern of stability and a pattern of continuous migration," notes Dr. Dunbar. "With RSA, we can tell within one year of surgery if an implant is likely to pass or fail the test of time. When tests show the implant is moving, we stop using that model and notify the manufacturer and our colleagues, so people stop getting implants destined to fail."

Sometimes it is not the implant but something about the person—such as their gait—that leads to implant failure. Dr. Dunbar's collaborators in Dalhousie's School of Biomedical Engineering are probing these issues (see story on page two).

Dr. Dunbar is also exploring hi-tech methods of ensuring implants are placed precisely in accordance with each patient's unique anatomy and walking mechanics: "We want to provide the best possible implant performance over the longest period of time."

Osteoarthritis of the knee: It's in the way you walk (partly)

Researchers already know that certain foot positions during walking can increase wear and tear on the cartilage of the knee, and may increase the risk of knee osteoarthritis (OA). But there are many ways of walking which also impact the mechanics of people's knees, and the state of their cartilage, over time.

Dr. Cheryl Kozey, a professor in Dalhousie's schools of physiotherapy and biomedical engineering, and her team are working with Capital Health orthopaedics researchers to learn how biomechanical and neuromuscular factors lead to OA in the knee. The researchers have been following more than 300 people—some with no symptoms, some with mild to moderate knee OA, and some who require knee replacement surgery—over the past 10 years. Their findings will lead to better results of joint replacement surgery, as well as ways to delay or even prevent the need for surgery.

"We want to understand how the cartilage destruction of OA begins and progresses, in order to find ways of managing the progression so people stay pain-free and active for as long as possible," Dr. Kozey says. "Demand for knee replacement surgery has tripled among people in their mid-40s and -50s in the past decade, and implants last less than 20 years, so we need new solutions."

The obesity epidemic is driving skyrocketing rates of OA. "Heavier people are at higher risk…their joints are bearing greater forces, which increases the rate of cartilage destruction," explains Dr. Kozey, adding that inactivity also contributes to deterioration in the joint. "People can decrease their risk by being active and maintaining a healthy weight."

But body mass does not tell the whole story. That's why Dr. Kozey and her team are using sophisticated equipment to analyze patterns of motion, forces and muscle-firing during walking. "It's the combination of motion and forces as a person walks that predicts not only who develops OA, but whose implant will fail," she says. "We're learning that the pattern of muscle firing is particularly predictive."


Dr. Kozey measures muscle-firing in study participant.

Such a finding points the way to potential solutions. "We believe that customized muscle training could be used both to delay a person's need for surgery and to prolong the life of their implant," Dr. Kozey says. "Depending on the individual, appropriate physical activity, weight loss, orthotics, braces, and other methods may also help."

For people in such pain they can't wait for an implant, Dr. Kozey's data is helping surgeons like Dr. Dunbar choose the best possible implant. She and biomedical engineer Dr. Janie Astephen-Wilson are exploring how knee implants interact with gait, motion and muscle-firing as patients walk. They've identified four distinct patterns of knee movement and which style of implant stays most stable in each. Their data is also helping surgeons place the implants for optimum long-term performance.

Pioneering cartilage regeneration

A global race for cartilage regeneration technology is underway and Capital Health is playing a key role on a leading team. Orthopaedic surgeon and professor Dr. Bill Stanish is principal investigator of a multi-national clinical trial that's testing the ability of a chitin-based gel to repair cartilage damage in the knee. "The product comes in a powder form, which we mix with the patient's own blood to form a fluid that's placed directly in the damaged area," Dr. Stanish explains. "It gels into a cartilage-like material designed to graft onto and repair the lesion."

Canadian researchers developed the technology, which has since been purchased by India-based pharmaceutical giant, Piramel Healthcare. Piramel is investing millions of dollars in clinical trials of the cartilage regeneration product. Follow-up examinations, including biopsies and MRIs, are being performed on all participating patients to determine the extent of the repair.

"It has been an extremely challenging project, involving stringent criteria and procedures, across 23 centres in Canada, Spain and Korea," notes Dr. Stanish, adding that the implications are enormous. "If we can successfully repair cartilage, we can keep people's knees and other joints working properly and may be able to avoid the need for surgery in many cases. This would be a tremendous boon, not only to these individuals but to health care systems that are staggering under the growing burden of osteoarthritis."

Treating ankle arthritis: fusion versus replacement


Elin Blondahl and Dr. Mark Glazebrook

Foot and ankle specialist Dr. Mark Glazebrook examines Elin Blondahl's ankle every year, as part of a long-term investigation of ankle replacement surgery outcomes. He replaced her worn ankle joint with a prosthetic implant in 2006, after x-rays showed she had virtually no cartilage remaining in her right ankle joint.

"The bone was rubbing on bone in my ankle," recalls Elin, who worked as an intensive care nurse at the time. "It was terribly painful; I was hobbling around and had to take time off work. I didn't know what I was going to do." Fortunately for Elin, she met the criteria for Dr. Glazebrook's study and qualified for an ankle replacement. The relief was immediate. "As soon as I recovered from the surgery, my ankle was 100 per cent pain free and fully mobile." Nothing holds her back, she says, not even cobblestones on the streets of Istanbul, where she walked for miles on a recent vacation.

Dr. Glazebrook is heading a national study to directly compare the results of ankle replacement surgery to the results of ankle fusion surgery. "Early attempts at ankle replacement surgery in the 1970s failed, so the procedure was abandoned in favour of ankle fusion, which reliably relieves pain and allows people to function," he says. "Advances in implant design and surgical techniques have since made replacements a viable way to provide better joint mobility than the fusion. We want to know how well they perform over the long term and which patients will benefit most from which procedure."

Funded by the American Orthopaedic Foot and Ankle Society and the Canadian Orthopaedic Association, the project is a prospective outcome study with a randomized, controlled trial involving six centres and approximately 400 patients across Canada.

Ankle arthritis is a significant health problem. In analyzing the national data (collected through a central database in Halifax), Dr. Glazebrook and his colleagues have found that end-stage ankle arthritis affects people's quality of life just as badly as end-stage hip arthritis. Its effect on overall health is even worse. As he says, "This study revealed why we must rigorously examine treatment options for ankle arthritis."

Preventing post-surgery blood clots

One of the greatest risks of orthopaedic surgery is venous thromboembolism—blood clots which form in the leg veins and may migrate to the lungs, creating a dangerous situation. While this risk is inherent in many surgeries, it is heightened when surgery takes place in the leg. Orthopaedics researchers have teamed up with haematologist Dr. David Anderson to see if Aspirin prevents blood clots after total hip replacement surgery as well as or better than a prescription anti-clotting drug.

On the horizon

Orthopaedics researchers at Capital Health and Dalhousie University are opening new frontiers in the realm of joint replacement surgery. New technologies at various stages of research and development include:

- porous metal implants, which bend to customize themselves to the patient's unique joint structure and mechanics
- clip-on gait analyzers, built into smart phones, which patients will take home to track their gait and feed the data back to central computers via wireless Internet; the data will help surgeons decide which implant to select and how to place it
- virtual reality software that allows surgeons to plan/practice each person's joint replacement surgery before making a real incision

Trauma research finds better ways to mend broken bones

Orthopaedic surgeons at Capital Health see 10,000 new fracture patients every year. Many of these patients have garden-variety breaks that are relatively simple to set, but many others require surgery to reposition the broken bone and hold it in place while it heals and forever after.

Capital Health orthopaedic surgeons are on the vanguard of a national research effort that's revolutionizing how many common fractures are treated. The clavicle, or collarbone, is a classic example.

"It used to be there was nothing you could do for a broken clavicle except try to reposition it externally and let it heal on its own," notes Dr. Ross Leighton, who is a leading member of the Canadian Orthopaedic Trauma Society, which organizes and funds investigator-driven clinical trials. "Through research we have proven that, when there is an overlap of the broken bone, it is far better to surgically reposition the bone and fix it in place with plates and screws. The patient is more comfortable right away and has improved long-term mobility and function in the arm and shoulder."

The Canadian Orthopaedic Trauma Society is the world leader in advancing orthopaedic trauma repair. "In 2008 we produced a third of the world's level-one evidence pertaining to fracture repair strategies and techniques," Dr. Leighton says. Based on multi-centre randomized controlled clinical trials, level-one evidence is the gold standard for evidence-based practice. And as he adds, "Halifax is one of the active contributors to the Canadian effort."

The researchers have also shown that reaming the bone to allow for larger nails provides superior healing and fewer complications in femur fractures. They are also looking into surgical solutions for fractures of the humerus bone. "We suspect that going in to reposition the bone and stabilize it with a metal plate may provide better results than a cast," says Dr. Leighton. "With this kind of research, we are able to make major gains in patient care very quickly, with reduced costs to the system."


Dr. Ross Leighton

IWK spinal surgeon collaborates with Capital Health to improve fusion results

One of Canada's top experts in spinal fusion surgery for the treatment of severe scoliosis, Dr. Ron El-Hawary performs about 70 of these day-long operations on adolescents at the IWK Health Centre every year. Now he is collaborating with Capital Health's Dr. Michael Dunbar to find a way to use RSA testing to assess and improve the results of spinal fusion surgery (refer to story on page one for more about RSA testing).

"We want to use RSA to determine the degree of 'drift' between the bone segments," says Dr. El-Hawary, explaining that the surgery involves aligning the out-of-place vertebrae, pinning them together with rods and screws, and then securing the fusion with a bone grafting material. "If there's any movement, there's a risk that the abnormal spinal curve could get bigger."

As Dr. El-Hawary explains, when an abnormal spinal curve is extreme, it places undue and potentially dangerous pressure on the heart, lungs and other vital organs and structures. "Once we have developed our methods for RSA testing, we will be able to ensure the ongoing stability of the spine," he says. "If we detect motion, we can go in and do a second surgery to reinforce and improve the fusion."

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